Making the human-machine-interface specific:
- Ethical, legal and social aspects of implants and neurobionics -

19th-21st January 2006, SCHLOSS WILKINGHEGE Münster

This joint-venture workshop from **Nanobio-RAISE** and **Nano2Life** was organised by the Centre of Bioethics at Münster University (Germany). Twenty-two international participants with interdisciplinary background (see list at the end of these minutes) stayed from 19th January until 21st January 2006 at Schloss Wilkinghege Münster (Germany) and shared their knowledge, information and opinions about the ethical, legal and social aspects in the field of nanobiotechnology.

minutes:

Lecture: *Prof. Dr. Ludwig Siep*

Ethical problems of nanobiotechnology

The meaning of ethics within the framework of ELSA (ethical, legal and social aspects) corresponds with a common understanding of ethics. This can be distinguished from the strict scientific meaning of ethics which includes scientific methods (philosophical, theological, juridical etc.). For further discourse about nano(bio)technologies (NBT), it will be necessary to have both, a broad public discussion about NBT and interdisciplinary research with the involvement of various scientists.
Part of the long term consequences of NBT are the technical developments that are to be expected in the future (e. g. self-replicating robots). This could imply changes in the human self understanding, a loss of self-control or a “machine-feeling” (e. g. brain enhancement) as well as new forms of social inequality (nano-divide, tier medicine etc.). Changes in the perception of technology and nature raises questions about the nature of NBT itself, the benefit-risk-relation and the demands on the own body ("technical perfection").
The short-term problems of NBT include different fields like clinical diagnostics, therapy and environmental issues. Clinical diagnostics might raise conflicts with informational self-determination, i. e. whether employers want to use new diagnostic procedures before engaging new staff. Prediction of diseases without therapeutic options and more commercialization of medical diagnostics (lab-on-a-chip, telemedicine) could become reality. Possible problems in the field of therapy could be the uncontrolled and damaging intrusion of nanoparticles into the human body (e. g. damaging intrusions into embryos). Uncontrolled distribution of nanoparticles could be dangerous for the environment. Considering nanoimplants, problems with unwanted interchange between material and human tissue or with the patients' autonomy (diagnostic implants) could arise in the near future. Incorporated implants could change patients' self-perception and self-understanding. Enhancement and possible social inequality might also be problematic. In the long run the problems will touch the autonomy and, concerning nanoimplants, changes in the prediction of the human body or the body as material consisting of pieces which can be replaced, and discrimination or loss of solidarity towards "imperfect" people.
The important question is, who is interested in the "nano-push"? In which direction will the industry develop (concentration, sustainability of products)? Which interests does the military have (who possesses high research budgets) and do politicians really want benefits for the public or are they more interested in prestige and influence?

Discussion:

The innovation about nano(bio)technologies:

The possibility to collect and alter data in the scaling range of nano enables progress in different fields of applications and results in a combination of sciences - and their subjects - which formerly were separated: physics, chemistry, biology, medicine, information technologies etc.. The common thing about "nano" is primarily only the range between 1-100 nm (10^{-9} m). In contrast to for example genetic engineering with its key agent DNA, the central substance of NBT is only the scale. But what is really new about this technology? Besides the new scale in the nm-range the NBT have the character of enabling technologies, which means that there will be ethical problems in the future which can not be known or even predicted at the moment. NBT are also known as converging technologies, nano- and biotechnologies as well as the information technologies and neuroscience (NBIC) could converge to a new, all-embracing science. One question is if these new technologies will result in new ethical questions. The scope and the number of specific applications will increase, but will there be a new type of ethical questions (*Grunwald*)? What about the step from µm to nm, is it really as big as it seems to be (*Hayhurst*)? But even if there are no specific and genuinely new ethical questions concerning NBT, it would not be superfluous to think about and discuss such topics.
Old questions or problems from discussions like the GM-debate (genetically modified food) are not automatically bad questions. Rather it is a precise accentuation of already known ethical, juridical and social problems in the framework of nanotechnologies and nano(bio)technologies. The underlying ethical challenge is to look at and to face the variability in the nano(bio)technologies and to keep the list of ethical questions as open as possible (*Rehmann-Sutter*).

Short- and long-term perspectives:

The temporal aspect of the technical developments (short- and long-term perspectives) itself is one point, but perhaps it should also be reasonable to give a temporal dimension to the specific application or to try an assessment of the date of realisation for a specific application (*Autiero*). Apart from that, there are questions as to how ethics should cope with a situation where it is impossible to decide which topics or applications are realistic and which are more or less "science fiction" (*Ach*). One way to solve this problem is to design scenarios. Such future-scenarios can function as models for possible realities and can help to anticipate different developments and assessments. They are of course models, certainly neither right nor wrong, but they imply the present state of knowledge and are able to influence the forming of opinions and positions (*Grunwald*). These scenarios could have two purposes: they should anticipate ELSA aspects and informing politicians or scientists about such scenarios should have positive effects on the further development of NBT (*Grunwald*).

"Precautionary principle":

The identification of ethical problems is usually connected with a precise issue. Because of this it could be possible that it is probably too late to start thinking about ethical problems when the corresponding technologies (applications) already exist. The assessment of the possible risks in the sense of a "precautionary principle" could help to avoid this situation. The "precautionary principle" can be divided into a soft and a hard one. A soft "precautionary principle" is common in science; it demands investigations about possible risks, but as long as there is no proof of an actual risk the progress of a technology should not be restricted. In contrast to that a hard precautionary principle does not allow any technical development until there is the proof of no risk at all (*Bruce*). One opinion is that risks unlike ethical aspects can usually be quantified (*Sakellaris*), the other opinion believes that the risks of nano(bio)technological developments in the future, especially their risk assessment can not be quantified, because this should also imply aspects like risk-divide, nano-divide as well as emotions, uncertainties and personal opinions of

the experts (*Hansson*). On the other side a correct risk assessment should be free of emotional aspects and the "precautionary principle" should be characterised as a risk-management (*Sakellaris*). The concept of a soft precautionary principle is sufficient if a specific action is connected with particular risks (which can be anticipated). Apart from this scientific approach to risk-assessment, which is based on the collection of data from experiments, there is also a social risk-assessment which comprises the possibility of something being perceived as dangerous (resulting in zero risk as a possible social demand) (*Hansson*).
At least for NBT no one asks for a hard "precautionary principle", because a zero-risk-politic can not be realised (*Nordmann*). This differs from the field of nanomedicine where strict (ethical) research-regularities already exist which are not very different from "the precautionary principle". These regularities require for example pre-clinical and clinical trials prior to medical use (*Siep*).

Lecture: *Prof. Dr. Christoph Rehmann-Sutter*

Extending the sensitive body - as far as the molecular world
Anthropological implications of the AFM

If simple photography already had the potential to change our visual perception, what will AFM (Atomic force microscopy) do with it? Photography can create artificial realities (e. g.: paper-clip photogram from Moholy-Nagy), light gets a tangible shape and photos can cause emotions and moods (e. g. Rebecca from Strand). The observer/voyeur point of view can differ very much, e. g. the emotionality towards the painter`s object can be influenced or even switched off e. g.: draughtsman drawing a recumbent woman from Albrecht Dürer, the painter sees his object through a grid [stares at the object] and transfers the shape of the object to a geometric grid on his canvas).
Photography developed from its early days of the camera obscura and first microscopy, which both use light to get a copy of reality, via electron microscopy (TEM: Transmission electron microscopy or REM: raster electron microscopy), to the preliminary end, the AFM. In contrast to light microscopy and photography AFM does not yield a copy of reality but makes the interactions between the tip and the surface (sample) visible. So AFM does not visualise the surface that is to be analysed, but the forces, bonds and interactions of the tip and the sample. A specific example showed a tip which formed a covalent bond with an atom taken from the surface. The AFM figures in this special case did not show the atoms of the surface which had actually been analysed but the two new orbitals of the tip.
These examples raise the question if the visual perception of the natural reality will be changed by such new possibilities in the sensual world. Three cases are made for further discussion:
firstly, there is a "paradox of the surface", i. e. AFM influences and destroys the surface it analyses, as it influences the bonds and interactions of the atoms. Secondly, AFM visualises forces between bodies (tip and sample) and creates a visionary paradigm of tactility. And thirdly nanotechnological developments like AFM - in contrast to optical methods - can bring up interactive aspects of seeing (in the sense of touching).

<u>Discussion:</u>

Role of pictures:

Which role do figures or pictures play in the domain of science? What are they able to demonstrate? Methods like AFM provide no copy of reality, the figures are the sum of the constructed and calculated experimental results. Only constructed visions are shown (*Nordmann*). What does this mean? On the one hand a scientific figure can only work as a tool and no (serious) scientist would take it for real. Pictures/figures are one hint or spot and together with all the other results they can provide an impression of the whole subject. A picture of for

example the jumping atom gives only the last missing link for its existence. Pictures/figures can help to answer a question and are therefore not right or wrong on their own. They have to be interpreted and seen in a specific context (*Eisenbarth*). Besides, these constructed figures with the appearance of a visible reality are dangerous because it is very human to think something that has once been seen can be changed or modified (Lego-argument) (*Bruce*). Another problem could be the act of seeing itself, e. g. if a medical doctor does not see the patient as a person any more because he only looks at the set of data which represents a restricted picture of the patient (*Rehmann-Sutter*).
The existing methods regarding e. g. digital photography today can manipulate pictures and figures in extreme ways. Because of this, the dividing line between fiction and reality could disappear. The problem with scientific figures/pictures is just one small part of the greater problem with the growing number of tools for picture-manipulation (*Hansson*). Despite of this there would probably be no real trouble with the line between fiction and reality. Scientists use such tools for manipulation to increase the plausibility of their experimental results. And the resulting pictures, although formally “wrong”, are often more useful, because they are more readily understood by the general public (*Nordmann*). A similar example is computer simulation. Looking at these simulations, it is always clear that they do not represent reality and even children possess a media competence that enables them to distinguish between fiction and reality. Results of several studies showed that children recognise the differences between TV, video, video games, computer games, etc. concerning imagination and the real life (*Hansson*). Nevertheless it might be a good idea to generally identify (mark) all the manipulated pictures and figures ("picture police") (*Nordmann*).

Lecture: *Prof. Dr. Eva Eisenbarth*

Nanotechnological improvements of biomaterials

Biomaterial implants like hip prostheses, dental implants or intraocular lenses have been known and used successfully for a long time. At the moment, biomaterials can be divided into four subgroups: high-tech materials in the beginning, inert substances as a next step, materials with an increasing level of biocompatibility being the latest stage of development. Biocompatibility means the ability of the material to perform with an appropriate host response in a specific application. Biomaterials must fulfil very different requirements regarding the spectrum of various applications. In some cases they have to be inert and an integration into the surrounding tissue has to be avoided, other cases require a real integration into the tissue with an intended degradation of the transplanted material. Furthermore, biomaterial should possess a mechanical toughness that allows the material to stay and function properly for a long time, in most cases for a lifetime. Another point worth mentioning is that there are requirements for the obtainability of a material and its aesthetics (e. g. dental implants). Finally, one should also keep the expenses for such a material in mind.
The development of biomaterials aims at the improvement of the interface-reaction between implant and tissue. The necessary surface modifications for this reason are classified into three domains. First the 3-D physical microarchitecture of the surface with pores or a certain degree of roughness, the second focusing on the biochemical properties like ion release, multi-layer coatings or coatings with biomolecules. The third one deals with the pysico-chemical properties of the surface like the distribution of electrical charges, wettability or conductance.
A better biofunctionality can be achieved by altering the surface topography of the implant, its composition and its physico-chemical properties. New nanotechnological methods could on the one hand help to create such surfaces and help improve the properties of the materials, for instance by decreasing the surface particle size to nm scale. On the other hand they could also be helpful in the optimisation of the interactions between implant and tissue. The ultimate goal is to

develop a tissue-engineering material that can successfully utilize the natural cell- and tissue-information system (biomimetic character) and therefore can meet higher biological demands.
Such new methods and applications might be very costly and as an unwanted result a two-tier medicine is possible. This is another aspect that should be taken into account in the discussion about nano(bio)technologies.

Lecture: *Prof. Dr. François Berger*

State of the art and connected ethical issues in human neurobionics

The human brain function is based on electrochemical communication of synapses. The complex network and its regulation is based on the integration of activating and inhibiting synapses at a electrophysical and neurochemical level. High frequency stimulation (HFS) is a good example for the progress in the field of microtechnology with prospects to nanotechnology. Neurosurgery currently applied uses electrodes which target specific brain areas. HFR of the sub-thalamus nucleus (STN) for example mimics a lesion at the stimulated position and results in a functional neuronal inhibition, in which the inhibitory effect is dependent on the applied frequency. The STN is a little target and in former times the STN of patients with Parkinson's disease was destroyed, but this practice implied the possibility to affect and destroy not only the STN but also neighbouring regions of the brain. Furthermore, the STN has additional functions e. g. limbic activity which could be influenced by the stimulation. The stimulation of patients with Parkinson's disease by HFS showed this method as a very effective treatment against tremor and other severe motor complications. HFS with its inhibitory effect can be extended to many other pathological settings like dystonia, various psychiatric disorders and for example epilepsy. Some patients showed adverse effects during HFS, e. g. one woman had transient acute depression when stimulation was delivered. When the stimulation was stopped, this effect also stopped immediately. This demonstrates how closely benefit and unwanted psychic influences on the patients are connected. Most important in this context is the reversibility of HFS and that the frequency of the stimulation is individually dependent on the patient and the disease. In addition only patients with severe features and motor complications of Parkinson's disease who gave their informed consent should be treated with HFS.
Nanotechnology will help to improve the diagnostic detection of brain disorders and can enable more specific therapeutic treatment in the future. Very small nano-instruments could reach brain areas that can not be reached today. Even nano-magnetic instruments could be possible, which arrive at their target via blood circulation and can therefore replace intracerebral electrodes.

<u>Discussion:</u>

Risk of therapy and informed consent:

How do the shown therapies deal with the risks/dangers for the patients? Is there even an abuse of patients who are at the end-stage of their diseases? Is a general justification for therapies at all possible that takes extreme risks for the patients (*Bruce*)? For the special case of the HFS it is questionable if the therapy is really more dangerous and risky than to take a tablet like Aspirin. The perceptive response of HFS is very different, because it is a physical intervention and not a medicamentous therapy (*Berger*). There might be the option to designate a tolerable range of risk (*Khushf*). Regarding the two patients who showed side effects during HFS with laughter and acute depression it could be also necessary to demand a risk-management and monitoring (*Haker*). Another point concerning the informed consent of the patient is if this consent is enough to justify such intervention like HFS, especially when the patients are in an advanced stage of their Parkinson's disease. Research collides with clinical practice, the interventions should have a substantial advantage for the patient, a mere social benefit should not be enough for the justification (*Hansson*).

treatment experiments (“Heilversuch”):

The shown HFS therapy could be seen critical because it differs from well established research ethics. The treatment with HFS can be interpreted as so called " Heilversuch", that is possible for individual patients but not for a group of patients. For this reason the ethical practice with such treatment experiments remains very uncertain. One solution to this problem could be the involvement of clinical ethics committees, who participate in the decision of the treatment experiment from case to case (*Siep*).

"Nano-divide":

Nano-based individual therapies could be associated with very high costs. The development of nanotechnological applications in the future could probably divide society into two classes (two-tier medicine) (*Nordmann*). An example for this could be tissue engineering with genetically modified individual cells. In the international point of view a "nano-divide" could become reality, the industrial countries could afford the new therapies and on the other hand the developing countries (third world countries) would not be able to pay for them.

Lecture: *Prof. Dr. Sjef Gevers*

Legal aspects

Nano(bio)technology stands for a great variety of technologies and applications, in many cases they are "enabling" and develop continuously. Law is also a complex system which connects different kinds of rules, their sources and regulation levels (national/international).
Law is interested in the effectual use, not the nature of a technology. Concerning the regulation of nanotechnological developments three possibilities are to be distinguished. First, nanotechnological applications can be accommodated well within the existing legal system like for example in the domain of medicine. Second, some applications may require additional adjustments of the law that are specificly related to nano-aspects. And third, in some cases the existing legal system is not sufficient and a revision of more general legal/societal arrangements is needed.
Legal analysis in the EGE-report (European Group of Ethics) to ICT-implants:
The report tries to identify relevant ethical issues by looking at accepted international principles like dignity, integrity of body and mind, privacy and autonomy as well as data protection. Besides generally mentioned aspects like GMP (Good medical practice), the EGE-report tries to determine other aspects concerning nano implants that could be appropriate for a legal discussion.
As to the role of the law with regard to nano-implants: there are a lot of aspects that are already regulated to some extent (e.g. regulations on manufacturing and marketing; on good medical practice with regard to implantation). Other issues deserve more consideration, e. g. the meaning of the "precautionary principle", medical issues like early detection of possible irregularities in the human body, data protection and the protection of the privacy if the implant is able to collect and/or transfer information, and issues of ownership and control. Finally, there are also relatively unexplored areas which could be appropriate for legal consideration and in which law should intervene. This includes alterations of the physical or mental facilities without a medical objective i. e. in the domain of enhancement.
A conclusion could be that law should not intervene directly with technology specific regulations. Procedural law may be more effective than substantive law in this case, soft law (not binding law, private regulations) could be better than hard law in some cases. Additionally it seems necessary and important to bring such regulations to an international level and to involve self regulatory initiatives which often can draw on a high level of expertise.

Discussion:

Patents/Patent law:

Will new inventions require new regulations/rules? Are the new nano(bio)technological inventions patentable? Will problems with licences arise with these new patents? Questions to patents are not only difficult to answer in general but we surely can expect new problems in the field of patenting law. The access to patents should be seen in the international dimension. For this reason the whole patent topic should be regulated and shifted to an international level (*Gevers*).

Legal regulations of nano(bio)technology:

Rules are normally not changed until it is really necessary, to add a new rule with every new technology is not possible. But in the final analysis, it may become inevitable to adjust existing legal arrangements to the new circumstances. Even if one tries to make the law as much independent as possible from technological innovations, one cannot anticipate all future developments (Gevers).

Lecture: *Prof. Dr. George Khushf*

Ethical issues integral to nanobiotechnological research related to the human machine interface

The human-machine-interface is a good example for a qualitative change of the possibilities to technically manipulate human beings by means of nano(bio)technologies. It is very difficult to frame the newness, because we tend to fall back on current options or to fly away to fantasy. The first task of ethics is the development of an appropriate frame for the upcoming problems. Since such framing is in a non linear social context, existing classical risk-management does not fit.

Nanotechnologies are defined in very different ways by different institutions (e. g. National Science Foundation, NSF). In addition to the scale also the functional aspects of nano(bio)technologies are crucial. Nano(bio)technologies can bridge the cleft between classical and quantum physics (mesocosmos as a transition region). They include complex concepts, the line between knowledge and doing is cancelled, the control of processes gets a new quality and the nanotechnology itself is inter- and transdisciplinary (example: viruses as containers with self-organizing ability).

If ethics is focused on near-term perspectives it is restricted to a cost/benefit assessment, if it is focused only on the long-term perspectives it could yield in just speculations about the future of humanity. For this reason it is very important to look at the mid-term perspectives which connect an integrated vision as a balancing element between what is now and what will be. The importance of the mid-term perspectives can be explained by the example of a research project at the MIT-ISN (Massachusetts Institute of Technology – Institute for soldier nanotechnologies), where scientists are developing a battlesuit that utilizes numerous features such as responsive armour, medical monitoring and various other facilities.

The publications of the research groups ("short-term-perspectives) do not show the real connecting aim but only single details. In contrast the aim of the research objective can be seen well from the description of the mid term perspectives.

The creation of human-machine-interfaces raises a lot of questions. Interfaces which act intermediary between humans and machines are developed as very small machines working in the body or for example as brain-machine-interfaces. One example for such an interface is the research work from Nicolelis who implanted sensors into the brain of a monkey, so the monkey could control the movements of the arm of a robot.

These kinds of developments could be helpful in the treatment of spinal cord injury or in the military field and besides could have a relevance in a social context for the realisation of the so called "information revolution".
The creation of a human-machine-interface is embedded into the social, cultural and historical background of our civilisation. The Cartesian tradition defines the human soul as the genuinely human element, whereas the body is not living material, like machines, the brain/mind functions as a linkage between body and soul. The new developments in the field of nano(bio)technologies can change this integrating function of the brain into a technical event. That could mean in the end that the human brain is regarded as a simple machine.
In the context of the brain-machine-interface nano(bio)technologies have an enabling character, they represent the point of convergence and are able to overcome the two dichotomies of the natural and the synthetic or the human and the mechanic.
The challenge towards ethics is the integration of the different levels of importance and to determine them as parts of the mid-term-perspectives in the research field.

<u>Discussion:</u>

Role of ethics:

Which role should ethics play, which role should ethicists play in the context of the new developments concerning nano(bio)technologies? The shown visions and utopias could be seen as a chance, an opportunity in a positive way. A technological determinism should be avoided ("progress not determinism"). The alternative way of the Amish people who reject any technological progress is only appropriate for a small community. The rest of humanity must deal with progressing developments of technology (*Khushf*). It is questionable if the known background information that are for example collected and discussed by the ethics board of Nano2Life open the opportunity of a real influence on technology (*Siep*). In general it would not be possible to say "No" to a developing technology and to stop it on a global stage. For this reason we have to take the existing utopias very seriously (*Khushf*). The role of ethics is represented in the idea of ELSA to connect ethics and technology in a way that ethics should accompany the development of technology (*Siep*). Ethical issues should be integrated into research. For this, a new configuration of research could be necessary ("convergence"). Ethics should be a real integrated component of the whole technology-development-project (*Khushf*).

Enhancement:

Enhancement is often defined as a perspective for the future. But various already existing applications can also be called enhancements. These include for example doping which is very common in the domain of competitive sports and is still considered as something that should be combated (*Berger*). Another example of existing enhancement is the field of prosthetics where research and development try not to just substitute for example a leg with something that looks like a leg, but to permit an optimum of functionality. Regarding enhancement it is therefore not questionable what “good” could be achieved but rather what would be at all possible, how far could and would we go (*Khushf*). The consequences of enhancement are manifold and affect very different spheres of life. The perception of disability and health could be changed due to the opportunity of enhancement. For this reason it is important to ask for the anthropological dimension and who we want to be respectively (*Haker*). Basically it should be kept in mind that there are always two sides, enhancement could offer advantages and disadvantages and could in the end even cause damage (*Khushf*).

Lecture: *Richard Hayhurst*

Ready to talk nano?

How can "nano" achieve a positive (appropriate) image in public? Mass media play a big role in the forming of opinion. For this reason it is very important to know the basics in handling the media. On the one hand we have scientists with media experience which is in most cases restricted to the publication of scientific results in specific papers like “Nature” or “Science”. On the other hand we have a lot of (hungry) journalists who have to care for the publication of their articles. Journalists are usually no experts in science, they need just a story (sex, scandal or personalities). To enable a good cooperation with the media it is necessary to accept this enclosed principle of publication.

Scientific research has been looked upon as something positive for a long time (technical belief). This image has changed dramatically in the last years. Now science reporting concentrates on the negative consequences and dangers or the scandals. The former technical optimism has been replaced by an almost sceptical attitude towards science. A positive attitude towards science can be observed only for example in the pre-Christmas period when the prevailing mood is positive and harmonic in general. This shows that for a publication even the point of time and the appreciation of the public mood have to be considered.

"Nano" possesses no big media presence at the moment, it is still seen as neutral and even in the scientific journalism it is not mentioned very often. Keeping the faults that were done with other scientific developments (e. g. genetic engineering, GM genetically modified) in mind, a stigmatisation of "nano" should be avoided.

To begin with, a precondition for this is to understand how media work and secondly to always keep the story-principle in mind. Perhaps the role of the bioethicists in this context could be to function as intermediaries between science and media.

<u>Discussion:</u>

How can nano(bio)technology and its results be successfully communicated to the public? A fruitful cooperation between science and media would require scientists who know about the techniques that are important for an appropriate publication (*Weltring*). The story is important, this fact is not easily understood by scientists who think that the presentation of the scientific results should be enough for a good publication (*Bruce*).

Media training could be one possibility to teach the relevant persons (i. e. scientists) to provide information to the media that do ensure both, the use in a story and correct publication in a scientific sense. In this context it is important to mention that the scientists do not want to address their information to the journalists but to the public (*Sakellaris*). Intermediaries like public relation experts could function as consultants, on the other hand journalists are more interested in real people than the PR-experts (*Bennett*).

Besides this more linear concept of cooperation, one could think about the idea of a true partnership of all parts who are involved in the opinion forming process. Opinion forming means no one way direction, nature scientists, ethicists, social scientists, lawyers and journalists in the case of nano(bio)technologies should all take part in all steps of the technological development. The aim was to create a common vision of the whole project (*Haker*). This demands a permanent dialogue and implies the interest and special facilities of all partners and necessitates the time required. On the side of the journalists there is often not even time to become acquainted with the issue to ensure an appropriate presentation. It is therefore questionable if the postulated dialogue could be realised.

Authenticity:

A very important aspect concerning the dealing with the mass media is the authenticity of the involved persons. It should always be obvious from which direction someone is acting (*Hansson*). Research scientists could not be promoters of the new technique they investigate. They would not only lose the scientific neutrality, but also the authenticity in the public. Bioethicists could function as intermediaries between science and journalists, they could not provide “The Truth” like scientific results usually claim to do, but they could define and take positions and communicate them to the public in a serious, plausible and credible way.

Recommendations for future ELSA research topics:

The workshop concluded with picking up some recommendations for future ELSA research topics. Three issues seem to be of special significance to the participants:

1) Vision assessment: What values do or rather should drive NBT? How to connect the far reaching and more or less utopian expectations in the nano-debate to the more realistic ones? The difficult task seems to be - on the one hand - to focus on specific applications of NBT and - on the other hand - not to loose sight of the long-term expectations and visions. In this regard something like "vision assessment" seems to be in order.
2) Specific ELSA-topics to be discussed are:
    - Problems of toxicity of nano-particles (in health care applications as well as in food or environmental applications): We have to face problems of safeness of nano applications and materials. In order to come to grips with them, risk assessment has to be accompanied by risk management. One question to be answered in this regard is what kind of reactions/courses of action would be appropriate (moratorium, precautionary principle)?
    - Nano-devide: There is a danger that the access to NBT could be so expensive that it could be inaccessible to certain parts of the population. This would pose new problems of equity and justice. One question to be discussed here is how to avoid the emergence of an uneven distribution of the chances and the burdens of NBT.
    - Intellectual property rights and patenting issues: Patents on NBT applications could lead to new forms of dependency from patent holders or to high costs for the use of patents, which restrict further research or the distribution of inventions. One question to be answered would be how to guarantee fair access to knowledge and information. Furthermore all the questions of the patentability of nano-particles have to be discussed.
    - Neurobionics: Changes driven by implants and human-machine interfaces might have consequences for a patients' self-feeling and self-understanding. Furthermore they pose the question of enhancement and maybe new dangers of social inequality. One point is the question what regulations regarding interventions into the human brain are necessary/appropriate?
3) Communication: How can NBT and its results be successfully communicated to the public?

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