Vision Assessment in the Field of Nanotechnology – A first Approach

Extended Abstract

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Even though Visions of future developments are widely use in (political) debates on science policy there exist very little investigation on the use, the role and the impact of visions in the field of science policy.

Introduction

The debate about Nanotechnology was accompanied from its early beginning by visions and myths comparable to the field of space flight, superconductivity, or nuclear technology. Although the entanglement of science and fiction is not as strong as it is for space flight, research policy and research founding are strongly influenced by visions and myths in the field of nanotechnology or even dominated by it. For that reason, further developments in these fields are less determined by scientific progress but by the dynamic of the debate on visions which are perceived in public. Although this relation of the debate about visions and research policy seems to be obvious it is quite difficult to determine the concrete impact of a special vision. It is not possible to measure the contribution of a certain vision to the design of a research program. To bridge this discrepancy between the obvious influence of the visions on the debate and the problem to measure their impact is the aim of vision assessment.

What is vision assessment?

The purpose of vision assessment is to disentangle meaning, use, and background of visions to understand their influence on the dynamic of a debate in a certain field.
Vision assessment can be analytically divided into several steps which are not sharply separated from each other but which serve different sub-objectives and involve different methods.[1]
Vision assessment starts with a survey of most commonly used visions in a certain field, here it is Nanotechnology (NT). In the next step these visions are analysed concerning their content, their use and role in the debate. The result of this analysis is a map of the debate where the actors, their use of the visions and the context in which they use them is summarised. A further step is the evaluation of the visions regarding their cognitive and ethical content. And finally, vision assessment addresses the question how persons and groups involved in the debate and affected by the visions should deal with them.
In this contribution we present a first approach how visions in NT could be categorized to make them accessible for a further and detailed vision assessment.

Some Remarks on NT

First we would like to summarize three aspects of NT which are important to understand the dynamic of the debate on NT.

- NT is an umbrella term. Due to the definition of NT by a specification of scale the content of what should count to NT and what not is quite fuzzy.[2]

[1] A detailed presentation of the method of vision assessment can be found in [Grin 2000], a short summery of the purposes and steps of vision assessment in [Grunwald 2004].

– NT is an enabling technology. This means that NT is only one component of a bigger system, which may give the product the crucial functionality. So, there will be many very different products for very different purposes containing the same NT.

– NT is more science than technology. Most of the concepts named by NT are in an early stage of development, some are even only concepts, most of them are in the stage of fundamental research.

Vision communicated within Nanotechnology

Different Types of Visions

There exists a broad variety to categorise the different visions, which are communicated in the field of NT. Usually the visions are distinguished by their time horizon, e.g. short term visions (up to 15 years) and long term visions (up to 50 years). Or they are distinguished by their potential for realization, realistic visions vs. unrealistic visions (utopias) (see for example [Paschen 2004]). We would like to present another categorization. The visions could be subdivided into four categories: *problem related visions, assembler based visions, visions of product improvement, and material based visions.* In Appendix 1 a selection of the most common visions communicated in the field of NT is listed and arranged according to these categories.
This categorization is not as common as those mentioned above, but it helps to analyse the visions in respect to their relation to NT, and to the direction and range of impacts, the visions deal with. Furthermore it is not feasible to distinguish the visions by there realizability. An estimation of how close the visions are to reality or even of their potential of realizability might be the result of the process of a vision assessment but can not be the starting point for an analysis. For that reason the proposed categories distinguish the visions in respect to their degree of concreteness. Although in all categories a range of concreteness could be found, the proposed classification is helpful for the ongoing analysis.

Problem Related Visions

These visions are characterized by their insensitivity to NT. Mostly, there is no connection to NT despite the fact that it is pretended that NT will solve the mentioned problem. Related to the assessment of these visions this means, that there could not be found any arguments whether these visions are realistic or not.
Evidently, the content of these visions stems from old problems of human being and often could be traced back to Christian culture. For example it is promised that due to NT blind people could be made seeing, deaf people hearing, and lame people walking.

Assembler Bases Visions

These visions starting from the existence of nano size robots (nanobots) or Drexlerian assemblers, which are molecule or cell sized machines which could build up atom by atom every thing which is desired. Assembler based visions are characterized as not being limited by any known practical constrains but only by fantasy. Even though it is obvious that these visions have no reference to real objects they are a very important part of the discussion about NT.

[2] For a detailed discussion see [Decker 2004], [Schmidt 2003]

Visions of Product Improvement

This type of visions has its starting point in already existing and often widely commercialized consumer products and predict a significant enhancement of their performance due to NT. Typical examples are computers with 100 or even 1000 times higher performance or with 100 to 1000 times more storage capacity. Other samples which are often mentioned are solar cells which will be cheaper and more efficient or even could be synthesised by printing or painting due to NT.

In contrast to problem related visions, the impact of the nanotechniques which are inherent in the respective vision of product improvement will get imaginable and is therefore accessible for a more detailed analysis.

A special group of visions which belong to the category of visions of product improvement are visions based on tiny complex systems like tiny satellites, which could be shot into space by a magnetic gun, or a lab on a chip. These visions are encouraged by the enormous developments in the microelectronic industry. They are characterized by a projection of this ability of miniaturization of systems which are at present only known from the macroscopic world. In the visions it is assumed that things like satellites, reconnaissance aircrafts, manufacturing facilities up to whole factories could be shrunken to the size of a hand or even down to several millimetres. In a certain sense these visions are half on the way to the visions based on the existence of assemblers. Furthermore these visions have strong relation to the field of robotics and artificial intelligence.

Material Based Visions

The third category of visions concerns developments in the field of materials. This category of visions is the most concrete but often leaves open what could be realized with the new material. Often it is appealed to the recipient to imagine whatever could be done with a material which is for example "*ten times stronger and a multiple lighter than steel*". In a way these types of visions are more expectations than visions, because visions stand for a more encompassing prospect in a special field or development than for an extrapolation of a special aspect. Some of these material based visions address well known demand for example a material, which combines the machinability of metal but the heat resistance of ceramic. The visionary content relies on the huge multitude of combinations of properties the new material should bring together due to NT. The impression grows that all perceivable combinations could be realized in the near future. Against that background these material based visions are quite powerful. Beside the combination of properties of existing materials this category of visions includes a group of visions which is related to the so called functionalization. This means that a given material could be improved by a treatment which leads to further functions. A good and well known example is the antireflection coating of glasses. In the context of NT there exist a lot of expectations that due to NT new functions of materials could be discovered. Often it is explicitly named, that these functions are not known at the moment, but that there will be some. To underline the potential of these kinds of visions or expectations we would like to draw your attention to the functionality of semiconducting. The functionality of semiconducting ends up momentarily with the whole world of IC-technologies. This example underlines that the visions of this category sound simple often due to their lack of concrete pictures of what could be realized by that new (functionalized) material, but with these examples in mind the huge potential of these visions is reasonable.

We would like to mention a further variation of the material based visions: smart materials. With smart or intelligent materials usually materials are meant which have in a certain extent the ability to change their properties depending on the state of the environment. Already existing examples are sunglasses which could change their transmissibility depending on the brightness of the light the glasses are exposed to. Characteristic for the visions based on smart

materials are that they are a combination of functionalization together with the use of a metaphor. The ability to react to one or more conditions of the environment in this context is named to be smart or intelligent. The use of this metaphor is an important aspect of this kind of visions. A main part of their visionary content relies on this transfer in use.

Of cause the material based visions also address problems which should be overcome. The distinction between visions which are material based improvements and problem oriented visions is not so clear. But the difference is important if one would like to estimate the quality of the vision and if the promise could really fulfilled by NT. If it is only predicted which problem will be overcome by NT the degree of speculation is much higher than for visions which explain by which material and its functionality it will overcome the problem in question.

Different Range of Impact

Even though the categorisation of the visions we have chosen is related to the different degrees of concreteness, the range of impact of the visions between and within the different categories is diverse. For example in the category of problem oriented visions there could by found visions related to very concrete problems like the desalination of see water and promises that nanotechnology will lead to more efficient desalinations systems, or visions which are related to problems like the fight against cancer and other diseases up to visions which are related to problems which are as fundamental as the problem of aging. In the category of material based visions there are concrete visions like scratch resistant coatings for acrylic glass up to the vision of a space elevator or of huge tent-like roofs which could cover whole cities.

Literature

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