Anticipating the Future of Nanotechnology:  
Some Thoughts on the Boundaries of Sociotechnological Visions

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1) Visions as a Guarantee of the Future

Nanotechnology is extremely visionary. The most significant nanotechnological innovations are expected in the coming decades. Futuristic scenarios envisaging societal applications for nanotechnological products – e.g. innovative drug delivery systems in medicine or smart devices designed for the mobile lifestyle – are communicated at the interface between science, business and the mass media. These visions function as *means of communication* (Kommunikationsmedien) which the relevant actors use not only to discuss the perceived goals, developments and uses of nanotechnology, but also to consider the opportunities and risks posed by such developments.¹ Technology assessment attaches great importance to the analysis and evaluation of nanotechnological visions, as they are considered to have a significant impact on nanoscientific and nanotechnological development strategies and to influence how nanotechnology finds its way into society (e.g. Paschen et al. 2004; Grunwald 2004).

¹ In my DFG-sponsored research project I am examining strategies of negotiating innovative medical devices in nano- and microsystems technology. The question guiding my research seeks to discover the means of communication (e.g. images, metaphors, visions) by which evidence for the novelty of a nanotechnological innovation is produced in the communication processes conducted between science, business, and the mass media. Visions can be analysed as constitutive elements of knowledge in the processes of communication and negotiation between different discursive orders (i.e. orders of knowledge). From a sociology of knowledge perspective I assume that the production of knowledge regarding the ‘new’ is only possible by recombining and creating new combinations of ‘old’ (tried and tested) elements of knowledge of discursive orders evident in academic science, business and the mass media (e.g. popular culture). Visions are hybrid forms of knowledge on which such ‘discursive innovations’ can be analysed (see also Lösch 2004).
Nanotechnological visions are quite versatile, since nanotechnology is situated at the crossroads between established technologies such as material sciences, bioengineering, information and communication technologies. Due to its multi-disciplinary nature, nanotechnology is expected to lead to continual improvements (incremental innovations) in the various disciplines through new convergences between the individual scientific and technological branches. At the same time such convergences between, for example, nanotechnology, microtechnology, biotechnology and information technology are expected to make completely new products (radical innovations) possible. With regard to the ‘societal implications’ of nanotechnology, and corresponding to this double effect, nanotechnology is expected to improve established structures and tendencies already observed during the process of implementing information technologies and biotechnologies. At the same time, the introduction of nanotechnology could have unpredictable societal implications due to the novelty of the products. On the one hand, the emphasis on nanotechnology’s innovative potential has the effect of making its future uncertain. On the other hand, the visionary predictions serve to produce certainty regarding the future. Nanotechnologies are portrayed as improvements of current technologies and products.

In reference to the history of the concept ‘future’ the following statement may be made: visions of the future structure our “horizon of expectations” by limiting the spectrum of possibilities (Kosellek 1979; cf. Hölscher 1999: 235). From this perspective visions are seen as minimalizing the complexity of an uncertain future. In addition to studies on future expectations, which mainly investigate the meaning of time-related prospects (like periodizations) in scientific technological visions, this contribution suggests shifting the emphasis to the spatial dimensions of such predictions. From this perspective expectations of the nanotechnological future construct ‘socio-technological spaces’. Nanotechnological products and uses are arranged in spaces that are simultaneously imaginary and real – the spaces are imaginary, such that they assume potential societal implications of future nanotechnologies; they are real, such that the effects of nanotechnology are described by means of spatial semantics and discursive orders that have already proven their value in describing the effects of current technologies. The envisaged products and uses are arranged

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2 In this context, the term ‘societal implication’ refers to all effects of implementing technologies which are perceived as having a societal impact, for instance, the economic, ecological, sociostructural, juridical and political consequences of a particular technology.

3 The source material on future expectations of nanotechnology as a converging technology is rich and diverse; cf. the following two reports by interdisciplinary expert groups: Roco/Bainbridge 2002; EU-HLEG 2004.
in socio-technological structures that have already been observed. Visions are the means by which the processes of communication between different social systems (science, business and the mass media) select the possible socio-technological constellations, in which nanotechnologies find their way into society.\(^4\)

This contribution seeks to explain the ‘surplus value’ of an analysis of the spatial dimensions of visions when compared to a vision assessment that is oriented on chronological dimensions. Our point of departure is the program and preliminary results of vision assessments in the technology assessment of nanotechnology. Clearly, ordering the visions according to their chronological periodizations and according to an evaluation of their epistemic status creates a dilemma for the development of normative recommendations of actions when dealing with visions.\(^5\) Consequently I suggest a non-normative study of the effectiveness of visions and, to this effect, I will explain the ‘surplus value’ of a spatially oriented observation of communicated visions. In conclusion I will explain the meaning of the perspectival shift for a vision assessment, which does not judge the visions, but uses them rather as tools for normative decisions to accept or reject specific nanotechnological products.

2) The Vision Assessment Program

The role of visions, Leitbilder (‘guiding visions’) and metaphors as constitutive for the societal implementation of new technologies has been the object of technology assessment studies oriented on leitbild-research for some time now. It is the programmatic intention to place emphasis on the necessity of researching Leitbilder and visions (cf. Mambilrey et al. 1995, Dierkes et al. 1996, Grin/Grunwald 2000). This demand is made with the justification that visions, by reason of their being a means of strategy, can influence processes of development and the socio-technological acceptance of innovations and, by reason of their being a means of communication, can form a common platform of understanding among the actors participating in the development and utilization of new technologies. Thus it is understandable why the research perspective of a vision assessment is so important for the technology assessment of future technologies.

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\(^4\) Oriented on Luhmann’s concept of the holistic distinction between medium and form in generalized symbolic means of communication, visions are seen as medium, strategies of spatial formation are seen as form (Luhmann 1998: 190ff).

\(^5\) The assessment of visions according to their epistemic status means to judge them according to their factual scientific content. During this process the ‘knowledge’ of a vision is measured according to the present state of accepted scientific knowledge.
When the demands made in this area of sociological technology research are put together, it becomes evident that researching visions of the future is relevant for technology assessment in two respects: in its function as a prospective tool, the examination of visions and the observation of the acceptance of particular visions makes it possible to assess future possibilities and risks posed by a new technology. It is possible to prepare oneself in advance for new regulatory demands. With respect to its formative intention, technology assessment can use the visions themselves as means of communication between the various actors – the engineers and technical experts, the investors, and the public – involved in the development and utilization of new technologies in order to support and encourage the desired innovative processes by means of the communicated dialogue between these actors.

In his talk on “Vision Assessment as a New Element of the Technology Futures Analysis Toolbox” Armin Grunwald from the Institute for Technology Assessment and Systems Analysis (ITAS) in Karlsruhe emphasizes a renewed relevance for the technology assessment of assessing visions, which has become particularly evident in the debates surrounding nanotechnology (Grunwald 2004). Technology assessments of nanotechnology require, so Grunwald, that previous approaches to leitbild-research be expanded analytically and methodically. In order to achieve this requirement, Grunwald has developed a program that provides for the following procedural steps: the first step is the “vision analysis”, which like discourse analysis involves the process of mapping to organize its object of study. The second step is the “vision evaluation”, which assesses the visions according to their epistemic status and normative content. The results of these two steps serve as the data basis for the third step, called “vision management”, which Grunwald describes as “a rational management of visions” (Grunwald 2004: 9f). Also included under the heading of vision management is the use of visions in technology assessments as formative actors.

Grunwald defines vision assessment as a further development of leitbild-oriented approaches in the technology assessment and distinguishes it from the use of visions in venture management. Compared to the technical Leitbilder and visions used in venture management, which are designed as praxis-related futuristic portrayals contextualizing concrete technological developments, the visions requiring analysis and assessment are characterized by their long-term status and strong speculative elements. These visions function like an intermediary between Leitbilder and science fiction stories (Grunwald 2004: 2ff, 4ff; cf. also Coenen 2004: 82ff).

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6 For the differentiation between prospective and formative functions of technology assessments, cf. the overview by Grunwald 2002.
By positioning the visions between praxis-related technical Leitbilder and the speculative scenarios of science fiction literature, Grunwald bases his vision assessment on a relatively open concept, according to which a vision can be any type of knowledge (a scientific fact, a futuristic utopia, or social, economic and technical knowledge or skills etc.). Accordingly, visions are understood to be hybrids between various forms of knowledge (e.g. natural science, industry and business, popular culture etc.).

3) Time and Truth in Nanotechnological Visions

The first identifiable results of the vision assessment in the technology assessment of nanotechnology are the remarks on “nanotechnological visions” in the report of the technology assessment project “Nanotechnology” of the Office for Technology Assessment of the German Parliament (TAB) in Berlin (Paschen et al. 2004). In this report the necessity of a “critical examination” of nanotechnological visions is recommended since it is “an important contribution to the rational and relevant discussion on the future of nanotechnology” (ibid: 20). Through critical analysis the vision assessment could, for instance, have the job of identifying exaggerated expectations and fears that might later realize themselves to be obstacles for an innovation (ibid). The analysis of widely distributed futuristic visions is particularly relevant for this task. For the technology assessment the question may be raised regarding “an appropriate method of dealing with nanofuturism” (Coenen 2004: 79).

Analytically speaking, the answer to this question is comparable to the first two steps in Grunwald’s programmatic concept, as it requires first an ordering and then an assessment of the visions. In the TA report, the first two steps are carried out simultaneously during the development of differentiating criteria. Nanotechnological visions are divided into optimistic and pessimistic, unrealistic (utopian) and realistic as well as short-term and long-term. In comparison to the utopian visions, realistic visions, as the report states, are based on “contemporary scientific findings” and “do not contradict the known natural laws” and the “structural conditions of the imagined development”. “Long-term visions encompass time frames upwards from one and a half decades, short-term visions relate to the next fifteen years at the most” (Paschen et al. 2004: 257). The visions’ formative differences on the basis of their chronological periodization are critically assessed according to their epistemic status and ethical desirability and are connected to their contents.

7 The quotes from German sources have been translated by A. Heede.
The empirical basis are the visions currently being debated by the European media, i.e. in Germany, which for the most part originated in the US American context. The dominant nanotechnological visions here are divided into two orders of discourse:

To the *first* discourse are counted realistic short-term and long-term visions in research policy, academic science, and industry which were developed in the workshops of the *National Nanotechnology Initiative (NNI)* (Paschen et al. 2004: 19f). Short-term realistic visions from the milieu of the *NNI* are, for instance, the development of synthetic inner organs, technological substitutes for sensory organs, improvement in the reliability of electronic systems by increasing the precision of manufacture, as well as textiles with innovative functions and qualities (ibid: 263). Long-term visions are the images of new possibilities for telepresence, new ways to take the edge off of aging and to improve human capabilities, innovative goal-oriented medications, and invisible artefacts for surveillance purposes (ibid: 264).^8^

The second discourse is dominated accordingly by futuristic and utopian long-term visions from milieu of Eric Drexler’s *Foresight Institute* in California (Paschen et al. 2004: 19f). A particularly good example of the sort of optimistic, unrealistic visions to be found in this “strongly futuristic”, utopian discourse are the visions of future nano machines. These so-called assemblers, whose images derive from Eric Drexler’s *Engines of Creation* (1986), could someday produce practically all macroscopic material and products by molecular manufacturing (Paschen et al 2004: 268f). Considered equally as unrealistic as these visions are those ones based on Drexler’s assembler images; to take an example, the pessimistic visions created by Bill Joy foresee the fall of man by nanomachines or nanorobots gone out of control (ibid: 273).^9^

The recommendations in the TA report for dealing with visions, i.e. “vision management”, that have resulted from these procedural steps remain ambivalent: On the one hand optimistic long-term visions could, in comparison to short-term, product-related visions, better serve to awaken an interest for nanotechnology in the areas of academic science, politics, and industry as well as among the public. In addition, this type of vision is suitable for assessing the future societal and technical implications of implementing nanotechnology and initiating a related dialogue between the participating actors. On the other hand, however, there is a danger of...

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^8^ See e.g. Roco/Bainbridge 2002; Roco/Tomellini 2002.

^9^ This vision was the subject of a debate staged in Germany in mid-2000 in the *Frankfurter Allgemeine Zeitung*, a daily newspaper which had reprinted Bill Joy’s article, originally published in *Wired* and having the title ‘Why the future doesn’t need us’ (*FAZ* 6.6.2000). A compilation of the debate is located in Schirrmacher 2001.
promoting goals that are too ambitious and thus could end in disappointment. The popularization of futuristic optimistic visions also necessarily conveys their opposites, that is, the popularization of pessimistic horror visions (Paschen et al. 2004: 20, 319; cf. Coenen 2004: 89).

The vision assessment is thus stuck in a dilemma: on the one hand, futuristic and speculative long-term visions are especially suitable, due to their effectiveness in communication processes, for a vision management. On the other hand, their use seems very problematic when viewed from a normative perspective, since these future scenarios do not orient themselves on the criterium of the scientific fact. The essential criterium of order for a vision assessment is thus the chronologically oriented distinction between short-term visions with little meaning and long-term visions with greater meaning. From a normative perspective, however, this greater meaning manifests itself as ambivalent for the prospective and formative technology assessment.10

But this ambivalence can be interpreted as the result of building the TA report on the basis of a specific analytic and methodic perspective: the connection of a mapping order according to the chronological periodization to a content-related assessment of visions according to their epistemic status. The long-term visions that are particularly effective means of communication have moved closer to the unrealistic and – normatively speaking – problematic visions. The criterium of assessment for their real content is their calculation according to the present state of scientific knowledge. The functionality of this chronological order for the vision assessment must, however, be questioned: long-term visions necessarily exceed the present state of scientific knowledge. Since they attempt to anticipate a future which cannot be certain. Present scientific knowledge can certainly be overcome in an uncertain future.

The assessment of visions according to their real or factual content does not say anything about their effectiveness in communication processes. The examination of their function as means of communication, however, was a requirement set by the leitbild-oriented technology assessment itself.

10 A survey of experts from various scientific disciplines and from industry also confirmed that the chronological periodizations of nanotechnological visions of the future correspond particularly to assessments of the visions’ feasibility or of their speculative content. See the results of the study commissioned by the BMBF entitled “Nanotechnologie pro Gesundheit 2003“ (Farkas 2004).
4) Space and Mediality of Visions

To assess the mediality of visions on the basis of their capability of influencing future scientific and technological developments and the sociotechnological acceptance of nanotechnology is not to ask about the “truths” of the visions, but about their “simple effectiveness” (Mambrey et al. 1995: 31) of meaning. Their effectiveness must be observed during the processes of communication. In determining the function of visions as intermediaries the crucial factor is not the expected feasibility of the content portrayed in the visions, rather – according to my thesis – the discursive ‘spaces of possibilities’ (Möglichkeitsräume) that are opened in the visions and in which the uncertain future of nanotechnology is connected back to the already observed sociotechnological effects of established technologies.

Comparable to the Leitbilder and metaphors as means of communication in the technosociological leitbild-research, visions can be observed as media that enable “structural connections” (in Luhmann’s sense) between functional systems of society. Thereby they can function as mediators between the various systems (Mambrey et al. 1995: 47). The visions enable this intermediary function by reason of their character as a hybrid between various orders of knowledge. That is why they can form communicative points of contact between science, business and the mass media. Through their medial function (and through their function of producing meaning), visionary anticipations of the future are of a performative and influential ‘nature’. They produce the conditions for attracting attention and gaining acceptance (Foucault 1981), which are required for the selection of preferences and evidences for specific research questions, investment decisions, and staged scenarios by the mass media. The effectiveness of visions is already evident once certain visions are communicated regularly and heaped at the interfaces of crucial functional systems – between politics, science, business, and the mass media. Empirical examples of visions that function as means of communication can also appear to be ‘unrealistic’ (if they are viewed from the perspective of science and technology): e.g. highly futuristic visions based on long-term developments like the self-sufficient medical nanorobots, which transport active agents purposefully to seats

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11 Metaphor analyses in the area of the sociology of knowledge that examine the role of metaphors in the scientific discourse regarding innovations (e.g. Maasen/Weingart 2000) take a comparable perspective.

12 With the term ‘space of possibilities’ (Möglichkeitsräume) I am referring to the attempt to cancel out the distance between past real experience and unclear future experience beyond the horizon of expectation.

13 On the performativity of the anticipations cf. e.g. Michael 2000; Konrad 2004.
of illness inside the body and carry out surgical interventions directly inside the cells.\textsuperscript{14} These visions can also be short-term: e.g. scenes seeming relatively ‘realistic’ which portray the possible integration and use of nanotechnological products in future daily life, such as biocompatible hip joints, bicycle helmets that maintain contact with the cyclists’ employers, and fabrics that are coated to resist stains.\textsuperscript{15}

Visions that are distinguished according to the structure of the TA report “Nanotechnology” as being either short-term or long-term, realistic or utopian, optimistic or pessimistic are thus equal in their analytical relevance. Their \textit{spatial} dimension is crucial. By spatial dimension I mean to refer to the make-up of the spectrum of possibilities in social spaces suggested by the visions in which the necessarily uncertain future is connected to the certainty of the present time. The question is now: with the help of which \textit{forms} is the connection made?

The history of concepts has already referred to the exclusive expressibility of time – e.g. of the future – in spatial metaphors (Kosellek 1979). Versatile studies in the area of the social science and technology research are now working with spatial metaphors like the “battle” for the “future space” (e.g. Brown et al. 2000; on nanotechnology cf. Selin 2002). More than a naked metaphor, however, space becomes comparable to a model once \textit{space constitutive strategies} like demarcation, order and distribution in space are analyzed as forms with which we are simultaneously restricted and enabled to talk about the future through the medium vision.\textsuperscript{16}

In the futuristic scenarios of medical nanotechnology there is a vision, for instance, in which nanorobots (or nanotechnological submarines) active inside the human body seem to play a functional role. The anticipated technological innovation is staged as a scene of intervention of a technical instrument in bodily spaces whose spatial boundaries and arrangements are known coordinates. In future projections concerning the use of innovative nanotechnological

\textsuperscript{14} Visualized scenarios of medical nanorobots are found in the most diverse publications, so, for instance in investment guides (e.g. Beckmann/Lenz 2002), in popular scientific magazines (e.g. \textit{Scientific American} 2/2001), in the daily press (e.g. \textit{Frankfurter Rundschau} 9.12.2003), or in medical specialist journals (e.g. \textit{Der Onkologe} 10/2001). Most of the images portraying these scenarios derive from the “Nanomedicine Art Gallery” organized by Freitas on the homepage of the US American \textit{Foresight Institute} (Freitas 2004).

\textsuperscript{15} Such scenarios are sketched, for instance, for the magazine \textit{Pictures of the Future} of Siemens AG, Munich (e.g. \textit{Pictures of the Future} 1/2003). The same scenario is also found, with only slight modifications, in an informational brochure published for school children by the \textit{BMBF} (BMBF 2004: 28 ff).

\textsuperscript{16} The space constitutive strategies of a relational arrangement and distribution are adopted from Martina Löw’s sociological concept of space (Löw 2001). This theory lays claim to the specifying of space as a means of communication and simultaneously as an analysis of social reality (ibid: 12).
materials and communication technologies in daily life, the ways of use are portrayed as distributions and arrangements in real-world spaces (e.g. street scenes in a big city).  

5) **Forms and Strategies of Visionary Spatial Construction**

Visionary scenarios may be described as strategies for the ‘colonization’ of the future (e.g. Brown et al. 2000; Selin 2002). In visionary ‘battles’ for the future, the boundaries of the possible are marked by processes of inclusion and exclusion. Metaphorically speaking, the ‘territory’ is ‘appropriated’ and ‘colonized’ by future innovations, by which I mean not only technological products, but also societal uses and their distribution in social spaces. Technological products and their societal uses are arranged and classified in spaces that are not only envisioned but also already existent. Future products and means of use are set in relation to observed, present technological and social structures and to their transformation. Three functionally dominating forms or strategies for creating space by visions can be distinguished in the discourses on the future of nanotechnology: strategies of demarcation (processes of inclusion and exclusion), strategies of spatial ordering (processes of localization and modification), strategies of distribution within space (relationship between technology and its uses).

1) To the category strategies of demarcation belong, for instance, abstract definitions of what nanotechnology is today and what it can be in the future. The space constitutive strategies serve to determine the external boundaries of spectrum of possibilities. Definitional boundaries are determined in product-related scenarios, futuristic visions or in science fiction stories. But this process of demarcation is also taking place in the EU guidelines to foster scientific advancement, in the recommendations of the VDI and in technology assessment. The establishment of differences, e.g. in the sense that nanotechnology must be distinguished from miniaturized microtechnologies or from the molecular manufacture of synthetic chemistry, can lead to the inclusion or exclusion of specific scientific disciplines or economic production sectors and thus influences the media’s perception of these disciplines and branches. There is definitional dispute concerning, for instance, whether all manufacturing processes working in an order of magnitude smaller than 100nm should be called nanotechnology; or whether the ‘label’ nanotechnology requires that the design of new structures be constructed from atoms and molecules; or whether nanotechnology must be

17 Here I am thinking of a futuristic scenario presented by Siemens AG. Cf. note 15.

18 These institutions are interested in applying different conceptual definitions to the various elements (see Decker et al. 2004: 10ff).
reserved, as Eric Drexler has implied with his visions, solely for molecular fabrications by means of nanomachines.\textsuperscript{19}

2) Strategies of future use of nanotechnological products, on the other hand, may be called strategies for manufacturing the \textit{inner spatial order} of the spectrum of possibilities. They serve to localize the means of use at specific sites with the help of portrayals of local functions and their modification. Scenarios of use compete with one another concerning, for instance, whether nanotechnology should be applied in industrial production, especially when the talk is of enhancing the precision of coating techniques; or whether new areas of production or new industrial branches should be created. With everyday technologies the strategies seek to clarify, for instance, where nanotechnological products can make everyday processes easier and more efficient; or where nanotechnological products can fully reorganize everyday activities. In the area of communication and information technologies, it is presently being debated whether nanotechnology will lead to an extension of communication networks or whether, for instance, new, direct switches between communications technologies and sense organs enable us to create new means of communication that could function as replacements for established forms of communication. In the area of medicine the interest is on determining, for instance, where nanotechnology might be applied to improve therapy and diagnosis. Will nanotechnology lead primarily to an extension of present labor diagnostics (here the keyword is ‘lab on the chip’)? Will it become possible to use nanoparticles to create completely new drug carrier systems that are able independently to seek out an accumulation of sickness in the body and then treat it with medication? Will these new medication transport systems replace or extend old diagnostic and therapeutic forms? Where will medicine otherwise primarily serve diagnostic and therapeutic goals? Where will the fields of application lie for a form of medicine that is technologically improved with respect to the human body?\textsuperscript{20}

3) Finally, visions compete for the \textit{inner distributions} of the means of use in social spaces. Here, discussions on the social opportunities and risks of nanotechnology play an important role. In the discourses concerning the ‘nano divide’ – comparable with the past debates on the ‘digital divide’ – the discussion ranges on questions like these: Which institutions, populations, groups, and individuals can and should have access to nanotechnological products? Will nanotechnology in the medical arena lead to price reductions in the public health services and thus enable equal access to the technological innovations for ‘everyone’?

\textsuperscript{19} See e.g. Drexler et al. 1991; Smalley 2001; Bachmann 2002; Jopp 2003; Boeing 2004.

\textsuperscript{20} See e.g. Drexler et al. 1991; Freitas 1999; Jopp 2003; Boeing 2004.
Will nanotechnology enable the creation of new treatment methods, which because of their cost-intensity will be available only to affluent citizens, thereby strengthening the trend toward second-class medicine? Will nanotechnological innovations sink the production costs of goods in the industrial sector so that many different population segments can be given an equal opportunity to consume nanotechnological products? Will availability be limited – from a global perspective – to the wealthy countries, while the poorer regions of the world continue to be excluded from the new production sectors? Will the nanotechnology industry create new jobs on an extensive scale? Will nanotechnological manufacturing processes lead to a continued rationalization of labor, excepting the few new jobs created for highly qualified engineers and technicians?\textsuperscript{21}

The three strategies of constructing space refer to anticipations that make the uncertain future more certain for them by negotiating nanotechnological products and means of use in comparable forms, such as was already the case in the debates in the 1980’s and 90’s regarding genetic engineering and information technologies. These strategies connect to experiences, observed sociotechnological effects of genetic engineering and information technology with the new, anticipated technological qualities and social implications of nanotechnology.

6) Societal Connections for the Nanotechnological Future

If one wants to study the effectiveness of nanotechnological visions, it is advisable to inspect the connections of ‘old’ technological and social structures and tendencies with the anticipated ‘new’ effects. These become most evident when one looks at the strategies of ‘colonization’ of the future as space. In the connection of experienced elements and anticipated elements, evidences for nanotechnology are created that produce meaning not only for science and business but also for the mass media. All three strategies (external boundaries, inner arrangements, and distribution in space) allow directive connections for scientific research questions, financial investment decisions or staging of newness by the mass media. In contrast to chronological periodizations, the spatial dimensions of the visions are more revealing since the observation of simultaneity of space makes it possible to relate the ‘uncertain’ with definite knowledge.

The observation of the accumulated communication of specific visions through science, business and the mass media allows us to make conclusions about the construction of the

\textsuperscript{21} For the discussion on the ‘nano divide’ cf. e.g. Drexler et al. 1991; Frankfurter Rundschau 3.4.2004; Paschen et al. 2004: 24, 316f.
future space, in which nanotechnology will be used. The observation also allows conclusions about dominant development strategies of social and technological implementation of nanotechnology.

The crucial significance of the visions is not, however, that they show what is possible technologically, rather they can show where technological innovations can sensibly be applied societally. In this sense, analyses of sociotechnological visions can be relevant by the very reason of their normative character. Communication through the visual medium implies that reflections on what is societally possible, what can be decided, desired, and wanted are already taking place.

7) References


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