Innovation: The European Journal of Social Science Research
Vol. 21, No. 1, March 2008, 41–64

Routledge
Taylor & Francis Group

RESEARCH ARTICLE

Convergence or mediation? Experts of vulnerability and the vulnerability of experts' discourses on nanotechnologies – a case study

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(Received 15 July 2007; final version received 10 October 2007)

Since 2004, risk in the context of nanotechnologies has been criticized as being too abstract and an all-inclusive category. Moreover, the concept of risk is not precise enough to describe the potential issues related to the development of nanotechnologies. Instead, experts on technological development emphasize risk communication. In the field of nanotechnologies, this term was redefined in February 2005 in relation to the question of societal acceptance of nanotechnologies. Risk communication is about gaining stakeholder acceptance of policy decisions, whilst the public and stakeholders are encouraged to participate actively in the communication process through public consultations or hearings. Thus, on the one hand, the category of risk has been pragmatically nuanced to better highlight the vulnerability of the communication of nanotechnologies. On the other hand, this vulnerable communication is not the result of a deficit of information. It is based on the idea of participation, where vulnerability hinges on the social groups specialized in the design, application and diffusion of nanotechnologies within society. How is such participation possible, and what does it entail? We develop this question in the framework of a comparative survey of experts in the development of nanotechnologies in Grenoble (France) and Hamburg (Germany).

Keywords: nanotechnologies; experts; region; risk; externalities; civil society; convergence; mediation

Introduction

The first studies of significance on risk communication emerged in the late 1990s (Davis 1997, Sund and Carlo 1997, Schibeci and Barns 1998) from the debates on public fears regarding the development of nuclear energy and its affiliated technologies (Webster 1991, Ohlmer 1992, Skinner *et al.* 1993, Malaver *et al.* 1999). The objective was to better understand these fears by analysing how these technologies were being represented and used, and to promote societal acceptance of nuclear energy (Bader 1993, Gutteling 1993, Quill and Suchman 1993, Urban and Hoban 1997). In the field of nanotechnologies, risk communication was introduced in February 2005 to advance societal acceptance of nanotechnologies. Nanotechnologies stress the importance of "gain[ing] stakeholder acceptance of policy decisions. It may include

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ISSN 1351-1610 print/ISSN 1469-8412 online

DOI: 10.1080/13511610802002221
http://www.informaworld.com

economic, *social and ethical values* as well as the scientific facts''.[1] In the past, ''[p]olicy-makers used to take a top-down approach to risk communication (from regulator to public), whereas a more modern approach encourages public and stakeholders to participate actively in the communication process through public consultations, hearings, etc.'' (*ibid.*). For this article, we looked at the prospect of such participation by three different types of stakeholders involved in the field of nanotechnologies, who were interviewed in Grenoble (France) and Hamburg (Germany): scientists, representatives of technological culture and representatives of civil society.[2] Given the largely unknown risks and possible dangers related to nanotechnologies, how do these experts communicate them?

This question relates to emerging studies on the ambivalence of nanotechnologies. Although nanotechnologies promise new opportunities for development and growth for contemporary societies, this does not suffice to build public trust and to foster their acceptance by society. From 2000 to 2004, consideration of society's ambivalence was largely absent from experts'' discourses on the risks of nanotechnologies, which mainly focused on the toxicity of materials being reduced to a nanometric scale.[3] Risks regarding the appropriation and inscription of these technological innovations within society were hardly mentioned.[4] Likewise, the idea of improving public information about nanotechnologies was sidelined, although the lack of such information was considerable.[5] Since 2004, however, there have been noticeable improvements. Risks of non-appropriation of nanotechnologies, or failures regarding the inscription of nanotechnologies within society, are now closely linked to missing or to inadequate communication about these technologies. Such considerations have resulted in experts on technological development paying more attention to the communication of nanotechnologies to the public, as well as to the risks related to this communication.[6] Moreover, ''risk'' has evolved to refer to the relationship between risk and danger rather than to that between risk and security. According to the systemic theories of society which emphasize the difference between risk and danger, *risk* can be defined as the uncertainty effected by an actor's decision. *Danger*, on the other hand, relates to the unforeseen damage stemming from the actor's environment.[7] For our study, we have modified the distinction between risk and danger somewhat. Instead of speaking about the uncertainty triggered by one actor's decision, we talk about *risk* in terms of the volatility of an actor's discursive position in a context in which the actor is not sure of the possible dangers nanotechnologies may pose for society once they are implemented. We use the concept of *vulnerability* to emphasize the volatility of the experts'' discursive position, and their uncertainty about the dangers of nanotechnologies. These considerations lead us to a second question which complements the first question mentioned above: how do experts assess their engagement in the process of promoting societal acceptance of nanotechnologies?

To analyse these questions, personal interviews with experts were carried out in the metropolitan regions of Grenoble (France) and Hamburg (Germany). The statements made indicate that no comprehensive evaluation of stakeholders'' perceptions on successful further development of nanotechnologies exists. While scientists and representatives of civil society prefer convergence, a result of improved information sharing, the representatives of technological culture advocate mediation as the outcome of increased public discussion.

After providing some details on the experts'' characteristics and the process of data collection, we apply the concept of danger to nanotechnologies and draw some analogies with respect to the mistrust in nanotechnologies and genetically modified organisms. The next section is devoted to the concepts of convergence and mediation, and their application to the further development of nanotechnologies. The article closes with a summary and the main results of the study.

Experts on nanotechnologies in Grenoble and Hamburg

We identify our experts as actors who regularly engage in activities that are either materially or symbolically remunerated (e.g. scientists at an organization), or who are practically involved in the field of nanotechnology on a daily basis (e.g. citizens' activists). That is, ''activity'' and ''involvement'' typify the experts we targeted. We identified three types of experts, i.e. three typical activities or characteristics of experts involved in the field of nanotechnologies in Grenoble and Hamburg. Their socio-institutional positions comprise:

- *scientists* – the developers or designers of nanotechnologies, or teams working on the methods or concepts, who support the developments of technologies at a molecular or submolecular level, i.e. persons who work primarily at scientific research and competence centres, researchers, lecturers and associated academics in the field of technical sciences, natural sciences, physics, pharmacology, life sciences and social sciences;
- *representatives of technological culture* – promoters and optimizers of nanotechnologies within society, whether they are associations for the socio-cultural valorization of the scientific and technical culture, or private or semi-public companies for the economic valorization of the development of nanotechnologies;
- *representatives of civil society* – public organizations, civilian associations or citizens' movements which stimulate the public debate about nanotechnologies.

In the following section, we provide details about the persons we interviewed in Grenoble and Hamburg, and explain their backgrounds.

Scientists

We contacted the scientific research and development centres MINATEC (Grenoble) and Hansenanotec (Hamburg), and carried out seven interviews. MINATEC is the first European institute for micro- and nanotechnologies and combines education, research and industry. It opened in June 2006 following a planning phase that began in the late 1990s. The institute is located close to the University Joseph Fournier, the Centre d'Energie Atomique (CEA) and to the Laboratoire d'Electronique de Technologie de l'Information (LETI). It includes laboratories belonging to the Centre National de la Recherche Scientifique (CNRS), such as the Observatoire des Micro- et Nanotechnologies (OMNT), and has a department for researchers in social sciences and arts (IdeasLab). In Hamburg, nanotechnologies have been developed at the Hamburg University within Hansenanotec,[8] a scientific and competence centre. It functions as a framework for scientists working in the various disciplines of the

natural sciences and physics. In May 2007, Hansenanotec was incorporated into the Interdisziplinäre Nanowissenschafts-Centrum Hamburg (INCH).

Representatives of technological culture

We conducted two interviews at CCSTI-Grenoble (Centre de Culture Scientifique, Technique et Industrielle) and at CAN-Hamburg (Centrum für Angewandte Nanotechnologie). In contrast to CAN, which is a new public company established in 2005, CCSTI has existed since 1970 and was in fact the first Centre de Culture Scientifique, Technique et Industrielle in France. It functions as a "1901" (i.e. not acquisitive) association and was founded on the initiative of the four universities of Grenoble, the research centres of Grenoble (funded by the CNRS) and the public collectivities of the region. Since 2001, it has been legally based on the Charte CCSTI.[9] This Charte describes the aims of CCSTI, which consist of diffusing and promoting technological and scientific culture within society. CAN, on the other hand, specializes in technological transfer between universities, research centres, private companies and industry. It was founded on the initiative of the region of Hamburg, the City of Hamburg, the University of Hamburg and Hansenanotec. CAN acts primarily in the area of health (polymeric nanostructures, chemical synthesis of nanotechnological products, measures of nanoparticles). It benefits from experiences such as those drawn from the NanoBioTech programme (developed in Münster between 2000 and 2004),[10] which the NanoBio-Europe programme has expanded since 2005.[11] CAN is also supported by various companies, which are legally and economically in charge, the most important of them being Beiersdorf AG, Eppendorf AG, Olympus Winter and Ibe GmbH, Evotec Technologies GmbH and Nanogate AG.[12]

Representatives of civil society

We contacted two actors involved in the public discussion on nanotechnologies, namely the association Vivagora (Paris)[13] and the opponents of nanotechnologies Pièces et Main d'Oeuvre (or PMO).[14] Vivagora is also a "1901" association. It was founded by journalists and scientists in 2003. It promotes social debates on technological innovations, particularly on nanotechnologies. PMO has drawn together a small number of French opponents to nanotechnologies in Grenoble. This group was also established by former journalists and appeared on the nanotechnology "scene" at the end of 1990. Since 2002/2003, it has abandoned its initial label Ordinary Citizen for PMO, and disassociated itself from traditional political protest movements like, e.g., ATTAC. The group has set up an online website, which its members use as a means of publicity, propaganda and communication. The members of the group remain anonymous. They rarely discuss their actions, except within the framework of more or less confidential debates organized by them.[15] PMO refused to meet us face-to-face. Nevertheless, we received some answers to our questions by email, before the group invited us to read the abundant literature accessible on their website. This last type of actor was identified in Grenoble only. In Hamburg, there is no association or group of citizens of this kind which can be clearly identified, or which stimulates public debate on nanotechnologies.[16]

In parallel, we also requested and obtained three complementary interviews at ZT-Consulting in Düsseldorf, in the buildings of the Verein Deutscher Ingenieure (VDI) attached to the German Ministry of Education and Research (BMBF), as well as an interview in Neuchâtel at the Centre Suisse d'Electronique et de Microtechnique (CSEM-SA). We do not include these talks in the present analysis of expert interviews. Our aim here is to focus only on the comparison between Grenoble and Hamburg. However, we use them in order to control the interpretation proposed below of the vulnerability of experts'' discursive position on nanotechnologies.

From fieldwork to the data

We were in close contact with the scientists, representatives of technological culture and representatives of civil society during a six-month period (from November 2006 to April 2007). Within this time frame we took up our first contacts with the experts and conducted the interviews. They were carried out face-to-face on the basis of a semi-directed questionnaire consisting of 10 questions (see the questionnaire below [Appendix A]) and which lasted about 90 minutes per expert. The interviews were recorded and we prepared a summarized feedback of the most important results of our case study.

The first question was an open one. We asked each expert to spontaneously name four or five words they associated with nanotechnologies. The purpose of this question was to better understand the basic elements of their depiction of nanotechnologies. The experts expressed their opinions freely to the other nine questions, which referred to three dimensions, namely: (a) the danger of nanotechnologies; (b) the actions the experts are involved with in the field of nanotechnologies, and (c) the reflections of the experts regarding reactions towards their own actions. These questions helped us describe each specific type of expert with reference to her implication in the design, the application and the diffusion of nanotechnologies within society. In the following enquiry, and in accordance with our main focus on the experts'' discourses on nanotechnologies and their risks, we concentrate on the first group of questions (a), and describe the corresponding results.

In order to control the comparison of the discourses of our experts, we performed a statistical analysis of the discourses collected. We drew up a list of key words appearing in all interviews, made up of words consisting of at least four letters and having been expressed three times or more. This list includes substantives, adjectives, verbs and adverbs. We excluded interjections (ah, euh, he, wow!, etc.), logical functions (and, but, then, thus, that, etc.), and typical expressions related to body language (laughter, sighs, silences, etc.).[17] This list of common key words has been used as a grid to filter and to reconstruct the clusters of the main issues and subissues attached to the experts'' discourses. We used a level of probability of $p = 0.05$ in order to build the clusters. This means that our clusters arrange words together which we can reasonably suppose belong to the same thematic context at the level of probability considered. Thus, the clusters obtained can be compared regarding their relevance in a given discourse of a given expert. This process, which consists of coupling semantic analysis and statistical control has a double advantage.

On the one hand, this enables us to correct the principal skew of our investigation related to the unequal number of interviews. Our investigation cannot avoid this

skew, which reflects the situation in Europe where there are more scientific experts than experts acting as representatives of technological culture, without taking into account the experts representing civil society who are very rare, and particularly difficult to contact.[18] Thus, if we considered only the raw data of our interviews, we would privilege the discourse of one type of actor over another. Our statistical control restores the balance, enabling us to compare the most relevant theme of each expert's discourse.

On the other hand, our method corrects a second bias which often appeared in the interview situation. It consists of identifying one expert's discourse with her type, e.g. with her socio-institutional position, and further, with her kind of activity or occupation as an expert. If we assume that there is always a "position" from which one speaks, we must also assume that this position might exist for several actors more or less independently of their activity as an expert or their affiliation to a specific socio-institutional position, e.g. their type. Conversely, actors of the same type can support very different arguments, which might even largely divert from the usual discourses and the typical viewpoints of their socio-institutional position. This is the reason why it is important to reconstruct the network of the relevant subissues related to the main ones they discuss. It enables us to better understand the experts' relationships with the interests and stakes of the discourse which they support in its complexity, without reducing it first to the interests and the stakes which they would typically assume.

We also undertook a survey of the specialized literature on the vulnerabilities of the communication of nanotechnologies, and on the analysis of these vulnerabilities. We would like to use this literature to balance the interpretation of our interviews. However, at present, nothing truly significant has been published on this topic, apart from some studies belonging to the field of risk communication and risk perception like those already mentioned above. We have extended our research to the non-specialized literature on the danger of nanotechnologies. It consists mostly of journalistic papers from professionals specializing in the fields of science and technology that have mostly been published on the Internet. Publications related to the vulnerability of the communication of nanotechnologies emerged in 2005. As a subject receiving very little prior attention, in 2005 it comprised 14% of the information collected about the danger of nanotechnologies. It contributed 18% in 2006, and 4% in the first two months of 2007. This represents an average progression of 0.8% per month compared with 2005, and 0.5% per month compared with 2006. Obviously, the information published on the danger of nanotechnologies remains the least frequently discussed issue.[19] However, compared with the other information published on this topic, it has increased the most since 2000. The experts who we contacted shared this assessment.

Danger of nanotechnologies

The experts we met speak about the danger of nanotechnologies by referring to three themes that are closely linked. The main themes concern (a) the toxicity of nanotechnologies and the evaluation of this toxicity, which is usually complemented by a discourse regarding (b) the role of expertise within the field of nanotechnologies, e.g. the identity of the expert's activity, and of himself in this field, and (c) the risks regarding the inscription of nanotechnologies in society. We first describe the main

issue of the toxicity of nanotechnologies. Then, we analyse the related subissues mentioned by the experts and the societal risk related to nanotechnologies. We present our results for the three types of actors taken together, and subsequently specify them for each type of actor.

Toxicity

Among the subissues associated with the toxicity of nanotechnologies ($n = 43$), the risks related to the implementation of nanotechnologies within society form the core, particularly the uncertainty attached to nanotechnologies themselves and to their interaction with our material environment. A representative of the technological culture summarizes this situation: "There are neither standard test systems which allow us to support the assumption that 'this is toxic, and this is not toxic', ... nor is there in the field of standards something saying what exactly nano is. And everyone can write on one's puppet 'Nano inside'". Toxicity appears to be an issue on which the experts speak with little precision. The reason they mention is the same: there is not enough reliable information available on this topic. This informational insecurity has an impact on their daily professional activity. The experts often refer to the difficulties they confront when they want to regulate the production of nanotechnologies which could be toxic. We asked a scientist about his position regarding the relationship between the possible danger of nanotechnologies and public health. He answered:

> There are two beautiful examples from last year: MagicNano, which was bought by Penny, which in turn has nothing to do with nanotechnology, and which simply is a very good cleaning agent in its liquid form for which they have a permission, thought that they also could sell it as an aerosol. But if the spread particles of this aerosol are inhaled, they cause breathing problems, and I had callers saying to me "nanotechnology is scrap". And this had in principle nothing to do with nanotechnology. In the last year, there was NeoSino, a company which produces a preparation for the building of muscles, which actually succeeded well on the market so that the company earned a lot of money, which convinced them to sell this product on their website. They maintain that there are nanoparticles in their product, which lead to the building of muscles; nobody understood how it is supposed to work, but anyway. Then, a broadcast channel did an investigation. They also came to investigate us ..., and they came up with the result that there are particles of citrine inside in different sizes, and no nanoparticles. Thus, one can drink it, it won't hurt, but it won't bring you anything, either.[20]

The question of toxicity covers 32% of all relevant main themes mentioned by the experts in their discourse at the level of probability used. In other words, it monopolizes one-third of the experts" discourse. However, the relevant subissues attached to it cover only 9% of all the associated subissues. This means there is a strong variability in the argumentation of experts about the toxicity of nanotechnologies, which can be explained on account of the impossibility for the experts to secure their communication about the danger of nanotechnologies, i.e. to rely on sufficient reliable information that enables them to clarify the relationships between toxicity, nanotechnology and (public or environmental) risks. We have come across this same result for each type of actor interviewed in both Grenoble and Hamburg.

If the scientists often speak about the toxicity of nanotechnologies, they also consider that there are lots of debates on the topic and that it is very difficult to define it with precision. Moreover, toxicity is not only a challenge for experts; it is also a societal challenge:

> Again, for me we have not to communicate in order to explain what nano is good for. This is first about understanding the world into which they pull us, and then about structuring this world. Thus, this is broader than the question of the risks, of the stuffs and the like, of the risks of toxicity, of the economic externalities, etc.

As a problem for experts, according to the scientists, toxicity supposes their intervention because they can analyse and control it. However, this is not enough to regulate the case of toxicity as a whole, which raises political questions and questions regarding public health or the management of environmental challenges. Thus, the scientists support the general tendency that leads each expert to consider toxicity as a hybrid problem of a scientific and a public nature.

The representatives of technological culture speak more and most unilaterally about toxicity. For them, the problems related to the toxicity of nanotechnologies are, and should primarily be, a concern for actors possessing adequate specialized knowledge of nanotechnologies. The representatives of civil society do not significantly address the issue of the toxicity of nanotechnologies at the given level of probability considered. This does not mean that they do not think about the dangers of nanotechnologies. They simply do not focus on toxicity when they speak about the danger of nanotechnologies. Because the danger of nanotechnologies is an important problem, the representatives of civil society consider that it goes beyond the unique problem of toxicity, involving concerns about the (scientific and collective) knowledge about nanotechnologies and the public risks. This last opinion is echoed in the discourses of all actors about the subissue of expertise.

Expertise – knowledge

Expertise is the preferred subissue that the experts speak about, associating many topics with it ($n = 177$). It supports the affirmation that any discourse on the danger of nanotechnologies requires the knowledge of the person who is talking about it. What kind of knowledge do the experts mean? Or in other words: who is considered to be an expert? Although our experts mention, above all, scientists, they do not ignore the citizens involved in the research and the distribution of information on nanotechnologies within society. Speaking about a meeting of scientific experts on nanotechnologies, a scientist stated: "For me the idea is to open and to diffuse this kind of information". The issue of expertise gives all actors the opportunity to express how they understand the construction of the scientific and of the collective knowledge.

Scientific knowledge is categorized in groups: "We set up mixed teams with experts, industrial partners ... and we are working hard at the industrial management". This process requires the organization of seminars where each expert can obtain information about progress within the various fields of nanotechnologies organized along specific themes. Another scientist comments: "One can do syntheses at the end of each meeting, one can do annual syntheses, and one can also organize

seminars which depend on the initiative of the experts when they need to summarize results.''

Collective knowledge is also seen as being categorized in groups. It emerges from public discussions and debates. The experts consider public discussions to be important in order for non-specialists and ordinary citizens to account for public decisions regarding the development of nanotechnologies. A representative of civil society told us that

> one should develop the idea of public discussion as a new media . . . , i.e. structurally, not from the viewpoint of the experts, but from the integrated pragmatic viewpoint of the *civil society* which has knowledge, and which presents the advantage of integrating these questions in a certain way, and with a view to local concerns.

A representative of technological culture summarizes these arguments with reference to the example of the relationships between nanotechnologies, economy and science:

> The work on the nanos shows the need for multiple collaborations. I do not know how that can really be translated in economic terms, at the level of the enterprises; but rather than being monocultural within a factory . . . , or within a manufacturing process of something which is a bit specialized, on the contrary, we are there, with an increasing breadth of competences, because we will need more data processing, more robotics, more biology, more chemistry.

It is not surprising to find most support for the issue of expertise among the scientists. They best exemplify the tendency shared among our experts. Their discourses cover all the dimensions mentioned above. The representatives of technological culture, on the contrary, do not follow this tendency, and do not mention it as a subissue very much. Obviously, there is expertise and there are experts on nanotechnologies, but they are not members of the scientific world or the public. They work initially in the industrial sectors, or in the strategic partners'' sectors, for example, as promoters of technical and scientific culture:

> We are the know-how optimizers for the knowledge developed at the university. What is going on within the field of cold chemistry is the domain of experts who are developing a super-knowledge, who know about the synthesis and the functioning of nano-particles, and we are there in order to facilitate that the requests of the industries are conjoined with the research of the university, and at the same time, we worry about patent evaluation and the valorization of the university, and we are reaching a point at which we can publish them by ourselves . . . Thus, I hope that regarding know-how, we are even a more reliable partner for industry than the university. We are definitely the partner for industries which are concerned with the management of projects.

The representatives of civil society speak more about expertise and the experts than the representatives of technological culture, but like the latter, they do not support the general tendency much. The question of expertise does not lead them to see the supposed danger of nanotechnologies as posing a problem only for experts and scientists: ''What gives us the right to speak is neither our job, nor our personal situation, but our quality of being anonymous, ordinary citizens, i.e. experts of our own lives''. Ordinary people have more right than anyone else to question the culture of innovation, as well as the problems resulting from it, typically the patents

published in the field of nanotechnologies or the visibility or traceability of products containing nanotechnologies.

Thus, in Grenoble as well as in Hamburg, the issue of expertise gives each actor the opportunity to describe the most important strategic partner when it comes to knowledge on the danger of nanotechnologies. For the scientists, this knowledge is a composite, taking into account the individual qualities of scientists, the upstream research results and occasionally the various forms of applied and collective knowledge. For the representatives of technological culture, this is above all an applied knowledge which one typically finds in industries and companies. They provide the means needed by the scientists in order for them to optimize the industrial culture of technical work and for the resulting products to be distributed within society in the light of science. For the representatives of civil society, knowledge must be essentially a collective good before it becomes scientific; this is a partnership which is often seen as being ambivalent. Collective knowledge has to be tied to a debate about the societal stakes of nanotechnologies. Thus, if all actors support the idea that the possible danger of nanotechnologies requires an investment in expertise, and more generally in the development of a more profound and wider knowledge of nanotechnologies, each actor tends to look for this knowledge where it is easily accessible for him, namely either in his own group, or among partners linked to his interests, and the stakes of the knowledge promoted and defended by the group. Our actors thus think that the risks related to nanotechnologies can be better discussed, particularly the societal ones.

Risks and societal vulnerabilities

The societal dimension appears in the foreground of the experts'' discourses about the subissues of the risks related to nanotechnologies, and has been detached from other topics of discussion ($n = 120$). The society of nanotechnologies "to come'' is the most frequent topic under discussion. The experts often understand it as a society defining itself outside all possible strict dichotomous differences. It can be a society of paradoxes, or a society of "the collapse of ethics'' (one representative of the civil society), i.e. a society integrating itself without reference to questions about human values and socio-cultural rules:

> There is no longer the real on the one hand, and the virtual on the other. This is clear. There is the real and the virtual, which influence each other, which are permanently bound together, which entail risks, risks of losing control, risks of the real person living entirely in the virtual world, and of the transgressing into the real while believing oneself to be in the virtual. (Scientist)

Nevertheless, the experts remain sceptical when they evaluate the utility of the category of risk used to speak about this society of nanotechnologies, even if, like this scientist, all of them stress: "We certainly need a discussion about the chances and risks of nanotechnologies, no doubt''. However, says another scientist, "at the moment, the risks are something we are not looking at, which we have not looked at yet, or at least very little. Sometimes we have an expert who brings back information to us, but in general one speaks little about it''. Other scientists reinforce this opinion, saying: "nanotechnologies and their risks, this is not the trick. What is interesting in a certain manner is not the question of the risks''. This scepticism

dominates among the representatives of civil society, expressed in almost identical terms: "I do not use the term of 'risk' . . . , the society to come is not written". If the topic of the risks related to nanotechnologies frequently appears in the discourses of the experts, and if its subissues are also numerous, its weight in the argumentation of the experts about the danger of nanotechnologies is not proportionally more important than that of the toxicity. Indeed, we observe that the subissues shared by experts when they speak about the risks of nanotechnologies account for 7% of all topics evoked at the level of probability considered. In other words, if the experts consider the risks of nanotechnologies as an important topic, they all show ambivalence in the use of this category. A representative of civil society expresses loudly what the other actors sometimes keep to themselves: "There are hardly risks, rather certainty. The use of the word 'risk' abuses the language". Does this mean that the question of the risks does not seem to be relevant for our experts?

Scientists are not far from this opinion. Although they mention the problem of risks more often than the representatives of technological culture and those representing civil society, they do it in order to better relativize its relevance. It does not make it possible to describe, nor to explore, what is at stake in the societal changes brought about by nanotechnologies: "If we remain with it, it seems that we only see things with the *lorgnette* because these technologies have such a capacity to transform our environment . . . We should not stick to the technique; instead, we have to understand its effects, and to anticipate them." In this sense, the category of "risk" is denounced as an *a priori* answer to the still largely unknown world of nanotechnologies: "Indeed, we are here in a world which is not at all logical, which is also a world of the imaginary, of belief, and actually these are joined together today". In a similar way, representatives of the technological culture do not see how the convergences of economic sectors, which nanotechnologies could support, would bear risks: "That is simply too broad. You can take each kind of industry, and you can consider each kind of possible industrial improvement, too. Finally, the question is always: does it have to stay on the market? The market decides, and that's all". Yet, the scientists, the representatives of technological culture, and those of civil society share a very similar position on the risks related to the danger of nanotechnology. For the scientists, the category of "risk" does not support a scientific examination of the impact of nanotechnologies within society. The representatives of technological culture also think that this category does not allow us to take into account the impacts of the development of nanotechnologies within economic sectors in a relevant way. The representatives of civil society claim that to speak about risks does not make possible critical questioning about the impacts of patents on innovation and about the possible restrictions of civilian and personal liberties resulting from their implementation within society.

These critical considerations about the category of "risk" result in a double strategy. On the one hand, they provide each group with the possibility of reaffirming its own interests and the stakes each one projects in the development of nanotechnologies. The representatives of technological culture highlight it more, seeing nanotechnologies as a stake of primary importance for socio-economic development. The representatives of civil society emphasize the importance of a critical look at the consequences of technological development for our society. The scientists strike the greatest balance between viewing nanotechnologies as supporting societal chance and as accelerating systemic risks. For them, the problems raised by nanotechnologies are

still largely unknown. This should be noted in order to support scientific research in this field. More generally, this relativization of the risks as a self-explaining category meets an aim which the three types of experts share. The risks, they say, do not build a framework within which one can adequately investigate and understand the possible danger of nanotechnologies. Risks have to be questioned. They have to be broken down, to be placed within society; and it is necessary to be dispassionate about it. Saying this, the experts hope to get more relevant access to the debates about the supposed danger of nanotechnologies, where the specific stakes of each actor have been preserved in order to delimit a space for possible collaborations on this topic.

Do these requirements of reliable knowledge and the transparency of actors'' involvement solve the ambivalence of the communication about nanotechnologies? This does not seem to be the case. Indeed, the three types of actors recall that nanotechnologies appear in public, where some technological innovations have bad press. The example of public mistrust in biotechnologies illustrates this. How do the experts in the fields of nanotechnologies deal with this kind of mistrust?

Mistrust in nanotechnologies – some analogies to genetically modified organisms

In an abstract and emerging field such as the field of nanotechnologies, the word "nano" tends to quickly be associated with the feeling that the miniaturization of technologies at a scale below perceptibility could be abused to manipulate citizens. This feeling is all the more present when favourable conditions for it exist. In the opinion of all experts, this gives rise to the various kinds of discourses on genetically modified organisms (GMOs).

All experts fear that the spectre of GMOs motivates public opinion to be wary of nanotechnologies or to adopt a moratorium in order to slow down or stop scientific and industrial developments in this field. This concern was expressed most vehemently in Grenoble. A scientist says:

> In order to facilitate the implantation of the nanos within society, it would be necessary to set up a certain number of operations over time, but the economic race means that this might not be done, or it will be done too late. Thus, it will be rejected at some point. At the moment, GMOs are a complete flop. At the moment, and in my opinion this has been true for a long time. It is a depiction that has been installed.

Similarly, a representative of civil society says:

> Indeed, with the GMOs I do not understand why the public authorities do not understand that the statement is that they did not sort through the information, and that we have to arm ourselves in order to sort through the information about the nanos, instead of having a boomerang effect in 2008–2009, when we will always find a bad guy, and if it is not Monsanto, it will be L'Oréal. Here it is; we got the bad guy. We see it, it is happening, see the Friends of the Earth ... they will take any pretext. The nanos will be out.

A representative of technological culture tells us a story about a biologist in a debate about GMOs and innovative technologies:

> He said "There is no observable problem, so there is no problem with GMOs", which is simply amazingly stupid ... Therefore, people are overall against GMOs, while they do

> not even know what they are talking about. After that it is impossible to make any more comparisons. It is over, because the media is already there.

A scientist summarizes this migration of the hostility towards GMOs to nanotechnologies as follows: "First, let's take the GMOs; then we take the nanos."

The discourses of our experts are echoed in the specialized literature on nanotechnologies in the past few years. The amalgam with GMOs has also been denounced by actors criticizing the development of nanotechnologies[21] and by actors supporting it.[22] All fear that this kind of amalgam will not enable us to deal with the socio-political, socio-economic and socio-cultural stakes of the development of nanotechnologies, whether they are defined in terms of opportunities or risks.[23] All of them underline the laxity of the public authorities in terms of legislation and standardization of nanotechnologies in the same terms:

> Currently, lots of debate within government and industry circles on nanotechnologies centre on avoiding a repeat of the "debacle" of the public rejection of GMOs. Despite this, no concrete legislation has been developed to manage nanotechnology's risks, and public interest in science remains seriously underfunded (Chain Reaction 2006, p. 44).

The scientists and representatives of civil society take this kind of discourse into account: "The public authorities are responsible", as one scientist tells us, and he continues:

> At the European level, there was no very clear behaviour, even other things which also allowed – things going further than they should. Thus, after a while, people got suspicious. Afterwards, if you want to work on the communication in order to say some kind words, people see you as being a liar. This is also normal, since for 50 years, they have been lied to.

A representative of civil society adds: "It is well-known that there is a necessity to do the job, and that people do not want to do it . . . , but the public authorities don't take it into account seriously."

The use of the stigmatization of public authorities is a means to call for more engagement regarding the standardization of norms related to nanotechnologies (AFNOR, ISO). Since 2004, this problem has been abundantly discussed in Europe (see Nordmann 2004, p. 39, Oud 2005, p. 38), and was recalled during the conference introducing the *Nanomonde* exhibition in Spring 2007 at the Cité de la Science in Paris (see Cité des Sciences et de l'Industrie 2007, p. 16). Standards for nanotechnologies would not only ensure the systematic control of products containing nanotechnologies, but also the regulation of economic competition in this field.[24] They do not just prevent one taking advantage of the current legal gap to test one's nanotechnological products directly on the market.[25] It is above all a means of creating a context for (technical) measurements and (socio-economic and socio-political) recommendations with which it may be possible to prevent not only the toxicity of nanotechnologies, but also the vulnerabilities of communication about it, supported by the amalgams between nanotechnologies, and other more frequently discussed innovative technologies, such as biotechnology.

This initiative is very important not only because such norms are not to be expected before 2009, but also because the standardization of nanotechnologies will increase the information available about then. This would then signify a first step in

the development of reliable knowledge and the promotion of the transparency of actors'' involvement in the fields of production and societal implementation of nanotechnologies. However, would this end the mistrust of nanotechnologies?

Convergence and mediation

The statements of the experts highlight that there is some overlap in their reasoning about the risks associated with nanotechnologies, but that some gaps exist as well. Two possible toeholds to overcome these gaps are the concepts of *convergence* (as a sort of working together; the coming together of several complementary actors within the fields of nanotechnologies) and *mediation* (as a sort of public discussion; a position between the actors involved in the fields of nanotechnologies). As will be argued below, the experts'' opinions differ with respect to these concepts.

Taken together, the experts all share the same basic elements when they discuss the problem of the danger of nanotechnologies: reliability of knowledge and transparency of actors' involvement are required. Now, the experts do not use these elements in their discourses in the same way. However, it seems that the regional anchoring of the experts does not play a discriminative role. Our results indicate that the scientists and representatives of technological culture in Grenoble express very similar views to those of their colleagues in Hamburg. This applies to all actors except for the representatives of civil society, since these were found only in Grenoble. Yet when we consider the actors in accordance with their ''type'', we observe that the scientists and the representatives of civil society support analogous arguments.

Despite the regularly mentioned example of carbon nanotubes, whose danger has been proven, the scientists underline the lack of information and of its reliability regarding the danger of nanotechnologies. It is necessary to find a solution to this problem initially within the scientific community, and thereafter this information must be disseminated within society. The representatives of civil society also underline the lack of information, and its unreliability on the danger of nanotechnologies. It is therefore necessary to familiarize citizens with nanotechnologies. They will then be able to develop their knowledge about nanotechnologies and open a dialogue with other actors involved in this field, particularly with scientists.

On the other hand, arguments of the representatives of technological culture can be distinguished from those of the scientists and of the representatives of civil society. The representatives of technological culture recall that the danger of nanotechnologies is not only a problem of knowledge about these technologies. It primarily regards the fabrication of products containing nanotechnologies. It is certainly important to improve scientific and collective knowledge about nanotechnologies. However, one should not forget the culture of technical knowledge and of work within high-tech industries and companies either. Attention should also be paid to the manufacture of technologies on the nano scale, which has to be taken into account in order to describe their impact within the economic sectors and society. Here, too, debate is important.

Consequently, since nanotechnologies unify technologies that work at the molecular scale, they are expected to have major implications for the development of industrialized economies and societies. Numerous application possibilities exist, e.g. implantation in the human body, in microelectronic components, in chemical

gases and in the atomic structure of materials. This induces untested interactions between people, social systems and material environments. In this context, nanotechnologies form part of the "converging technologies" and influence both the organization of the economic sectors diffusing them and the civil society in which they are implanted. Converging technologies not only require that the borders between established techno-industrial developments should gradually disappear, thus enabling strong interdisciplinarity.[26] They also lead to analogous linkages of various economic sectors, as well as social structures in several fields within society.[27] In other words, nanotechnologies are expected to bring the findings of science to the public in order to build a harmonized and sustainable knowledge society.

However, this opinion is quickly moderated by the majority of the experts interviewed. It already is doubtful, they say, that nanotechnologies will lead to such a strong homogenized technological network. Thus, it is all the more doubtful that the hypothetical strength of such a network would bridge the gap between science and society, and thus help to decrease the mistrust in nanotechnologies.

Once more, the scientists and representatives of civil society defend similar arguments, taking into account this gap between science and society. They share the following idea, expressed by a scientist:

> You can ask a researcher, or you do not need to ask him because he does it for himself, he is not locked up in his test tubes, he is aware of them. But you cannot ask him to explain these things to people. It is definitely not his job.

Another scientist adds: "It does not function like that. They are hyper-specialized, and they do not want to go beyond their nanometer square". For the representatives of civil society, scientific specialization has a bad image in public, related to a persistent mistrust in the sincerity of the discourse of scientists. In a symptomatic way, a representative of civil society expresses this idea, referring to the example of GMOs:

> The background of the biotech and GMOs experience . . . , the double language, the organization of debates on topics which are not at the heart of the issue, which should criticize the system, the obstruction of the discussion of real problems are basic tricks in my opinion.

These arguments reflect the importance of the reliability of information within the field of nanotechnologies in a typical way, and the communication about it. The scientists and representatives of civil society want the same thing: more reliable information, which they can trust in order to express informed recommendations, and which civil society can trust, too.

On the contrary, the representatives of technological culture do not view the reliability of information and the transparency of actors' involvement as the most important thing for a fair and trustworthy communication in the field of nanotechnologies. One representative of technological culture even denounces this idea:

> The model of communication of the science we are using is called the deficit model. It is the idea that it is necessary to inform, to inform, and to inform people until they accept other views, until they understand, and until they accept technologies, until they support the knowledge society, etc. But in fact, well, there are many studies which show that this

> model does not work, it does not work because actually the general level of knowledge of Europeans does not evolve much. There is always opposition towards GMOs. There are controversies about some technologies. There is resistance; and when one studies these people who resist, one generally realizes that they are highly accomplished persons. Actually, the more one learns, the more one doubts.

Consequently, the representatives of technological culture emphasize mediation more than convergence. Carried out by professionals in communication about nanotechnologies in order to relay their concerns, "one should simply go to the public, enter the discourses, and also engage in public communication; and in my opinion it finally always depends on what the listener retains and not on what I want to communicate". Here again, the discourse of the representatives of technological culture reflects their concern about the expression of the practical dimensions of techno-scientific culture, reflecting their concerns about the integration of industrial processes within society.

Convergence and mediation synthesize the different viewpoints of the scientists, the representatives of technological culture, and those of civil society. At the same time, they point to the challenge they share about the danger of nanotechnologies: to risk an open debate on nanotechnologies, i.e. a public discussion not only open to multiple actors, but actually requiring their collaborative engagement. For the scientists and the representatives of civil society, the idea of convergence expresses their ambivalence regarding this kind of debate, its organization, the exchange it might support between specialized knowledge and collective knowledge criticizing nanotechnologies. For the representatives of technological culture, the idea of mediation expresses the same ambivalent feeling, because for them an exchange about nanotechnologies does not only mean building a shared language in order to support a sustainable dialogue between two different forms of knowledge. More concretely, it is to communicate these forms of knowledge with the industrial cultures engaged in the practical fabrication of nanotechnologies, i.e. to find a bridge between two worlds which cannot coincide, even if they encounter and valorize each other.

The first experience of public debates on nanotechnologies at a national and an international level reinforces the ambivalence of the experts. The representatives of technological culture note that the public discussion does not seem to valorize the culture of the technical and scientific practices in the field of nanotechnologies in any decisive way. Certainly, communicating about nanotechnologies is a pragmatic way of expressing the value of this culture and favouring its transmission, but it is neither the only way, nor the simplest or best one. The scientists and representatives of civil society note the great difficulty of communicating together with scientists, industrialists, representatives of public authorities, of non-governmental organizations, and of citizens who do not necessarily know much about nanotechnologies. Incidentally, after some experience with public debates, the scientists tend to reserve their involvement all the more for the stimulation of these convergences. Indeed, they do not see how or why they should risk dealing with the collective knowledge on a subject of such great technical and scientific complexity. The representatives of civil society fear the perverse effect of the valorization of collective knowledge, leading to a cleavage in the debates, where popular wisdom favours the unilateral denunciation of technical stratagems, of the scientists as Doctor Jekyll-like, and of the work of the

industries within the field of nanotechnologies, viewed as "public enemy number one".

Eventually, convergence and mediation make the vulnerability of our experts' discursive position more acute. Indeed, the scientists, representatives of technological culture and those of civil society are not only ambivalent regarding the contents of communication about nanotechnologies. They are also ambivalent towards the modalities of the exchanges this communication could favour. These questions have been echoed in recent studies on the specialized and public debates on nanotechnologies. While mediation is often associated with the idea of a public discussion, convergence instead is coupled with the idea of "working together", of collaboration (*cum laborare*).[28] Moreover, while convergence supports a strong notion of engagement in an exchange with others, mediation is about transmitting information without noise. Nevertheless, both concepts have their own perverse effects. If mediation supports the circulation of communication as the representatives of technological culture believe, it does not automatically encourage the actors to get more involved in communication about nanotechnologies, which threatens the debate among experts and in the public realm. On the contrary, the convergence supported by scientists and representatives of civil society leads to an involvement in the debates about nanotechnologies, but this requires that communication should not be forced, i.e. to deal with people who do not want exchange about nanotechnologies, or who do not care about it, or who communicate in order to break any communication about nanotechnologies, or to make it impossible.

Conclusions

Convergence and mediation are often placed in the foreground in order to promote debates about nanotechnologies. In our interviews with three types of experts, i.e. scientists, representatives of technological culture and of civil society, the distinction between convergence and mediation appears to be less important in itself than the positions of the experts denoted by each concept when they speak about the danger of nanotechnologies. We have seen that these positions are that of engagement (scientists and representatives of civil society) and intermediation (representatives of technological culture). These are the two main forms expressing the experts'' shared ambivalence regarding the ways of communicating the danger of nanotechnologies, and of dealing with it within society. In other words, these are the two main organizing principles describing the vulnerability of the experts' discursive position on nanotechnologies in Grenoble and Hamburg. It finds its expression in typical expert questions about the kind of communication to organize, and the ways of organizing it in order to establish reliable information about nanotechnologies, to valorize the practices of the techno-scientific cultures, and to build trust within society. Could this kind of communication support multi-part engagements? Should it remain purely informational? Should it be normatively framed within a corpus of laws? Or should it rest on the initiatives of civil society, i.e. on the exchanges between experts and non-experts on nanotechnologies?

These questions might give the impression that eventually someone might reasonably doubt the reality of such communication. The experts interviewed are less pessimistic. They see the vulnerability of the communication on nanotechnologies as a necessary preamble to further implications in the expert and in the public debates

on the topic. Indeed, the scientists and the representatives of civil society do not play a conservative strategy. They do not seek to ensure their socio-institutional position only by limiting their communication to the regulation of their exchanges according to their interests and stakes. Both try to modify their individual and mutual implications in order to give another form to their understanding of convergence. Besides, they want to deal with the vulnerability of their own communication about nanotechnologies, and to avoid their specific position wielding the opposite effect, in accordance with the motto: "The more one speaks, the less one gets along with the other". In a similar way, the representatives of technological culture try to escape their position as intermediaries in order to play a more active role within the debates, which is not only about (specialized and non-specialized) knowledge, but also about (techno-scientific and industrial) practices. In other words, the experts in Grenoble and Hamburg try to use their vulnerabilities as a resource in order to find an appropriate way to collaborate, i.e. to create an exchange between convergence and mediation which could define the society of nanotechnologies to come.

Acknowledgements

This paper has benefited from discussions with participants of the workshop on Converging Science and Technologies which took place in Vienna in May 2007. We are indebted to Alfred Nordmann. Valuable comments by an anonymous reviewer are also gratefully acknowledged.

Notes

1. See <http://www.euractiv.com/en/science/risk-based-policy-making/article-133006> (all websites accessed September 14, 2007).
2. Grenoble and Hamburg offer regional similarities regarding the development of nanotechnologies. Hamburg is the second richest region in Germany (measured in GDP *per capita*) as Grenoble is in France, and both regions have a comparable socio-demographic structure. In both regions the development of nanotechnologies has been a primary interest since 2000. The governments of both regions and countries have supported the development of nanotechnologies through an active industrial policy in order to achieve ongoing regional prosperity.
3. Friedmann conducted a survey at Lehigh University on risk communication reported in newspapers and specialized periodicals in the field of nanotechnologies from 2000 to 2004, indicating that "[t]he number of newspaper articles found about health and environmental risks was low for both American and British coverage. Only 71 U.S. and 50 UK health and environmental risk articles were found between 2000 and 2004, with *The New York Times* (13) and *Washington Post* (9) running the most" (http://www.wilsoncenter.org/index.cfm?fuseaction=news.item&news_id=161177).
4. It is not sufficient to reduce the question of the vulnerabilities of nanotechnologies to questions of public health and public security, and it leads, as Jean-Pierre Dupuy suggests, "almost inevitably to mistakes" (Dupuy 2006, p. 3).
5. Friedmann's survey also states that 80% of Americans do not know anything about nanotechnologies (*ibid.*).
6. This is a new wave in studies on risks supported by analyses on both risk communication and public tolerance of innovative technologies (see e.g. Frewer *et al.* 1998, Baba 1999). These works clearly differ from usual studies on risk perception and their rationalization.
7. For a developed definition of the polarity risk/danger, see Luhmann (1991), pp. 30–31.
8. See CAN's website at <http://www.can-hamburg.de>.

9. See CCSTI-Grenoble's website: <http://www.ccsti-grenoble.org/02_institu_quinous.php>. Despite the centralist tradition dominating in France, the CCSTIs were not based on a national initiative, but instead on a local one (see the report of the French Ministry of Research: <http://www.ladocumentationfrancaise.fr/rapports-publics/064000812/index.shtml>). Because of their plurality, an association named *La Réunion* (see <http://www.ccsti.fr>) proposed in 1995 to unify the CCSTIs into one unique network. This led to the Charte CCSTI (2001), supported by the Ministry of Research (see <http://www.ccsti.fr/index.php?option=com_content&task=view&id=13&Itemid=28>).
10. The *NanoBioTech* programme developed in Münster was set up in parallel to the *CeNTech* project, which led to the establishment of the Centre of Nanotechnology supported by *tim*. This is a network of partners including the City of Münster, the chamber of commerce and industry, the University of Münster and its professional school, the Hamburger Sparkasse, and the public company Technologiepark. Münster used to serve as an example in Germany for the establishment of other similar companies such as CeNTech. CAN-Hamburg can be considered a good example. Some of its leading members were also leading members of the Technologiepark in Münster (see <http://idw-online.de/pages/de/news19950>).
11. NanoBioTech is the name of a cycle of annual international conferences which took place in Münster (see <http://www.nanobio-europe.com/programme/history-2000-prg.php?Script=1&SW=1280>). A similar cycle of conferences named *NanoBiotechnologies X-France* took place in France (Paris, 2000; Grenoble, 2003; Nice, 2005). Following an initiative of the technological pole of Münster at the end of 2003, the two cycles joined to form one unique cycle of international conferences named *NanBio-Europe* (2004). These take place in Münster once a year (see the programme of the conferences for 2007 <http://www.nanobio-europe.com/output.php?Script=1&SW=1280&CN=welcome_2007>).
12. Similarly to what was accomplished in Münster, CAN also forms bonds with partners in the economic sectors within the city of Hamburg, and actively communicates with actors supporting the life sciences in Hamburg, such as, e.g., the Hamburger Sparkasse, the Innovationsstiftung, the city's chamber of commerce and the Norgenta agency for the promotion of life sciences in north Germany. Also, some members of CAN have worked at the VDI centre, and some of them have cooperated with ZT-Consulting at VDI (see <http://www.zt-consulting.de>).
13. The website of Vivagora is <http://www.vivagora.org/>. A lot of useful information regarding the activities of the association is available, as well as several reports on the debates promoted by the association, or which it takes part in.
14. Most of the documentation produced by PMO is accessible at <http://rezal404.org/pmo/spip.php?page=plan>.
15. PMO have numerous relationships with the associative network, in the alternative and the artistic scenes within and (though to a lesser degree) outside Grenoble, such as, for example, with the Parisian association ReZal404 (<http://rezal404.org/>). Officially founded in 2003, ReZal provides PMO webspace on one of its servers. They also diffuse information through an Internet–radio programme (<http://www.radio404.org>) and a web–TV programme (<http://www.tv404.org>), as well as exhibitions and other demonstrations they organize. PMO also find relays by several other political groups that take their discourse into account, such as <http://www.rebellyon.org>, indymedia, the supporter of economic decrease, the anti/alter-mondialists or more recently the Parisian students'' group Oblomoff, who made a virulent speech against nanotechnologies at the exhibition *Nanomondes* at La Cité de la Science (Paris; see <http://paris.indymedia.org/article.php3?id_article=78307>).
16. The experts we met in Hamburg confirmed this for such as actors at Hansenanotec, who wonder why they are the only ones trying to move forward by planning the first German public debate at the end of 2007. To no avail, we also contacted the Greens in Hamburg,

ATTAC and Antifa-Hamburg (anarchists). It seems that this observation applies to Germany, which would confirm a tendency also observed at the international level: "no NGOs have as yet come out against nanotechnology as a whole, although specific elements of the risks have been highlighted" (Roco and Litten 2006, p. 9). However, there is one exception: the association Wissen Allmende (<http://www.wissensallmende.de/index.php?id=35>) in Berlin, founded by the person in charge of the branch of ATTAC-Hamburg, Oliver Moldenhauer.

17. We are looking for the depictions of actors who are deeply involved in the field of nanotechnologies, and who are used to dealing with the issue of the danger of nanotechnologies. Therefore, these elements are of less interest for our purpose.
18. This emerges from our sample in the framework of the support action FragoNano, one of the modules of the European initiative Science in Society, developed within the EC framework research programme no. 7.
19. From 2005 until 2007, the non-specialized information published on risk communication rates was about 20–25% of the total amount of non-specialized information published on the danger of nanotechnologies. Nevertheless, it is interesting to observe that the non-specialized information published on risk communication increases in a comparative way to non-specialized information published on the socio-economical and socio-cultural risks related to nanotechnologies during the same period of time (from 28 to 32% of the total amount of information). As a comparison, the non-specialized information published on the toxicity of nanomaterials and on their possible dangers for human health remains the most published topic, representing about two-thirds of the total amount of information published on the danger of nanotechnologies.
20. This same type of problem was mentioned, also, when we asked the experts about the possible danger of nanotechnologies for the natural environment.
21. See the Special Issue 97 of the ecological initiative Chain Reaction launched by the Friends of the Earth in Australia, and entitled *Size Does Matter* (2006). This gives a good overview of the information on the relationships between GMOs and nanotechnologies, which is considered to be too fragmented and not reliable enough. Some statements can be found in this report about the relationships between nanotechnologies and nuclear research, or nanotechnologies and social surveillance.
22. See the report of the National Risk on Governance Council *Survey on Nanotechnology Governance*, edited by Roco and Litten (2006). See also the report of the 4th European Forum on Nanotechnologies, which states: "Fears which emerge must be calmed by implementing a real discussion between the different actors. The dialogue between scientists and the general public must avoid past mistakes, as was the case for GMOs, where the absence of distinction between various techniques, contempt of information and an incomplete study of the risks, legitimately caused a massive rejection by the general public and a great mistrust with respect to the 'agro-business' 90" (European Nanotechnology Gateway 2005, p. 37).
23. The ethical committee of UNESCO on nanotechnologies expressed this concern openly, and in relationship with GMOs, when its members met in Paris in July 2005: "It was also said that the scenario that was presented seems so scary that public opinion may be mobilized against nanotechnology, like with GMOs, preventing possible benefits. Is this technology intrinsically dangerous or is it only its possible use? One should avoid that some sort of paranoia prevents public benefits. Mr. Gordijn emphasized the strong influence of the gray-goo scenario in the public debate, despite its recognized obsolescence. Even if it was possible, molecular engineering in other ways would be more efficient. Some publications such as the novel Pray had a huge influence anyhow, as had already been the case with genetics" (UNESCO 2005, p. 4).
24. At the moment, as one of the scientists highlights, economic competition in the fields of nanotechnologies is anything but transparent: "A lot of enterprises do not want people to

communicate about their presence here ... just because it would be information for the competitors. I am speaking about enterprises which are not known to play an active role within the fields of micro- and nanotechnologies. In order to live happy, let us live hidden; it is not useful to tell the competition this, ah, yes, this is not so dumb ... And within the same structure ... you can obviously not meet the individuals, but two enterprises in competition, you can obviously not speak about a common topic, because you have to be honest, but without one knowing that the other is present in the cycle''.

25. A representative of civil society makes that point as follows: ''One very well knows ... who is currently producing these carbon nanotubes in the South-East, thus, they put them on the market as synthetic graphite, and this is the illustration that indeed, something is put on the market before it has been monitored ... 10 tonnes in a year, 10 tonnes in a year of carbon nanotubes''.
26. A scientist says: ''There is a concept of convergence which is typical in science, too; e.g. there are scientific disciplines which are continually getting closer to each other. At a nano scale, the concepts are increasingly, let's say the boundaries are increasingly blurred, and it is now possible to collaborate in a very productive scientific way''. In the same way, a representative of technological culture states: ''Actually, once we are at the nano scale, we realize that we maybe can bring about a convergence of some technologies and some concepts from the life sciences, the chemical sciences, the physical sciences, informatics, robotics, etc.'' A representative of civil society tells us that he got involved in the field of nanotechnologies because he was fascinated by the idea of convergence: ''We were looking at the nanotechnologies because we realized that the issue of convergence should really be to deepen in its reliability, and at the same time in its ambition''.
27. A scientist tells us that this concept of convergence has to be widened to other scientific disciplines, and to society: ''Indeed, there is a convergence between nano, bio, informatics, and cognition, and I would like to add the research on the social aspect which should be analysed, too, because these convergences are not detached from the transformations in which we are involved in postmodern societies, because we are experiencing today a complete transformation of our society''.
28. The American way of dealing with experts on nanotechnologies and communication to the public is to bind debate with collaboration within the law in order to integrate public discussions in the agenda by law regarding the development of nanotechnologies in the United States (see The Congress of the United State of America 2007, pp. 5–6; special thanks to Mr Brice Laurent, Arizona State University, who forwarded this document to us).

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Appendix A – Questionnaire (German and French)

Fragebogen für die Experten

1. 4–5 Begriffe, die die Nanotechnologien am besten definieren
2. Regionale und nationale Bedeutung der Entwicklung und Implantation der Nanotechnologien?
3. Wie kann man die Position des Experten am besten beschreiben?

(a) Förderung – Unterstützung des Technologietransfers zwischen Forschung und Industrie?
(b) Vermittlung – Verbesserung des Dialogs zwischen Wissenschaft/Technologie und Gesellschaft?

(c) Regulation – bereitet mit öffentlichen Kollektiven/Vereinen einen normativen Rahmen vor, um die Austausche zwischen Technologie, Wirtschaft/Industrie und Gesellschaft auf einander abzustimmen?
(d) Alle drei Positionen (mehr oder weniger gleichwertig/nicht gleichwertig)?

4. Welche Aktivitäten beschreiben die Position des Experten im Bereich Nanotechnologien am besten?
5. Welche Aktivitäten unterscheiden den Experten von anderen, die im Bereich der Nanotechnologien tätig sind?
6. Welche Einstellung hat der Experte in den drei folgenden Bereichen:

(a) im Bereich der technologischen Entwicklung/im Produktionsprozess von Nano-Produkten?
(b) im Bereich der Kommerzialisierung/im Bereich des (zukünftigen) Verkaufs von Nano-Produkten?
(c) im Bereich des Gebrauches/im (zukünftigen) Konsumbereich von Nano-Produkten?
(d) im Bereich von Unternehmen/Organisationen, die im Bereich Nanotechnologien tätig sind/werden möchten?

7. Bekommt der Experte ein Feedback von seiner Handlung im Bereich Nanotechnologien? Wenn ja, welche Art von Feedback und von wem?
8. Seit Ende 2006 dominiert die Diskussion um die Risiken, die mit Nanotechnologien verbunden sind. Man spricht einerseits von wirtschaftlichen Risiken aufgrund von möglichen Koordinationsmängeln zwischen Unternehmen/Sektoren. Andererseits spricht man von möglichen schädlichen Folgen der Implantation von Nano-Produkten in der Gesellschaft (wie z.B. in den Bereichen der Gesundheit oder des Konsums). Sind die Nanotechnologien wirklich gefährlich? Ist es umgekehrt nur eine irrationale Angst?
9. Seit 2001–2002 bestehen in Europas Protest-Bewegungen gegen Nanotechnologien. Sie sagen, dass die Nanotechnologien eine Bedrohung für die Entwicklung des Menschen und der Gesellschaft wären. Kennt der Experte solche Protest-Bewegungen? Was wäre die Reaktion des Experten gegenüber solchen Bewegungen?
10. Wo sieht der Experte die größten Schwierigkeiten im Bereich der Nanotechnologien?

Entretien Experts

1. 4–5 mots qui définissent les nanotechnologies au mieux
2. Importance régionale (surtout) et nationale du développement et de l‘‘implantation des nanotechnologies pour l’expert
3. Comment peut-on définir au mieux la position de l’expert vis-à-vis des nanotechnologies? Est-ce une position:

(a) de soutien des échanges entre le complexe techno-industriel et l‘‘économie?
(b) de transmission de la parole et d‘‘amélioration du dialogue entre le complexe techno-industriel et la région ou la société?
(c) de régulation, où l’expert prépare avec des collectivités publiques ou des associations un cadre normé pour harmoniser les échanges entre la technologie, l‘‘économie et la société?
(d) les trois à la fois (de manière identique ou de manière différentiée)?

4.Quels sont les activités qui permettent de décrire la position de l’expert au mieux dans le domaine des nanotechnologies?
5. Quels activités distinguent l’expert d‘‘autres organisations également actives dans le domaine des nanotechnologies?

6. Comment se représente-t-on l'expert dans les trois domaines suivant:

(a) développement technologique/de la production des produits nanotechnologiques?
(b) secteurs économiques appelé à recevoir et vendre ces produits nanotechnologiques?
(c) domaines de l''usage/de la consommation future de ces produits nanotechnologiques?
(d) domaines des organisations analogues, qui travaillent également en rapport avec les nanotechnologies?

7. Est-ce que CCSTI reçoit un feedback de ses activités dans le domaine des nanotechnologies? Si oui de qui, et de quel type est ce feedback?
8.Depuis la fin 2006, il semble que l''on parle plus de risques éventuels liés aux nanotechnologies. On parle d''une part de risques économiques dus à la convergence et la surspécialisation des secteurs économiques actifs dans le domaine des nano. On parle d''autres part des conséquences pas toujours prévisibles potentiellement nocives de l''implantation des produits nanotechnologiques dans la société (comme p.ex. dans les domaines de la santé et de la consommation). Les nanotechnologies sont-elles donc dangereuses? Où s''agit-il de craintes irrationnelles?
9. Depuis 2001–2002 on voit apparaître en Europe des mouvements de protestation contre les nanotechnologies. Ces mouvements disent que les nanotechnologies seraient une menace pour l''homme et la société. Est-ce que l'expert connaît de tels mouvements de protestation? Quelle serait la réaction de l'expert vis-à-vis de ce genre de protestation?
10. Quelle est ou quelles sont les difficultés principales de l'expert dans le domaine des nanotechnologies?