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Experts of vulnerability and the vulnerability of experts'  
discourses on nanotechnologies – a case study.**

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by  
Christian Papilloud & Ingrid Ott

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## **Convergence or mediation?**

### **Experts of vulnerability and the vulnerability of experts' discourses on nanotechnologies – a case study.**

**Christian Papilloud\* & Ingrid Ott\*\***

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#### *Abstract*

Recent discussions about the evolvement of nanotechnologies criticize that the notion 'risk' is 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 of technological development speak more about risk communication. Within the field of nanotechnologies, they even redefined this expression in February 2005 and related it to the question of the societal acceptance of nanotechnologies. Risk communication is about to gain stakeholder acceptance of policy decisions, whereas public and stakeholders are encouraged to participate actively in the communication process through public consultations, hearings, etc. Thus on the one hand, the category of risk has been pragmatically nuanced in order to better highlight the vulnerability of the communication on 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 the vulnerability relies on the social groups specialized in the design, the application, and the diffusion of nanotechnologies within society. How is this participation possible, and what does it mean? We develop this question in the framework of a comparative survey on experts that are involved in the deployment of nanotechnologies in Grenoble (France) and Hamburg (Germany).

*Keywords:* nanotechnologies, society, risks, experts, collaboration.

\*Christian Papilloud, University of Lüneburg, Institute of Sociology, [papilloud@uni-lueneburg.de](mailto:papilloud@uni-lueneburg.de)

\*\*Ingrid Ott, University of Lüneburg, Institute of Economics, [ott@uni-lueneburg.de](mailto:ott@uni-lueneburg.de)

## Convergence or mediation?

### Experts of vulnerability and the vulnerability of experts' discourses on nanotechnologies – a case study.

The first works of importance on risk communication emerged at the end of 1990<sup>1</sup> from the debates about public fears regarding the development of nuclear energy, and its affiliated technologies.<sup>2</sup> Their objective was a dual. It was important to better understand these fears through the analysis of the representations, and the uses of these technologies.<sup>3</sup> This was also to make it possible to extend, and to renew the epistemological reflections started at the end of the 1980s on the concept of risk.<sup>4</sup> Risk communication synthesizes these two requirements. It also contributes to the falsification of the evolutionist conception of risk, seen as a framework where men have to adapt themselves to their threatening environment in order to survive. Rather, risk is an indicator of the vulnerability of human relationships to others, and to the objects which they exchange, or about which they communicate. Risk does not only inform us about the variation of these relationships. It also enables us to observe their transformations, and the ways they are reorganized.

Nanotechnologies radicalise this critical questioning of risks. Indeed, the miniaturization of the technologies at a nanometric scale has structural effects. It delivers functions not present in these technologies at an upper measurement level. These functions increase and diversify the possible relationships to the environment which these technologies make possible. Let us take an example. If we replace a water pipe of large diameter by a pipe of smaller diameter, we reorganize the relationship between the water and this pipe. One of the results of this transformation is the water pressure. It acts as a new functionality, which, on the one hand, can improve the quality of daily life, and which, on the other hand, means new possible issues related, for example, to the resistance of the pipe, the geological stability of the ground in which it should be buried, etc. In short: new risks emerge from unparalleled interactions between the technological support (the pipe), the matter (water/ground), and the human beings involved.

Let us observe that between 2000 and 2004, when the development of nanotechnologies gained more public attention in Europe, one spoke primarily about the risks of toxicity related to materials reduced to a nanometric scale.<sup>5</sup> Almost nothing was said about the vulnerability of these

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1 See Davis, N., 1997: 49-56; Sund, K.G., Carlo, C.L., 1997: 15-23; Schibeci, R., Barns, I., 1998: 204-226.

2 See Webster, W.P., 1991: 46-59. Ohlmer, B., 1992: 181-188; Skinner, C.S., Siegfried, J.C., Kegler, M.C. et al., 1993: 27-34; Malaver, R., Dastous, P.A., Carrasco, F., et al., 1999: 360-368.

3 See Bader, R., 1993: 275-288; Gutteling, J.M., 1993: 295-316; Quill, T.E., Suchman, A.L., 1993: 109-120; Urban, D., Hoban, T.J., 1997: 299-331.

4 See Bord, R.J., Oconnor, R.E., 1990: 499-506; Renn, O., 1992: 465-519; Maharik, M., Fischhoff, B., 1993: 345-353; Tanaka, Y., 1998: 243-253.

5 Friedmann conducts a survey at Lehigh University about risk communication reported in newspapers and specialized periodics within the field of nanotechnologies from 2000 to 2004, indicating that "The number of newspaper articles found about health and environmental risks was low for both American and British coverage. Only 71 U.S. and 50 U.K. health and environmental risk articles were found between 2000 and 2004, with The New York Times (13) and Washington Post (9) running the most"

relationships between technology/matter/human beings. Consequently, nobody asked about the appropriation and the inscription of these technological innovations within society.<sup>6</sup> In the same way, the idea to improve the public information about nanotechnologies was only touched on at the margins, whereas the deficit of this kind of information is enormous.<sup>7</sup>

Since 2004, this latter point has seen noticeable improvements. Risk has been criticized as too abstract and all-inclusive of a category. Moreover, the concept of risk is not precise enough to describe the potential issues related to the development of nanotechnologies. Instead, the experts of technological development speak more about risk communication.<sup>8</sup> Within the field of nanotechnologies, they even redefined this expression in February 2005 in relation to the question of the societal acceptance of nanotechnologies. Risk communication is about “to gain stakeholder acceptance of policy decisions. It may include *economic, social and ethical values* as well as the scientific facts”.<sup>9</sup> This assessment would have called to mind the traditional definition of the risks had the next lines the report not corrected the prospect in the following manner: “Policy-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). On the one hand, the category of risk has been pragmatically nuanced in order to better highlight the vulnerability of the communication on 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 the vulnerability relies on the social groups specialised in the design, the application, and the diffusion of nanotechnologies within society. How is this participation possible, and what does it mean? We develop this question in the framework of a comparative survey on experts in the development of nanotechnologies in Grenoble (France) and Hamburg (Germany).

### **Experts of nanotechnologies in Grenoble and Hamburg**

We have chosen the comparison between the two cities for the following reasons: Hamburg is the second richest region in Germany (measured in GDP per capita) as Grenoble is in France. In both the regions of Hamburg and Grenoble, the development of nanotechnologies has become a primary interest since 2000. The governments of both regions and countries have supported the development of nanotechnologies via an active industrial policy in order to achieve ongoing regional prosperity.

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([http://www.wilsoncenter.org/index.cfm?fuseaction=news.item&news\\_id=161177](http://www.wilsoncenter.org/index.cfm?fuseaction=news.item&news_id=161177)).

6 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: 3).

7 Friedmann’s survey reported before states also that 80% of the Americans do not know anything about nanotechnologies (ibid).

8 This is a new wave in the works on risks supported by analyses bringing together risk communication and public tolerance regarding innovative technologies (see f.ex. Frewer, L.J., Howard, C., Aaron, J.I., 1998: 388-393; Baba, M.L., 1999: 331-346). These works clearly differ from usual examinations of risk perception and their rationalization.

9 See <<http://www.euractiv.com/en/science/risk-based-policy-making/article-133006>>.

Hence both regions have some joint characteristics. Among them are

- Metropolitan areas with more than 1.000.000 inhabitants;
- Per capita income lies above the country's average income per capita;
- Nanotechnologies' clusters already exist. They are embedded in existing industrial structures and are expected to grow significantly during the coming years;
- Regional policy supports the development of the nanotechnologies' cluster as one strategic regional industry.

Thus, Grenoble and Hamburg offer comparable regional similarities regarding the development of nanotechnologies. We looked for the main experts in both regions. In our context, the "experts" are the actors who explicitly assert a regular, and materially or symbolically remunerated activity (f.ex. as a scientist, within an association), or an almost daily involvement (for example citizens' militancy) within the field of nanotechnologies. "Activity" and "Involvement" typify the experts who we looked for. We identified three types of experts, e.g. three typical activities or implications within the field of nanotechnologies describing the socio-institutional positions of the experts:

- a) Type A: the developers/designers of nanotechnologies, or the teams working on the methods/the concepts and supporting the developments of technologies at a molecular/under-molecular level, i.e. primarily scientific research centers and competence centers, researchers, lecturers, and associated academics in the field of technical sciences, natural science, physics, pharmacology, the life sciences as well as the social sciences; we identify this type by using the initials TA for actors of Type A;
- b) Type B: the promoters/optimizers of nanotechnologies within society. These can be associations for the sociocultural valorisation of the scientific and technical culture, or private as well as semi-public companies for the economic valorisation of the development of nanotechnologies; we give them the initials TB for actors of Type B;
- c) Type C: public organizations, civilian associations or citizens' movements which stimulate the public discussion about nanotechnologies; we label them with the initials TC for actors of Type C.

These three types of actors and their respective socio-institutional positions have been found in Grenoble as well as Hamburg:

- a) TA: We have contacted the scientific research and development centers *MINATEC* (Grenoble) and *Hansenanotec* (Hamburg), and we have obtained 7 interviews. *MINATEC* has been a structure

in project since the end of 1990s. It cost approximately 150 billion Euro. It is a unique structure in Europe of this importance. It opened in June 2006, and it is located close to the University Joseph Fournier, to the *Centre d'Énergie Atomique* (CEA) and to the *Laboratoire d'Électronique 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), as well as researchers in social sciences and in arts (*IdeasLab*). In Hamburg, nanotechnologies have been developed at Hamburg University within *Hansenanotec*,<sup>10</sup> a scientific and competence center. It acts as a structure for the scientists working in the various disciplines of the natural sciences and physics. In May 2007, *Hansenanotec* was absorbed by the *Interdisziplinäre Nanowissenschafts-Centrum Hamburg* (INCH).

b) TB: 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 young public company built in 2005, CCSTI has existed since 1970, and it was the first *Centre de Culture Scientifique, Technique et Industrielle* in France. It acts as a “1901” (e.g. not acquisitive) association. It was founded on the initiative of the four universities of Grenoble, the research centers of Grenoble (funded by the CNRS), and the public collectivities of the region. Since 2001, it has been legally dependent on the *Charte CCSTI*.<sup>11</sup> This *Charte* describes the aims of CCSTI, which consist in diffusing and promoting technological and scientific culture within society. CAN specializes in the technological transfer between universities, research centers, private companies, and industries. 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 (structuring polymeric nanostructures, chemical synthesis of nanotechnological products, measures of nanoparticles). It benefits from former experiences such as those drawn from the *NanoBioTech* program (as developed in Münster between 2000-2004),<sup>12</sup> which the *NanoBio-Europe* program has extended since 2005.<sup>13</sup> CAN is also supported by various companies, which

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10 See their online website at <<http://www.can-hamburg.de>>.

11 See the online address of CCSTI-Grenoble: <[http://www.ccasti-grenoble.org/02\\_institu\\_quinous.php](http://www.ccasti-grenoble.org/02_institu_quinous.php)>. Despite of the centralist tradition which dominates 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 pluralisation, an association named *La Réunion* (see <<http://www.ccasti.fr>>) proposed in 1995 to unify the CCSTIs in one unique network. This led to the *Charte CCSTI* (2001), supported by the Ministry of Research (see <[http://www.ccasti.fr/index.php?option=com\\_content&task=view&id=13&Itemid=28](http://www.ccasti.fr/index.php?option=com_content&task=view&id=13&Itemid=28)>).

12 The *NanoBioTech* program developed in Münster has been set up in parallel to the *CeNTech* project, which led to the construction of the Center 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 *Sparkasse* of the city, and the public company *Technologiepark*. Münster used to be an example in Germany for the creation of other similar companies as *CeNTech*. CAN-Hamburg can be considered a good example of them. Some of its leading members were also leading members of the *Technologiepark* in Münster (see <<http://idw-online.de/pages/de/news19950>>).

13 *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). After a mediation of the technological pole of Münster at the end of 2003, the two cycles joined in order to form one unique cycle of international

are judicially and economically in charge of it, the most important of them being Beiersdorf AG, Eppendorf AG, Olympus Winter and Ibe GmbH, Evotec Technologies GmbH, Nanogate AG.<sup>14</sup>

c) TC: We contacted two actors involved in the public discussion about the nanotechnologies, namely the association *Vivagora* (Paris)<sup>15</sup> and the opponents to the nanotechnologies *Pièces et Main d'Oeuvre* (or PMO).<sup>16</sup> *Vivagora* is a “1901” association. It was founded by journalists and scientific personalities in 2003. It promotes social debate on technological innovations, and particularly on nanotechnologies. PMO has gathered a small number of French opponents to the nanotechnologies in Grenoble. The group was also instituted by former journalists. It appeared on the scene of the nanotechnologies at the end of 1990s. Since 2002-2003, it has abandoned its first label *Ordinary Citizen* for PMO, and it freed itself from traditional political protest movements like f.ex. ATTAC. The group has built an online website, which its members use as a mean of publicity, of propaganda, and of communication. The members of the group remain anonymous. They hardly communicate about their actions, except within the framework of more or less confidential debates which they organize.<sup>17</sup> PMO refused to meet us face-to-face. Nevertheless, we could get some answers to our questions by email, before the group enjoined us to read the abundant literature accessible on their website. This last type of actor is visible in Grenoble only. In Hamburg, there is no association or group of citizens of this kind, which is clearly identified, or which stimulates the public discussion on nanotechnologies.<sup>18</sup>

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

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conferences named *NanBio-Europe* (2004). These take place in Münster once a year (see the program of the conferences 2007 <[http://www.nanobio-europe.com/output.php?Script=1&SW=1280&CN=welcome\\_2007](http://www.nanobio-europe.com/output.php?Script=1&SW=1280&CN=welcome_2007)>).

14 Similarly to what was done in Münster, CAN also makes bonds with partners of the economic sectors within the city of Hamburg, and it actively communicates with the actors supporting the life sciences in Hamburg such as f.ex., the Hamburger *Sparkasse*, the *Innovationsstiftung*, the Chamber of Commerce of the city, the *Norgenta* agency for the promotion of life sciences in North Germany. Also, some members of the CAN have worked at the VDI center, and some of them have cooperated with *ZT-Consulting* at VDI (see <<http://www.zt-consulting.de>>).

15 The website of *Vivagora* is situated at <<http://www.vivagora.org>>. One finds a lot of useful information regarding the activities of the association as well as several reports about the debates which the association promotes, or which it takes part in.

16 Most of the documentation which PMO produces is accessible at <<http://rezal404.org/pmo/spip.php?page=plan>>.

17 PMO has many relationships with the associative network, in the alternative and the artistic scenes inside and (even if less) outside Grenoble, such as, for example, with the Parisian association ReZal404 (<<http://rezal404.org/>>). Officially founded in 2003, ReZal provides PMO a webspace on one of their servers. They also diffuse information through an Internet – radio program (<<http://www.radio404.org/>>), and a web-tv program (<<http://www.tv404.org/>>), without speaking about the exhibitions and other demonstrations which they organize. PMO also finds 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 held a virulent speech against the nanotechnologies at the exhibition *Nanomondes* at *La Cité de la Science* (Paris; see online at <[http://paris.indymedia.org/article.php3?id\\_article=78307](http://paris.indymedia.org/article.php3?id_article=78307)>).

18 The experts we met in Hamburg confirmed this for, such as actors at *Hansenanotec*, which wonder that they are the only ones to try making things move forward by planning the first German public debates at the end of 2007. To no avail, we also contacted the Greens in Hamburg, ATTAC and *Antifa-Hamburg* (anarchists). It seems that we can generalise this observation 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, Litten, 2006: 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 for the section of ATTAC-Hamburg, Oliver Moldenhauer.

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. But we use them in order to control the interpretation proposed below about the vulnerability of experts' discourses on nanotechnologies.

### **From the fieldwork to the data**

We were in close contact with the regional actors TA, TB and TC during a 6 months period (from November 2006 to April 2007). At that time we took up our first contacts with the experts, conducted the interviews with the experts, and prepared a summarized feedback of the most important results of our case study. The interviews were recorded. They required about one and a half hours for each expert. They were carried out face-to-face on the basis of a semi-directed questionnaire entailing 10 questions (see the questionnaire enclosed [Annex A]).

The first question was a closed question. We asked each expert spontaneously to give us 4 to 5 words which they associated with nanotechnologies. This question should enable us to better understand the basic elements of their representations of nanotechnologies. The other 9 questions described three dimensions (3 questions/dimension) about which the experts could express their opinion more freely, namely: a) the danger of nanotechnologies; b) the actions which the experts support in the field of nanotechnologies, c) the reflections of the experts regarding the reactions obtained from their actions. These questions should enable us to describe the specific type of each expert regarding their implication in the design, the application and the diffusion of nanotechnologies within society. In the following investigation, and according to our main topic on the experts' discourses on nanotechnologies and their risks, we focus on the first group (a) of questions, and we describe the corresponding results.

In order to control the comparison of the discourses TA, TB and TC, we performed a statistical analysis of the discourses collected. We drew a single list of key words appearing in all interviews with words of at least 4 letters having been expressed 3 times and more. This list includes substantives, adjectives, verbs and adverbs. We excluded interjections (ah, euh, he, wow!...), logical functions (and, but, then, thus, that...), and the typical expressions related to the bodily language (laughter, sighs, silences...).<sup>19</sup> We used this list of common key words as a grid to filter, and to reconstruct the clusters of the main themes and subthemes attached to the experts' discourses. We used a level of probability at  $p=0.05$  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

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<sup>19</sup> We are looking for the representations of actors who are deeply involved within the field of nanotechnologies, and who are used to dealing with the thematic of the danger of nanotechnologies. Therefore, these elements are of less interest for our purpose.



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 in coupling semantic analysis, and statistical control, has a double advantage.

On the one hand, it enables us to correct the principal skew of our investigation related to the unequal number of our interviews. Our investigation cannot avoid this skew which reflects the situation in Europe, where there are more TA than TB actors, without taking into account the TC ones, who are very rare, and particularly difficult to contact.<sup>20</sup> Thus, if we only consider the raw data of our interviews, we would privilege the discourse of one type of actor over one another. Our statistical control restores the balance, enabling us to compare the most relevant theme of each experts' discourse.

On the other hand, our method corrects a second bias which often appeared in the interview situation. It consists in identifying one expert's discourse with his type, e.g. with his socio-institutional position, and further, with his kind of activity/occupation as an expert. If we assume that there is always a "place" from where one speaks, we also assume that this place might exist for several actors more or less independently of their activity as expert, of their affiliation to a specific socio-institutional position, e.g. of their type. Conversely, actors of the same type can support very different arguments, which even could be far away 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 subthemes related to the main ones which they discuss. It enables us to better understand the experts' relationships to the interests, and the 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 in the specialized literature on the vulnerabilities of the communication on nanotechnologies, and on the analysis of these vulnerabilities. We would like to use this literature to stabilize the interpretation of our interviews. But at the present time, there is nothing truly significant published on this topic, except 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 specialized within the field of science and technology that have been mostly published over the Internet. The publications related to the vulnerability of the communication on nanotechnologies emerge in 2005. As a subject receiving very little attention before then, in 2005 it comprised 14% of the information collected about the danger of nanotechnologies. It rated at 18% in 2006, and at 4% in the first two months of 2007. This represents an average progression of 0.8% per month compared to 2005 and 0.5% per month

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20 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 nr. 7.

compared to 2006. Obviously, of the information published on the danger of nanotechnologies, this topic remains the less often discussed.<sup>21</sup> But compared to the other information published on this topic, it has increased the most since 2000. The experts who we have contacted share this concern.

## **Danger of nanotechnologies**

The experts met speak about the danger of nanotechnologies using three themes significantly bound together. The main one concerns a) the toxicity of the nanotechnologies, and the evaluation of this toxicity. It is usually completed by a discourse regarding b) the role of the 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 the nanotechnologies in society. We first describe the main thematic of the toxicity of nanotechnologies. Then, we analyse the related subthemes of the expertise and the societal risk related to nanotechnologies. We present our results for the three types of actors taken together, and then we specify them for each type of actors.

### a) Toxicity

Among the subthemes associated with the toxicity of the nanotechnologies (n=43), the risks related to the implementation of nanotechnologies within societies make up the foreground, and particularly the uncertainty attached to nanotechnologies themselves and to their interaction with our material environment. A member of TB summarizes this situation: "There are neither standard test systems which would enable 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 a thematic on which the experts express themselves with little precision. The reason they mention is the same: there is not enough reliable information about this thematic. This informational insecurity has an impact in their daily professional activity. The experts often express their difficulties when they want to edict dispositions in order to regulate the production of nanotechnologies which could be toxic. We asked an actor TA about his position regarding the relationship between the possible danger of the nanotechnologies, and the public health. He answered: "There are two beautiful examples from the last year: MagicNano which was sold out by Penny, which has nothing to do with nanotechnology,

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21 From 2005 until 2007, the nonspecialized information published on risk communication rates is about 20-25% of the total amount of nonspecialized information published on the danger of nanotechnologies. Nevertheless, it is interesting to observe that the nonspecialized information published on risk communication increases in a comparative way to nonspecialized information published on the socio-economical and socio-cultural risks related to nanotechnologies at the same period of time (from 28% to 32% of the total amount of information). As a comparison, the nonspecialized information published on the toxicity of nanomaterials and on their possible dangers for human health remains the most published topic, representing about 2/3 of the total amount of information published on the danger of nanotechnologies.

and which simply is a very good cleaning agent in its liquid form for which they have a permission, so they thought that they also could sell it as an aerosol. But when the spread particles of this aerosol inhaled, one simply gets breath 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-up of muscles, which actually succeeded well on the market so that the company earned very much 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-up of muscles; nobody understood how it is supposed to work, but anyway. Thus, 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 at different size, and no nanoparticles. Thus, one can drink it, it won’t hurt, but it won’t bring you anything either.’<sup>22</sup>

The thematic 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 1/3 of the experts’ discourse. But the relevant subthemes attached to it cover only 9% of all the associated subthemes. This means there is a strong variability in the argumentation of experts about the toxicity of nanotechnologies, which can be explained in reference to the impossibility for the experts to secure their communication about the danger of nanotechnologies, e.g. to rely on enough reliable information to enable them to clear the relationships between toxicity, nanotechnology, and (public or environmental) risks. We have found this same result for each type of actors interviewed in both Grenoble and Hamburg.

If actors TA often speak about the toxicity of nanotechnologies, they 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 also is 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 of experts, according to the actors TA, toxicity supposes the intervention of the scientists who can analyse and control it. But this is not enough to regulate the whole case of toxicity, which calls forth political questions, questions regarding the public health, or the management of environmental challenges. Thus, the actors TA support rather accurately the general tendency that leads each expert to consider toxicity as a hybrid problem of a scientific, and a public nature.

TB actors speak more and most unilaterally about toxicity. For them, the problems related to the toxicity of nanotechnologies are, and should primarily be a concern of actors possessing the

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22 This same kind of problem was mentioned, too, when we asked the experts about the possible danger of nanotechnologies for the natural environment.

adequate specialized knowledge of nanotechnologies. TC actors do not express themselves significantly on the toxicity of nanotechnologies at the given level of probability considered. This does not mean that they do not think about the danger 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, TC actors consider that it goes beyond the unique problem of toxicity, involving concerns about the (scientific and collective) knowledge of nanotechnologies and the public risks. This last opinion is echoed in the discourses of all actors about the subthematic of the expertise.

## b) Expertise

The expertise is the preferred subthematic that the experts speak about, associating with it a lot of topics (n=177). It enables them to support the affirmation that any discourse on the danger of nanotechnologies requires the knowledge of one is talking about. Which kind of knowledge do the experts mean? Or in other words: who is considered to be an expert? If our actors mention above all the scientists, they do not forget the public of citizens involved in the research, and the distribution of information on nanotechnologies within society. Speaking about a meeting of TA experts in nanotechnologies, an actor TA says: “For me the idea is to open, and to diffuse this kind of information”. The thematic 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 built in groups: “we set up mixed teams with experts, industrial partners (...) and we are working hard at the industrial management”. This process requires the organisation of seminars where each expert can obtain information about the advancement within the various fields of nanotechnologies organized along specific themes. An actor TA 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 built in groups. It emerges from public discussions and debates. The experts consider the public discussions to be important in order for non-specialists, and ordinary citizens to account for public decisions regarding the development of nanotechnologies. An actor TC told us that “one should develop the idea of the 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 member of TB summarizes these arguments in 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 be really 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.”

One is not surprised to find the most support of the thematic of expertise among the actors TA. They are the best example of the tendency shared among our experts. Their discourses entail all the dimensions mentioned above. The TB, on the contrary, do not follow this tendency, and they do not mention this subthematic much. Obviously, there are expertises and experts on nanotechnologies. But they are not in the scientific world or in the public. They initially work in the industrial sectors, or in the strategic partners’ sectors, for example, as promoters of the 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 functionalization 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 valorisation 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 the industry than the university. We are definitely the partner for industries which are concerned with the management of projects”. The TC speak more about the expertise and the experts than the TB. But like the latter, they do not support the general tendency much. The thematic of expertise does not lead them to see the supposed danger of nanotechnologies as being a mere problem 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. of experts of our own lives.” The 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/traceability of the products containing nanotechnologies.

Thus, in Grenoble as well as in Hamburg, the thematic of the expertise gives each actor the opportunity to describe their most important strategic partner when it comes to the knowledge to promote regarding the danger of nanotechnologies. For TA, this knowledge is a composite taking into account the individual qualities of scientists, the upstream research results, and sometimes the several forms of applied and collective knowledge. For TB, this is above all an applied knowledge which one typically finds in industries and companies. They provide to the scientists the means needed in order for them to optimise the industrial culture of technical work and for the resulting products to be spread within society in light of science. For TC, knowledge must be essentially a

collective before it is scientific; this is a partnership which is often seen to be ambivalent. The 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 deep, and wide knowledge of nanotechnologies, each actor tends to look for this knowledge where it is the most accessible for him, namely either in his own group, or among partners close to the interests, and the stakes of the knowledge which the group promotes and defends. Our actors thus think it is possible to better discuss the risks related to nanotechnologies, and particularly the societal ones.

### c) Risks and societal vulnerabilities

The societal dimension appears in the foreground of the experts' discourses about the subthemes of the risks related to the nanotechnologies, and it 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 actor TC), 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 at 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." (TA)

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 actor TA, all of them stress that "we certainly need a discussion about the chances and risks of nanotechnologies, no doubt". However, says another actor TA, "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 for us, but in general one speaks little about it". Other actors TA reinforce this opinion saying that "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 dominant among TC is 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 subthemes 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 subthemes 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 thematic, they all show ambivalence in the use of this category. An actor TC expresses loudly what the other actors sometimes keep for themselves: “there are hardly risks, rather certainty. The use of the word ‘risk’ abuses the language”. Does this mean that the thematic of the risks does not seem to be relevant for our experts?

Actors TA are not far from this opinion. Although they mention the problem of risks more often than TB and TC, 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 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 at 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, TB do not see how the convergences of economic sectors which the nanotechnologies could support would bring 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 this, and that’s all.” Yet, TA, TB and TC share a very similar position on the risks related to the danger of nanotechnology. For TA, the category of risks does not support a scientific interrogation of the impact of the nanotechnologies within society. TB also think that this category does not allow us to take into account the impacts of the developments of nanotechnologies within the economic sectors in a relevant way. TC observe 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 to reaffirm its own interests, and the stakes each one projects in the development of nanotechnologies. Actors TB highlight it the more. They see nanotechnologies as a stake of primary importance for socio-economic development. TC recall the importance of a critical look at the consequences of the technological development within our society. TA strike the greatest balance between viewing nanotechnologies as supporting societal chance and viewing them as accelerating systemic risks. For them, the problems raised by nanotechnologies are still largely unknown. This should be recalled in order to support the scientific research in this field. More generally, this relativisation of the risks as a self-explaining category meets a aim which the three types of experts share. The risks, they say, do not build the 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 this. Saying this, the experts hope for 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.

Let us summarize. Taken all together, the experts share the same basic elements when they discuss the problem of the danger of nanotechnologies: the reliability of knowledge and the transparency of actors' involvement are required. Now, the experts do not use these elements in the same way in their discourses. It seems that the regional anchoring of the experts does not play a discriminative role. Indeed, our results indicate that TA and TB in Grenoble express very similar views to those of their colleagues in Hamburg. This thus applies to all actors except for TC, since we only find them in Grenoble. Yet otherwise when we consider the actors from the viewpoint of their type, we observe that TA and TC support analogous arguments.

Despite the constantly mentioned example of carbon nanotubes, whose danger has been proven, TA 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 then this information has to be spread within society. TC also underline the lack of information, and of its reliability on the danger of nanotechnologies. Therefore, it is necessary to familiarize the citizen with the nanotechnologies. Then, he will be able to develop his knowledge about nanotechnologies, and to open a dialogue with other actors involved in this field, particularly with the scientists.

Arguments of the actors TB can be distinguished from those of TA and TC. Actors TB recall that the danger of nanotechnologies is not only a problem of knowledge about these technologies. It first regards the fabrication of products containing nanotechnologies. It is certainly important to improve scientific, and collective knowledge of nanotechnologies. But one should not forget the culture of technical knowledge and of work within high-tech industries and companies either. One should also pay attention 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 within society. Here too, debate is important.

Do these requirements of reliable knowledge and the transparency of actors' involvement solve the ambivalence of the communication about nanotechnologies? It seems not. Indeed, the three types of actors recall that nanotechnologies appear in the public, whereas technological innovations have bad press. The example of the public mistrust in biotechnologies illustrates it. How do the experts in the fields of nanotechnologies confront this kind of mistrust?



## Mistrust in nanotechnologies

In an abstract, and emerging field such as the field of nanotechnologies, with the word “nano” one easily tends to associate 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 the favourable terrain exists for it. In the opinion of all experts, it gives rise to all kinds of discourses on the genetically modified organisms (GMOs).

All experts fear that the spectre of GMOs motivates the public opinion to be wary of nanotechnologies or to adopt a moratorium in order to brake or to stop the scientific and industrial developments in this field. This concern was expressed most forcefully in Grenoble. An actor TA 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 time. 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 representation which has been installed”. Similarly, an actor TC 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”. An actor TB tells us a story about a biologist in a debate about GMOs and innovative technologies: “He said ‘There is no problem observed, so there is no problem with GMOs’, which is simply amazingly stupid... Therefore, people are overall against GMOs whereas 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”. An TA summarizes this migration of the hostility from the GMOs to the 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 of the past few years on nanotechnologies. The amalgam with the GMOs has also been denounced by actors criticizing the development of nanotechnologies<sup>23</sup> and by actors supporting it.<sup>24</sup> 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

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23 See the special issue 97 of the ecological initiative Chain Reaction started 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. Same statements can be found in this report about the relationships between nanotechnologies and nuclear research, or nanotechnologies and social surveillance.

24 See the report of the National Risk on Governance Council *Survey on Nanotechnology Governance* (2006), edited by Roco and Litten. See also the report of the 4<sup>th</sup>. 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: 37).

development of nanotechnologies, whether they are defined in terms of chance or risks.<sup>25</sup> All of them underline in the same way the laxity of the public authorities in terms of the legislation and standardization of nanotechnologies: “Currently lots of talk within government and industry circles is centred on avoiding, with nanotechnology, 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 science remains seriously under funded” (Chain Reaction, 2006: 44). The actors TA and TC take this kind of discourse into account: “The public authorities are responsible”, as one actor TA tells us, and he continues: “At the European level, there were not very clear behaviour, even other things which also allowed – things going further than they should. Thus, after a while, people are suspicious. Afterwards, if one wants to work on the communication in order to say some kind words, the people see you as a liar, which is also normal, since for 50 years, they were being lied to”. An actor TC adds: “It is well known that there is a veillance to do, and that people do not want to do the job (...) but the public authorities don’t take it seriously into account.”

The use of the stigmatization of public authorities is a mean to call for more engagement regarding the standardization of norms related to the nanotechnologies (AFNOR, ISO). Since 2004, this problem has been abundantly discussed in Europe (see Nordmann, 2004: 39; Oud, 2005: 38), and it was recalled during the conference introducing the *Nanomonde* exhibition in Spring 2007 at the *Cité de la Science* in Paris (see Cahier d’acteurs, 2007: 16). Standards for nanotechnologies would not only ensure the systematic control of the products containing nanotechnologies, and the regulation of the economic competition in this field.<sup>26</sup> They do not only prevent that one takes advantage of the current legal gap to test one’s nanotechnological products directly on the market.<sup>27</sup> It is above all a means to 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 the communication about it, supported by the amalgams between nanotechnologies, and other more discussed innovating technologies, as f.ex. biotechnologies.

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25 The ethical committee of the UNESCO on nanotechnologies expressed this concern clearly, 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: 4).

26 At the moment, as an actor TA underlines it, economic competition in the fields of nanotechnologies is all 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 this to the competition, ah, yes, this is not so dumb... And within the same structure (...) one can nobviously not meet the individuals, but two enterprises in competition, one can obviously not speak about a common topic, because one has to be honest, but without one knowing that the other is present in the cycle.”

27 An actor TC 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, one put something on the market before it has been monitored (...) 10 tones in a year, 10 tones in a year of carbon nanotubes”.

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 available information about the nanotechnologies. It would then be a first step in developing reliable knowledge and promoting the transparency of actors' involvement within the fields of the production and of the societal implantation of nanotechnologies. But would this end the mistrust in nanotechnologies?

### **Convergence/mediation**

Convergence seems to be the most important stake of any activity carried out in the field of nanotechnologies. This word is not only used in order to describe the merging of scientific methods and disciplines.<sup>28</sup> It also describes the merging of social, economic, and political prospects and concerns.<sup>29</sup> As an actor TA says: "we deal with actors within the field of nanotechnologies who are going to converge, to converge intellectually". But this opinion is quickly moderated by the majority of the experts interviewed. If each one acknowledges the need for a multilateral exchange between all the actors involved with the nanotechnologies in order to better fight against the mistrust they may evoke, each one still remains reserved regarding the possibility of reaching the desired convergence.

Once more, TA and TC defend similar arguments that are based on the same principle: specialization. They share the following idea, expressed by an actor TA: "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 it. But you can not ask him to explain these things to people. It is definitely not his job". Another actor TA adds: "It does not function like that. They are hyper-specialized, and they do not want to go beyond their nanometer square". For TC, the specialization, particularly the scientific specialisation, has a bad image in public, related to a persistent mistrust in the sincerity of the discourse of actors TA. In a symptomatic way, an actor TC expresses this idea, referring to the example of GMOs: "The background of the biotech and GMOs experience (...), the double language, the organisation of debates on topics which are not at the heart of the thematic, which should criticize the system, the obstruction of the discussion of real problems are basic tricks in my opinion". These arguments reflect in a typical way the importance of the reliability of information

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28 As an actor TA says: "There is a concept of convergence which is typical of science, too, e.g. there are scientific disciplines which are continually moving 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 this in a very productive scientific way". In a same way, an actor TB says: "Actually, once we are at the nano scale, we realize that we maybe can, that we maybe can bring about a converge of some technologies and some concepts from the life sciences, the chemical sciences, the physical sciences, informatics, robotics, etc.". An actor TC tells us that he got involved in the field of nanotechnologies because he was fascinated by this idea of convergence: "we were looking at the nanotechnologies because we realized that the question of convergence should really be to deepen in its reliability, and at the same time in its ambition".

29 An actor TA 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".

within the field of nanotechnologies, and the communication about it. The actors TA and TC ask for more reliable information, which they can trust in order to express informed recommendations, and which the civil society can trust, too.

On the contrary, TB do not view the reliability of information and the transparency of actors' involvement as the most important thing for a fair, and a trusty communication in the field of nanotechnologies. One actor TB even denounces this as an issue: "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 the 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 are always resistances against GMOs. There are controversies about some technologies. There are resistances; 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, actors TB stimulate less convergence than mediation carried out by professionals in the communication about nanotechnologies: "one should simply go in the public, in the discourses, and there also engage in public communication; and in my opinion it finally always depends on what the auditor retains, and not on what I want to communicate". Here again, the discourse of the actors TB reflects their concern about the expression of the practical dimensions of the techno-scientific culture, reflecting their concerns about the integration of industrial processes within society.

Convergence and mediation synthesize the different viewpoints of the actors TA, TB and TC, and at the same time, they point to the challenge which they share about the danger of nanotechnologies: to risk an open debate on nanotechnologies, i.e. a public discussion not only opened to multiple actors, but particularly requiring their collaborative engagement. For the actors TA and TC, the idea of convergence expresses their ambivalence regarding this kind of debate, its organisation, the exchange it might support between a specialized knowledge and collective knowledge criticizing nanotechnologies. For the actors TB, the idea of mediation expresses the same ambivalent feeling, because for them, to have an exchange about nanotechnologies does not only mean to build a shared language in order to support a sustainable dialogue between two different forms of knowledge. Particularly, 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 can not coincide, even if they might encounter and valorise each other.

The first experience of public debates on nanotechnologies at a national and at an international level reinforces the ambivalence of the experts. TB note that the public discussion does not seem to valorise the culture of the technical and scientific practices in the field of nanotechnologies in any

decisive way. Certainly, to communicate about nanotechnologies is a pragmatic way to express the value of this culture and to favour its transmission. But it is neither the only way to do it, nor the simplest or the best one. TA and TC note the great difficulty of communicating together with the scientists, the industrialists, the representatives of public authorities, of non-governmental organisations, and of citizens who do not necessarily know much about nanotechnologies. Incidentally, after some experience with public debates, TA tend to reserve their involvement all the more for the stimulation of these convergences. Indeed, they do not see how or why they would risk dealing with the collective knowledge on a subject of such great technical and scientific complexity. TC fear the perverse effect of the valorisation of the collective knowledge, leading to a cleavage in the debates, where the popular wisdom favours the unilateral denunciation of the 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 problem of the vulnerability of communication about nanotechnologies more acute. Indeed, TA, TB and TC are not only ambivalent regarding the contents of the communication about nanotechnologies. They are also ambivalent regarding the modalities of the exchanges which this communication could favour. These questions have echoed in recent studies on the specialized and the public debates on nanotechnologies. If the mediation is often associated with the idea of a public discussion, the convergence is rather coupled with the idea of “working together”, of collaboration (*cum laborare*).<sup>30</sup> Moreover, if convergence supports a strong idea of engagement in an exchange with the others, mediation is about to transmit information without noise. Nevertheless, both concepts have their own perverse effects. If mediation supports the circulation of the communication as TB say, it does not automatically encourage the actors to get more involved in the communication about nanotechnologies, which threatens the debate among experts and in the public realm. On the contrary, the convergence supported by TA and TC lead to an involvement in the debates about nanotechnologies. But this requires not to force the communication, e.g. to deal with people who don't want to exchange about nanotechnologies, or who don't 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 the debates about nanotechnologies. In our interviews with experts TA, TB and TC, their meaning appear to be

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<sup>30</sup> The American way to deal with experts of nanotechnologies and communication in the public is to bind debate with collaboration within the law in order to integrate the public discussions by law within the agenda regarding the development of nanotechnologies in the United States (see The Congress of the United State of America, 2007: 5-6; special thanks to Mr. Brice Laurent, Arizona State University, who communicated us this document).

less important in itself than the positions of the experts denoted by each concept when the experts speak about the danger of nanotechnologies. We have seen that these positions are respectively that of engagement (experts TA and TC) and intermediation (experts TB), which are the two main forms expressing the experts' shared ambivalence regarding the ways to communicate about the danger of nanotechnologies, and to deal with it within society. In other words, these are the two main organising principles describing the vulnerability of the expert's discourses about nanotechnologies in Grenoble and Hamburg. It finds its expression in typical expert questions about the kind of communication to organise, and the ways to organise it in order to establish reliable information about nanotechnologies, to valorise the practices of the techno-scientific cultures, and to build trust within society. Could this kind of communication support multipart engagements? Should it remain purely informational? Should it be normatively framed within a corpus of laws, or should it rest on the initiatives of the civil society, i.e. on the exchanges between experts and non experts of nanotechnologies?

These questions might give one the feeling that eventually someone can 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 more implications in the experts', and in the public debates on nanotechnologies. Indeed, actors TA and TC do not play a conservative strategy. They do not seek to insure their socio-institutional position only by limiting their communication to the regulation of their exchanges according their interests and stakes. They try to modify their individual and mutual implications in order to give to their understanding of convergence another form. They want to deal with the vulnerability of their own communication about nanotechnologies, and they want to avoid that their specific position yields the perverse effect, in accord with the motto: "the more one speaks, the less one gets along with the other". In a similar way, the actors TB try to escape their position as intermediaries in order to play a more active role within the debates on nanotechnologies which is not only about (specialized and nonspecialized) knowledges, 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, e.g. to create an exchange between convergence and mediation which could define the society of nanotechnologies to come.

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## **Annexe A – Questionnaire (German&French)**

### **Experten Fragebogen**

1. 4-5 Begriffe, die die Nanotechnologie am besten definieren
2. Regionale und Nationale Bedeutung der Entwicklung und Implantation der Nano?
3. Position zu den Nanotechnologien?
  - a) Förderungsposition – Unterstützung der Austausch zwischen Technologie und Wirtschaft/Industrie insbesondere?
  - b) Vermittlungsposition – Verbesserung der Dialoge zwischen Technologie und Gesellschaft insbesondere?
  - c) Regulation – bereitet mit öffentlichen Kollektiven/Vereinen einen normativen Rahmen vor, um die Austausch zwischen Technologie, Wirtschaft/Industrie und Gesellschaft zu harmonisieren?
  - d) Die drei Positionen (mehr oder weniger gleichwertig/nicht gleichwertig)?
4. Welche Aktivitäten bezeichnen die Position des Expertes im Bereich Nanotechnologien am besten?
5. Welche Aktivitäten unterscheiden des Expertes von anderen, die im Bereich der Nanotechnologien tätig sind?
6. Welche Vorstellung hat man vom Expert in den drei folgenden Bereichen:
  - a) im Bereich der technologischen Entwicklung/im Produktionsprozess von Nano-Produkte?
  - b) im Bereich der Bewirtschaftung/im Bereich des (zukünftigen) Verkaufs von Nano-Produkte?
  - c) im Bereich des Gebrauches/im (zukünftigen) Konsumbereich von Nano-Produkte?
  - d) im Bereich von Unternehmen/Organisationen, die im Bereich Nano tätig sind/werden möchten?
7. Bekommt der Expert ein feedback von seiner Handlung im Bereich Nano? Wenn ja welcher Art von feedback und von wem?
8. Seit dem Ende 2006 spricht man mehr von Risiken, die mit Nanotechnologien verbunden wären. Man spricht einerseits von wirtschaftlichen Risiken wegen einer Überspezialisierung von wirtschaftlichen Sektoren. Andererseits spricht man von möglichen schädlichen Folgen der Implantation von Nano-Produkte 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 Drohung für die Entwicklung des Menschen und der Gesellschaft wären. Kennt der Expert solche Protest-Bewegungen? Was wäre die Reaktion des Expertes gegenüber solchen Bewegungen?
10. Was ist die grösste Schwierigkeit des Expertes im Bereich Nanotechnologie?

### **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 différenciée)?
4. Quels sont les activités qui permettent de décrire la position de l'expert au mieux dans le domaine des nanotechnologies?
5. Quelles 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 suivants:
  - a) développement technologique/de la production des produits nanotechnologiques?
  - b) secteurs économiques appelés 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'autre 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?

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Universität Lüneburg  
Institut für Volkswirtschaftslehre  
Postfach 2440  
D-21314 Lüneburg  
Tel.: ++49 4131 677 2321  
email: brodt@uni-lueneburg.de  
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