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DEMOCRACIES ON TRIAL

Assembling nanotechnology and its problems

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T H È S E

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TABLE

Foreword

In February 2010, I participated in one of the sessions of the French national debate on nanotechnology, notably a “workshop on ethics and governance” of nanotechnology. The format was quite unusual for a public debate. Because anti-nanotechnology activists had interrupted previous public meetings, the organizers had decided to adapt the debate, originally meant to be a series of public meetings opened to whoever was interested in participating. Thus, I had to fill out a form and submit it online. I received a response in an email in which I was asked for my mobile phone number and told to be at a Paris subway station the following day, 30 minutes before the debate was to begin. When I arrived at the designated time, a young woman handed me a map of the local area, where I could see the way from the subway station to the building where the debate would be held. After a short walk, I found the building and opened a dull and gray door with no sign on it. Two big men in dark suits greeted me and asked for my ID. Once cleared, I was shown to a staircase by which I got down to the basement of the building. At the end of a corridor with concrete walls, I finally arrived at my destination. In this closed and secret place, the debate would be protected from an unwanted public.

Like the other participants, I was sent to one of the rooms of the building to discuss in small groups issues related to the “ethics and governance” of nanotechnology. My group was quite small, and comprised, apart from myself, the president of the commission organizing the debate, a member of the French ministry of agriculture, a representative of an environmental movement partnering with industries and public bodies, and a member of a national consumer organization – all of them “friends of public debate”, as the president had called them[1]. A TV crew was filming us for later broadcast on a local channel in order to “account for the fact that the debate exists”.

The questions of “ethics and governance” discussed during this one-hour session were various. Some of them related to the “difficulty to locate the products in which nanomaterials were used”, particularly in the food industry, where “the industry did not seem to play the game”. This was problematic if the health and safety risks were to be regulated, and consumers informed, as the member of the consumer organization demanded. But for the member of the ministry of agriculture, there was “no nano in food”. Other interventions considered the “problem of participation”, and particularly the fact that anti-nano activists “refuse to enter democratic discussions” and had forced the organizers to hold a closed debate in the first place. Eventually, the president of the commission spoke about the “ethics issue”: how to construct a science policy program in an “ethical and democratic manner”? For him, this very debate was part of the answer.

[1] Quotes in this paragraph are excerpts from my fieldwork notebook.

As for my own role in the event, I was supposed to participate in the discussion, but felt increasingly uncomfortable. Previously, I had studied, and worked with, an association called Vivagora, which advocated the “democratization of technical choices”. Vivagora had been an initial supporter of public debate, but now criticized the organizers’ choice to stage closed events such as this one. I did not like the fact that my interventions could be broadcast, and my participation in this contested public debate made visible to actors like Vivagora. It was a relief that I had to leave early to meet with students. This excused me from the task of reporting the discussions, which the president of the commission had asked me to assume.

This short episode is an example of “public participation in nanotechnology”, and the many difficulties participation in ‘nano’ entails. First, public participation devices are not exterior to controversies about nanotechnology. The exceptional mechanism, through which the organizers had sought to exclude opponents of debate illustrates how investments are made to shield debate from an unwanted public, who conceives of participatory mechanisms not as ready-made instruments that could be “applied” to nanotechnology, but as components of a questionable nanotechnology policy. For the commissioners of the debate in the French government, this closed debate was to be made public (and the TV crew was there to ensure that it would be) and used to demonstrate that “it was there”, that nanotechnology was being discussed democratically. Second, whereas the debate was supposed to explore public concerns about nanotechnology, neither nanotechnology’s problems nor its publics seemed stabilized. Opponents refused the discussion, while participants to the debate were struggling to define what exactly they expected from it. Nanotechnology substances and products were not identified - discussions about their risks in the short episode narrated above evoked the question of their very existence – while science policy programs devoted to nanotechnology seemed to be central instruments in the transformation of nanotechnology into a public concern. In such a context, my external position was difficult to maintain. In this example, I was forced to engage in a device I had first intended to observe. I eventually left, as I sensed, not a threat to a “neutral” scholarly position, but a conflict between speaking publicly within this device and my engagement with the actors I was studying.

This dissertation initially started as an inquiry into the forms of “public participation” in nanosciences and nanotechnology, and originated from two observations. First, numerous calls for the “involvement of the public” were being heard throughout nanotechnology programs. Second, my disciplinary field – science and technology studies – had been concerned with the forms of public participation in science and technology, had described the ways in which patient organizations might be involved in the production of knowledge, the variety of lay and local knowledge, and the multiplicity of experiments that “democratized democracy”. It then seemed natural to look for examples of public involvement in nanotechnology, in which, possibly, "lay expertise" could be engaged, and ask about its effects on the making of nanotechnology.

As I moved forward in the study of nanotechnology and observed events such as the French national debate, it quickly appeared that an analysis focusing on "public participation" would miss the specific character of this field of science policy. Focusing on "public participation" would have meant that areas of "participation" (public debates for instance) were to be qualified beforehand as "participatory" in order to be included in the analysis. It would have implied that the boundaries of nanotechnology be defined in order to locate an area of activities where "public participation" happened. It would have carried with it implicit assumptions about the organization of democracy, supposedly made better thanks to more, or more efficient "participation". Eventually, it appeared to me that "public participation" was less an issue than democracy itself, that is, the many ways in which oppositions are organized, decisions are taken, legitimacy is gained, public objectivity is constituted, private and public sectors' respective areas of activities are defined, and, eventually, nanotechnology itself stabilizes as a collective problem.

Rather than "public participation in nanotechnology", this dissertation will therefore focus on "technologies of democracy", that is, the more or less stabilized instruments that problematize nanotechnology as a component of democratic activities. Through the analysis of technologies of democracy as they are experimented and critiqued, this dissertation explores the mutual construction of nanotechnology and democratic orders. It considers nanotechnology as a macro assemblage gathering material instruments and substances, science policy plans, collective concerns, and "publics", and enacting national and transnational spaces as it is stabilized. By considering various sites in Europe and the United States where nanotechnology is problematized, it interrogates the making of some of the activities of democratic life, namely social and technical representation, the administration of public problems, and social mobilization. The dissertation thus refrains from qualifying from the start what is "participatory" and what is not. This does not mean that the analysis loses any possibility to engage in the construction of democracy. As seen in the opening scene, my own engagement was at stake in the conduct of this study. The ways in which I have been engaged with nanotechnology will provide empirical foundation for the exploration of the normative value of the analysis.

Accounting for the construction of nanotechnology and democracy implies a methodological and theoretical reflection on the methods for an analysis of the democratic problems raised by nanotechnology. This will be undertaken throughout the dissertation, as I account for problematization processes and refine the analytical approach. But it is also necessary to understand in what ways nanotechnology is a political entity challenging democracies. This will be done in the first chapter, and will allow me to discuss two notions I will refine throughout the dissertation, namely *problematization* and *technology of democracy*. Once the methodological approach is clarified in the first introductory

chapter, I will then turn to the examination of sites where nanotechnology is problematized: sites, like science museums and participatory devices, where it is represented for publics (part 1), sites in national administration and international bodies where it is administrated (part 2), and sites where actors engage in its external or internal critique (part 3).

The challenge is to grasp "nanotechnology" as a hybrid, contested, and fluid entity, to locate the site where it is problematized, and to identify the "technologies of democracy" that constitute both nanotechnology and democracy. Identifying this challenge and trying to answer it have been the major part of my research work for the past five years. I owe a lot to Michel Callon. He was an irreplaceable guide in my first encounters with sociology and, later, in the development of this work. He has been a thoughtful, open-minded and stimulating *directeur de thèse*, without whom I would have had no chance to write this dissertation. Sheila Jasanoff welcomed me at the Kennedy School of Government in the early stages of this research. Since then, she has been a constant support and a permanent source of inspiration. I am grateful for all I have received from her. As I worked on nanotechnology and participated in academic and public events, I had the chance to benefit from numerous discussions with Arie Rip. I thank him for his help and his insightful comments on my work.

I thank Andrew Barry, Yves Sintomer and Andy Stirling for their participation in the jury of this dissertation. This is an honor for me to have this text read by these prominent scholars, whose works have been considerably helpful for me to understand the variety of sites where I could conduct an empirical political analysis of nanotechnology.

The *Centre de Sociologie de l'Innovation* has been an extremely stimulating and friendly environment over the past three years. I am grateful to Madeleine Akrich, and Catherine Lucas for her much needed support. The *atelier doctoral* has been the perfect place to enter the world of pragmatist thinking. I thank Antoine Hennion for his careful support and intellectual rigor. David Guston hosted me at the Center for Nanotechnology in Society at Arizona State University in 2007. I thank him for his openness to my external look at the CNS projects.

This dissertation is for a large part the outcomes of discussions and collaborations with my friends and colleagues Nicolas Benvegnu, Stève Bernardin and Michiel van Oudheusden. I am grateful for their help and constant interest in my work. As a friend, fellow *thésard* and demanding researcher, Benjamin Lemoine played a central role in the conduct of this research and the development of my arguments. I thank him for his permanent support, and, more importantly, for his invaluable friendship.

I developed the arguments in this dissertation with the help of numerous people, at the *Centre de Sociologie de l'Innovation* and elsewhere. Some of them commented on preliminary versions of these chapters, others wrote with me texts that I use in this dissertation and/or participate in collective research projects. I would like to thank Yannick Barthe, Kevin Burchell, Regula Burri, Antoine Cerfon, Jason Chilvers, Endre Danyi, Sarah Davies, Ariane Debourdeau, Pierre Delvenne, Pierre-Malo Denielou, Rob Doubleday, Liliana Doganova, Erik Fisher, Jean-Michel Fourniau, Pierre-Benoît Joly, Pierre-André Juven, Javier Lezaun, Dominique Linhardt, Alexandre Mallard, Morgan Meyer, Fabian Muniesa, Francesca Musiani, Vololona Rabeharisoa, François Thoreau, and Jan-Peter Voß.

Understanding the democratic questions raised by nanotechnology required collaboration with many people directly involved in its problematization. I am grateful to the people with whom I discovered this unusual field, and particularly to Dorothée Benoît-Broways, Daniel Bernard, Mathilde Colin, Benoît Croguennec, Nathalie Fabre, Stéphanie Lacour, Arila Pochet, and Françoise Roure. I owe a lot to Bernadette Bensaude-Vincent. As an "engaged scholar", she helped me understand the value of a position sometimes uncomfortable but also extraordinarily rich in epistemological and political terms.

The students of the *École de la Communication* at Sciences Po Paris have forced me to clarify the political value of STS. Over the past four years, they have stimulated my work more than they probably imagine.

Odile van de Moortel corrected the English and Rebecca Mitchells gracefully helped me cope with last minute hesitations about some of the central terms of this dissertation. I thank both of them for their willingness to make my gallicized English more readable.

CHAPITRE 1. VERS UNE ANALYSE DES PROBLEMATISATIONS DES NANOTECHNOLOGIES

Ce chapitre introductif définit le problème central de la thèse : comment la démocratie fonctionne-t-elle avec les nanotechnologies ? Le chapitre montre que les nanotechnologies sont une entité associant des objets, des futurs, des motifs d'inquiétude (*concerns*) et des publics. En utilisant le cas d'un projet européen visant à développer un réseau de laboratoires spécialisés en nanomédecine, la première section met en évidence les incertitudes fondamentales relatives à la définition des quatre composantes des nanotechnologies. Il apparaît ainsi que les nanotechnologies sont une entité politique de part en part, ce qui interdit pour l'analyse d'isoler une étape de « définition » du domaine, afin de pouvoir étudier ses « implications ». Les « implications » des nanotechnologies ne sont pas différentes des travaux permettant de les définir. La description des nanotechnologies est celle de la stabilisation d'assemblages associant objets, futurs, *concerns* et publics.

La seconde section du chapitre s'appuie sur cette démonstration pour introduire les concepts et outils analytiques utilisés dans la thèse. Comprendre la production conjointe de l'ordre démocratique et de l'entité que constituent les nanotechnologies nécessite d'étudier la *problématisation* des nanotechnologies. Le terme n'est pas neuf, et son usage peut s'appuyer sur plusieurs courants analytiques. En particulier, l'approche foucaldienne de la problématisation incite à refuser les dichotomies entre les « entités » et leurs « problèmes », afin de mettre au jour les processus qui constituent l'un et l'autre. La sociologie des sciences s'est elle aussi intéressé à la problématisation, afin de rendre compte de la construction d'alliances hétérogènes susceptibles de constituer des réalités techniques et sociales nouvelles. Dans la thèse, l'étude des problématisations des nanotechnologies est un moyen de mettre au jour des opérations de représentation, de gestion administrative et de mobilisation sociale. Elle permet par ailleurs de considérer comme un résultat de processus à décrire la position et le rôle du chercheur lui-même.

En faisant l'hypothèse que les enjeux démocratiques se manifestent lorsque sont exprimées et organisées des oppositions, il apparaît ainsi que la description des problématisations des nanotechnologies permet de s'intéresser à la production conjointe des nanotechnologies et de l'organisation démocratique. La troisième section de ce chapitre décrit les instruments analysés dans la thèse : définis comme des *technologies de démocratie*, ce sont les dispositifs qui problématisent, organisent la démocratie en même temps qu'ils définissent les nanotechnologies. L'entrée par les technologies de démocratie permet de mobiliser les méthodes des études sociales des sciences pour l'analyse des problématisations. On peut ainsi étudier les expérimentations et les démonstrations dans lesquelles les technologies de démocratie sont engagées. Ainsi, les trois parties de la thèse font écho à trois thèmes croisant les études sociales des sciences et la science politique : les processus de représentation et la réplication des technologies de démocratie (partie 1), les mécanismes de gestion publique et la définition d'existences (partie 2), les modes de mobilisation sociale et la production d'une extériorité (partie 3).

CHAPTER 1. Introduction: Toward an analysis of the problematizations of nanotechnology.

How does democracy function with nanotechnology? This question relates to both science studies and political science. It has analytical and normative dimensions, as nanotechnology is an entity in constitution, about which democracy is still to experiment. It makes it possible to examine democracy not as a ready-made form of collective organization, but as the outcome of trials to overcome. This requires an analytical focus on the problems democracy has to face. This angle has been advocated by political scientists analyzing the components of democratic life. For example, Pierre Rosanvallon proposes to "start from the *problems* democracy must resolve" in order to "investigate different national or historical experiences"[1]. The "problems" Rosanvallon is interested in are those of political philosophy, for instance "the tension between the sociological and the political principles of representation"[2]. Nanotechnology is an opportunity to pursue with empirical fieldwork the analytical interest for the "problems" democracy faces in order to study the construction of democracy itself. This first chapter explores the theoretical and practical challenges of the analysis of nanotechnology as an entity expected to be dealt with in democracy. By exploring the political dimensions of nanotechnology and the ways of studying them, it aims to define the methodological choices that will be followed, and introduce the conceptual notions that will be used and developed throughout the dissertation.

I start this chapter by exploring in the first section in what ways nanotechnology is a political entity. This can be read as a discussion on the notion of the "political" and the way of conceiving of the various dimensions of the political in the case of nanotechnology. But I am less interested in a theoretical reflection on the meaning of the "political"[3] than on very practical questions: how to undertake to study the making of democracy with nanotechnology? It is helpful to ground such an exploration on an example. I use a European project called *Nano2Life*, from which I draw links with the making of nanotechnology in Europe and the United States. *Nano2Life* was a European "network of excellence" in nano-biotechnology. It involved many of the technical areas labeled as nanotechnology, and allows me to explore the specificity of nanotechnology as a science policy domain. Using the case of *Nano2Life* as a starting point, I develop some tools, questions, and concepts proposed as instruments for the descriptions in the next chapters. Rather than ready-made tools to be "applied" to nanotechnology, they are concepts to be tested and refined as more descriptions are made in the following chapters.

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[1] Rosanvallon, 2008: 26

[2] *Ibid.*

[3] This has been a long-term concern of political theorists. More recently, it has attracted some interests in science studies (DeVriers, 2007; Latour, 2007).

Thus, I introduce in the second section of this chapter the notion of *problematization*. Focusing on problematization is a way of conceiving democratic activities in terms of the organization of oppositions and management of propositions for the definitions of collective problems. Consequently, the analysis of the making of democracy with nanotechnology can be performed through the description of the stabilizations and destabilizations of the problematizations of nanotechnology. This leads me to discuss, in the third section of this chapter, the empirical focus of the following chapters of the dissertation, namely the *technologies of democracy*, which I will consider as entry points to study the problematization of nanotechnology, and, thereby, the construction of democratic orders.

Section 1. Nanotechnology as a political entity

Objects

In January 2007, I met with Patrick Boisseau in his Grenoble office at a laboratory of the Commissariat à l'Energie Atomique called LETI (CEA-LETI)[1]. Boisseau, a biologist who had been working for CEA since 1987, had become coordinator of the "single European network of excellence funded under the 6th Framework Programme of the European Commission" called *Nano2Life*, which gathered 23 research institutions in ten different countries across Europe. As a "network of excellence", *Nano2Life* did not add new research projects to those conducted by the partners. Rather, it hoped to "reduce fragmentation in European nanobiotech" by undertaking various common initiatives, such as training programs in nanotechnology, exchange programs among partners, sharing of scientific equipment, and coordinating long-term research objectives among the partners.

The partners of *Nano2Life* would thus share their research projects, confront their results, and attempt to align their projects involving physicists and biologists. The range of cooperation between different disciplines was, for Boisseau, quite a new phenomenon. He told me that "the idea was really to bring together physics and biology, and use both of them for the development of new devices". By which he meant nanoparticles (that is, particles composed of fewer than 1,000 atoms) that could be used as tracking devices inside the human body for imaging, or as drug delivery devices (called "nanovectors"), bringing the drug to the very cell in need of it. "Regenerative medicine" was also a topic of inquiry, since "smart biomaterials" could be developed, that is, small-size components precisely targeted to be added to a human tissue. Nanoscale diameter fiber implants ("nanowires") could conduct an electric stimulation to a precise location in the body, for instance in the brain – the long term objective being nothing less than to cure Parkinson's and Alzheimer's disease[2]. Thus, *Nano2Life* was meant to bring together laboratories working with "nanoscale objects", designed to offer new properties thanks to the small size of their components. The laboratories involved in *Nano2Life* produced numerous objects made of assemblages of metallic atoms and biological molecules, implants and wires, nanoparticles and nanocoatings. Boisseau was enthusiastic about what the nanoscale could bring: nanoparticles could bear completely different chemical and physical properties from their non-nano counterparts, and, associated with biological materials, could pave the way for a "new biomedicine", tailored to the exact needs of the patient.

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[1] Unless otherwise specified, quotes in this chapter are excerpts from this interview.

[2] The objectives of *Nano2Life* are presented as follows on the project's website: "Diagnostics – In vivo imaging – In vitro diagnostics, Drug delivery – Nanopharmaceuticals – Nanodevices, Regenerative medicine – Smart biomaterials – Cell therapies, Implants and wearable sensors" (www.nano2life.org/, accessed Jan. 15, 2011).

The objects *Nano2Life* participants produced have an uncertain status. Nanoparticules are "new" substances in that they provide new properties (thanks to which, for instance, metallic particles can be used as tracking devices inside the human body, or to carry molecules of drugs). But how they differ from their non-nano counterparts, and whether, for instance, they are considered as "new particles" in current regulation is unclear[1]. Within European legislation, medical objects are regulated as either "products" or "devices", the former requiring stricter regulation (and constraining rules about human testing) than the latter. But whether a nanovector is a "product" or a "device" was uneasy to tell. This could be problematic, since these objects, developed for medical applications, would require human testing to be finalized. The uncertainty about where the *Nano2life* objects fall in the regulatory landscape is not a detail. It is a sign of the transformation nanomedicine proposes to bring to the conduct of scientific research, bringing together both physics and biology, both applied medicine and fundamental research, both human testing and upstream research, while paving the way for a medical discipline that attempts to specify its interventions according to the individual needs of the human patient, and, even more, to the needs of his each individual cell[2].

Nano2Life's material productions make a political dimension of nanotechnology explicit. Indeed, these artifacts "have politics", to use Langdon Winner's famous phrase, in that they inscribe users and long-term objectives in the organizations of health care[3]. More generally, and taking into account the flexibility of these objects themselves, one could interrogate the transformations they propose. How far do they challenge legislation, industrial strategies, the conduct of clinical trials, and the status of experiments with humans? Answering these questions is exploring a "political" dimension of nanotechnology's objects. To use a Latourian vocabulary, these objects reconfigure heterogeneous associations and make new ones emerge[4]. They are new material elements to take into account in the construction of a common world. They could be more or less equally distributed. They could benefit private companies, or be openly shared. They can offer new routes for the conduct of medical research based on the rapid development of applications, close relationships between physicists and biologists, and the blurring of boundaries between laboratory experiments and the development of medical treatments[5].

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[1] By considering controversies in the definition of the "nano-ness" of substances, chapter 4 will get back to this point.
[2] The argument is made by nanotechnologists themselves (see e.g. Jain, 2004; 2005)
[3] (Winner, 1992). This point has been largely developed by the sociology of science. For a recent example of the discussion of the "political qualities" of technological systems, see (Barthe, 2009).
[4] Cf. (Latour, 2005) for a presentation of the "sociology of association". The first meaning of the term "political" that Latour proposes is the introduction of new objects, and, thereby, of new associations – in which sense the discovery of a new planet or new materials is inherently political (Latour, 2007).
[5] Such an evolution has been described as "translational research" (Woolf, 2008).

Uncertain nanotechnology

The material dimension of nanotechnology is problematic though. For one can wonder what makes *Nano2Life* objects "nano". If "nano" points to the manipulation of matter at the atomic level, then it is best understood in terms of its scientific instrumentation – the main representative of which being the scanneling tunnel microscope (STM), which, by using the quantum "tunnel-effect", can picture individual atoms while simultaneously moving them. The STM was developed in the early 1980s. It made it possible to manipulate matter "atom by atom" – an idea that was central in the successive books of a scientist turned futurist, Erik Drexler, who advocated the development of "molecular manufacturing", by which "nanomachines" would be sophisticated enough to reproduce themselves[1]. What constitutes nanotechnology then was the topic of lengthy debates. Drexler and famous nanotechnologist Richard Smalley, Nobel Prize in Chemistry, the discoverer of fullerenes, and a key proponent of U.S. nanotechnology programs, opposed each other in the early 2000s in a series of articles about the feasibility of molecular manufacturing. The opposition can be summed up by what Bernadette Bensaude-Vincent called the "two cultures" of nanotechnology: while Drexler imagined using mechanical methods to manipulate atoms and construct nanomachines, Smalley, a proponent of a chemistry-based approach, contended that the mechanical "fingers" would be too "sticky" to manipulate atoms[2]. The opposition was not limited to academic circles. When the U.S. National Nanotechnology Initiative (NNI) was constituted in the late 1990s, Drexler argued that the NNI had sold nanotechnology to business interests, while representatives of private companies considered Drexler's visions as little more than "a wino's claims"[3]. The former considered that the NNI had gone "from Feynman to funding", that is, from a grand and path breaking vision prophesized by Nobel Prize Richard Feynman in the late 1950s and made of self-replicating nanomachines, to a collection of disparate projects, only gathered together because of their use of small-size objects, and, above all, economic arguments[4]. The latter contended that Drexler's arguments were little more than science-fiction, at best unrepresentative of what nanotechnology was in the concrete functioning of laboratories and businesses, at worst threatening to the general public, who could become skeptical of

[1] Drexler's book, *Engines of Creation*, became the central reference for nanotechnologists and "futurists" interested in molecular manufacturing (Drexler, 1990). The history of the STM has been explored by Davis Baird and Ashley Shew (2004). They reconsider its role in the making of the standard history of nanotechnology, and tie it to the strong connections between science and industry in this field.

[2] Bensaude-Vincent, 2004

[3] The anecdote is narrated by Ed Regis in an article in the magazine *Wired*. Regis describes how Drexler's attempts to convince Congress to fund a nanotechnology initiative eventually resulted in his own elimination in favor of business interests (Regis, 2004). I discussed this episode and its consequence for the contested nature of nanotechnology in (Laurent, 2010a: 28-32).

[4] Drexler, 2004

nanotechnology if fed with too many stories of self-replicating nanomachines potentially escaping human control – a risk Drexler himself had discussed in his work[1].

Hence the quality of being "nano", the "nano ness" of objects and programs, is not uncontroversial. For some, this requires to distinguish between "true" from "false" nanotechnology. Some nanotechnologists would thus contend that "true nanotechnology" is the making of molecular machines mimicking biological systems[2]. Other commentators prompt to distinguish the "truth" behind the "hype" – Drexler fueling the "hype", contrary to industrialists interested in the development of products using nanoparticles in (rather mundane) consumer goods such as textiles, construction materials, or cosmetics[3].

As for *Nano2Life*, this project gathered a number of objects, some already existing, others foreseen in the future, some based on isolated chemicals and others more sophisticated. *Nano2Life* was not concerned with molecular manufacturing as Drexler imagined it, but it did propose to use biological structure to construct molecular machines. *Nano2Life* also included in its objectives the development of nanoparticles that had been known for years, and which were, thanks to their integration in the project, rebranded as "nano". What made *Nano2Life* objects "nano" was, more than a single definition based on a scientific process (as genetic engineering could define biotechnology) or a material technology (as the computer could define information technology), their integration in science policy programs expected to attract public attention and support[4].

Consequently, looking at nanotechnology objects raises a fundamental difficulty: does the analyst need to distinguish between "true" from "false" nanotechnology, as authors trying to decipher the "nano hype" in order to identify "the truth behind it" would lead us to think? As I will argue throughout the dissertation, the contested and uncertain qualification of "nano" is to be the main focus of analysis if one wants to grasp the democratic challenge of nanotechnology. This requires that what makes an object "nano" is not considered as given, but as the outcome of negotiations and trials among actors, involving the evaluation of new physico-chemical properties, strategic economic considerations, and the construction of science policy narratives and instruments[5].

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[1] The discussion of the "grey goo" (that is, an uncontrollable cloud of self-replicating nanomachines) is presented in chapter 11 of *Engines of Creation*.
[2] Well-known French nanotechnologist Christian Joachim thus voiced his irritation at the widespread acceptation of the prefix "nano" in European and American programs (Laurent, 2010a: 33).
[3] Berube, 2006
[4] One could probably describe similar uncertainty in the definition of biotechnology programs. There is indeed "ontological uncertainty" about biotechnology products (Jasanoff, 2005a), as in nanotechnology (this will be discussed in chapters 4 and 5). The extension of the uncertainty to all the dimensions of the political that I am describing in this chapter might well be specific to nanotechnology.
[5] The displacement that I propose here is similar to the proposition of Luc Boltanski when studying "the making of a class". His perspective was to study the French *cadres* not as a ready-made social group that the sociologist could have deciphered, but as an entity resulting from the construction of a heterogeneous infrastructure (Boltanski, 1987).

Programming nanotechnology

Nano2Life was not just a project that produces knowledge and objects. As a "network of excellence" of the 6th Framework Programme – the only one in nanobiotechnology – it was a central component of the European research policy and was expected to "reduce the fragmentation of European research". As such, it was part of a global project that wished to organize the European Research Area according to the long-term objective of the Lisbon strategy, namely the "transformation process (of Europe) into a knowledge-based economy"[1]. *Nano2Life* was expected to answer a growing concern within European science policy circles: that European nanotechnology research was lagging behind that of other developed countries, most notably the United States. As a publication of the European Commission Directorate General (DG) for Research explained:

Europe is doing well, but has to reduce a gap with the United States and Japan in many fields and for many indicators. In addition, Europe has to observe carefully the development in the emerging nanotech countries China, India and Russia. Much will depend on Europe's scientific and technological excellence in order to strengthen the nanotech knowledge base in research and industry and not to ignore the parallel need for well-educated nanotech workers and researchers and world wide competitive infrastructure for knowledge production.[2]

This prompts me to make two important remarks. First, about the importance of the competitiveness argument, and of benchmarks among countries engaged in nanotechnology research. The author of the report from which the previous quote comes authored a paper in 2006 entitled "who is winning the global nanorace?"[3]. By then, nanotechnology policy had indeed become the scene of a race among developed nations. This was true from the viewpoint of Europe, as the previous quote illustrates, but equally manifest for the American counterpart. Testifying before the U.S. Congress in 1999, Nobel Prize Richard Smalley argued for the establishment of a coordinated federal program devoted to nanotechnology, which promised to "revolutionize our industries, and our lives", as an answer to growing economic threat from Europe and Japan. At that time, Smalley considered that:

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[1] References to the Lisbon strategy were explicitly introduced in the presentation brochures of the Nano2Life project.
[2] Hullmann, 2006a: 29-30
[3] Hullmann, 2006b

The U.S. does not dominate nanotechnology research. There is strong international interest, with nearly twice as much research ongoing overseas as in the United States. Other regions, particularly Japan and Europe, are supporting work that is equal to the quality and breadth of the science done in the U.S. because they have determined that nanotechnology has the potential to be a major economic factor during the next several decades. This situation is unlike the other post-war technological revolutions, where U.S. enjoyed earlier advances.[1]

The race for public funding went with a race for promises: the objectives of *Nano2Life* (such as "revolutionize cancer treatment") appear almost moderate when compared with the promises made by the proponents of U.S. nanotechnology programs. Their "utopian techno-visions" – an expression used by historian Patrick McCray - presented nanotechnology as no less than the "next industrial revolution"[2]. The second remark to make about the competitiveness argument is that it needs facts and figures to be sustained. Thus, scientometrics is regularly used in international bodies such as the OECD in order to demonstrate the growing importance of nanotechnology related research activities (as measured, for instance, by the numbers of papers published in journals identified as "nano", or using "nano" as a keyword) and describe the "state of the field" [3]. The European Commission uses, as in the report previously quoted, facts and figures in order to compare the European situation with that of other countries, most notably the United States. Statistics and indicators are expected to measure the quantity of nanotechnology research and its quality regarding criteria such as interdisciplinarity or number of patents. Thus, *Nano2Life*'s aim was not only the production of technical objects, but also the mobilization of research infrastructures that would ensure a leading European position in terms of patents and publications. In addition, the project was conceived as an answer to the European need for connections among laboratories scattered across the Union, and between fundamental and applied research. This implied the development of statistical tools, and criteria to define what was "nano" and what was not[4].

Consequently, nanotechnology appears as a science policy program, which integrates research projects for explicit, long-term strategic objectives supposed to be relevant for collective action. It is discussed in public institutions (such as the European Parliament or the American Congress), and administrative bodies. It is tied to questions of sovereignty and economic dominance of countries or international political spaces (such as the European Union). Indeed, as the measure of performance in

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[1] Smalley, Richard, 1999, Written testimony, House hearing: "Nanotechnology: The state of nanoscience and its prospects for the next decade", June 22, 1999, Committee on Science, Basic research subcommittee.

[2] McCray, 2005

[3] OECD, 2009, *Nanotechnology: an overview based on indicators and statistics*, STI Working Paper 2009/7. The case of the OECD working groups devoted to nanotechnology will be further examined in chapters 3 and 5 of this dissertation.

[4] Scientometrics works focusing on nanotechnology have developed sophisticated tools to measure the occurrence of "nano" (see e.g. Porter et al., 2008).

the "global nanorace" requires common definitions of what is "nano" and what is not, nanotechnology also appeared as an object of international concern, in that norms and standards were called for early in the development of nanotechnology programs[1].

Are nanotechnology objects and the long-term objectives presented in statistics and promises disconnected? This is what some commentators might lead us to think while trying to identify "the truth behind the hype", that is, the "real" laboratory practices that would lie "behind" the grandiloquent policy discourses based on futuristic promises and sustained by competitiveness arguments. But if one does not accept the dichotomy between "real" scientific practices and "false" nanotechnology, understanding the connection between the objects such as those *Nano2Life*'s laboratories produce, and the long term objectives forces to consider another component of nanotechnology: that of the instruments of science policy.

Futures

Patrick Boisseau was the coordinator of *Nano2Life*. He was also involved in many local, national and European projects. He had supervised the organization of the "*Nanobio* innovation center" in Grenoble, a research center partnered by CEA and the local university, which was meant to develop "new miniaturized tools for biological applications". Boisseau was a scientist who had become actively involved in the organization of nanotechnology research. He was not the only one. Nobel Prize Richard Smalley, in the U.S., was only the most famous of the scientists involved in the promotion of nanotechnology programs[2]. For Boisseau, "the synergies (were) clear" between *Nanobio* and *Nano2Life*: both initiatives were interested in the same nanotechnology applications, and defined as major objectives interdisciplinarity and application development. Boisseau's involvement in the local organization of nanotechnology research was tightly linked with the construction of European nanotechnology policy. During our discussion, Boisseau gave me a "vision paper" about nanomedicine, which had been released in 2005. He had participated in the writing of this publication of the European Union, which was the first step of the establishment of a "European Technology Platform" for nanomedicine ("ETP nanomedicine")[3].

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[1] E.g. in the European nanotechnology Action Plan.

[2] Cf. for instance the case of Vicky Colvin and her transformation of "responsibility" into a central concern of nanotechnology development (Kelty, 2009; McCarthy and Kelty, 2010). In France, Aurélie Delemarle described the case of a CEA director, Jean Thermes, who organized nanotechnology research programs in the Grenoble area (Delemarle, 2007). At the French national level, the people in charge of the program for the funding of nanotechnology at the National Agency for Research also come from CEA.

[3] European Technology Platforms are coordination mechanisms organized at the initiative of the European Commission and scientific actors. They are meant to contribute to the making of the European research policy.

The vision paper to which Boisseau contributed was crafted along the same themes as *Nano2Life*. It emphasized "Nanotechnology-based Diagnostics including Imaging", "Targeted Drug Delivery and Release", and "Regenerative Medicine", each of them illustrated by examples, such as "nanoanalytical tools" "incorporated into 'lab-on-a-chip' devices, which can mix, process and separate fluids, realizing sample analysis and identification"[1], "microfabricated device with the ability to store and release multiple chemical substances on demand"[2], or "'intelligent' biomaterials (...) designed to react to changes in the immediate environment and to stimulate specific cellular responses at the molecular level"[3]. For each of the three categories of products, "basis for a strategic research agenda" was proposed. For instance the vision paper considered, about nano-probes, that biocompatibility was to be improved.

The vision paper was only a preliminary step before the construction of a roadmap for European nanomedicine, written by researchers, industrialists, and officials from the European Commission, and to which *Nano2Life* directly contributed. For part of *Nano2Life*'s activities was the organization of "foresight exercises", through which the project could "identify the future applications or techniques to focus the research efforts on"[4]. The roadmap that emerged from the ETP nanomedicine and *Nano2Life* was meant to coordinate European research and define objectives for the next nanotechnology policy initiatives. It identified problems to be solved and potential outcomes. For instance, it defined "devices for drug delivery" as "targeted applications", and then pointed to "key R&D priorities" (e.g. biocompatibility of materials and miniaturized systems), needed technologies (e.g. "nanocapsules"), the "challenges" to be met (e.g. the stability of the device) and the diseases supposed to be cured (cancer, diabetes, or cardiovascular disease)[5]. The roadmap refused a model based on the autonomy of the academic sphere. On the contrary, it considered that nanotechnology required early identification of promising domains and definition of research funding flows. Fundamental and applied research had to come together, and the roadmap heralded "public-private partnerships" as instruments through which nanotechnology could be developed according to the objectives defined, with limited public funding support.

From the example of *Nano2Life*, nanotechnology appears as the outcome of science policy initiatives that connect developments in laboratories and long-term perspectives, material productions of objects, scientific results and expectations about the future. The roadmap that originated from *Nano2Life* and the ETP nanomedicine proposed a construction of nanobiotechnology bringing together administrative, industrial and scientific actors in the making of a technological domain connecting industry and academic research, fundamental and applied research, for the sake of the economic and

[1] Nanomedicine vision paper: 16
[2] *Ibid.*: 24
[3] *Ibid.*: 28
[4] www.nano2life.org; accessed January 12, 2011.
[5] Nanomedicine vision paper: 30

social European development[1]. Less than a representation of nanotechnology that could be assessed according to the accuracy of its description of a scientific reality, the roadmap actively contributed to produce nanotechnology by gathering scientists, rationalizing current developments in scientific laboratories, reflecting on their potential evolutions, and eventually operationalizing them in the making of European nanotechnology programs. *Nano2Life*'s motto was "bringing nanotechnology to life": it was as much about applying nanotechnology to biological applications as about making nanotechnology exist.

Nano2Life was not the only component of nanotechnology-related policy initiatives in Europe. Other programs in materials science, electronics, and environmental sciences were launched, within a global European nanotechnology strategy, presented in the "Action Plan" the Commission released in 2004[2]. The Action Plan aimed to make the European research area a major actor in nanotechnology research. This required, as seen in the example of *Nano2Life*, the operationalization of the future of nanotechnology in science policy instruments. In the United States as well, the future of nanotechnology was operationalized in roadmaps and programs of development. The most visible of these instruments is certainly the "four generations of nanomaterials", presented in a graph made by Mihail Roco, the director of the U.S. National Nanotechnology Initiative (NNI). It proposes a synthetic vision of the development of nanotechnology, in which "passive nanostructures" are followed by "active nanostructures", "systems of nanosystems", and "molecular nanosystems". When Roco published the graph in 2004, the last three generations were to be developed in the future (figure 1).

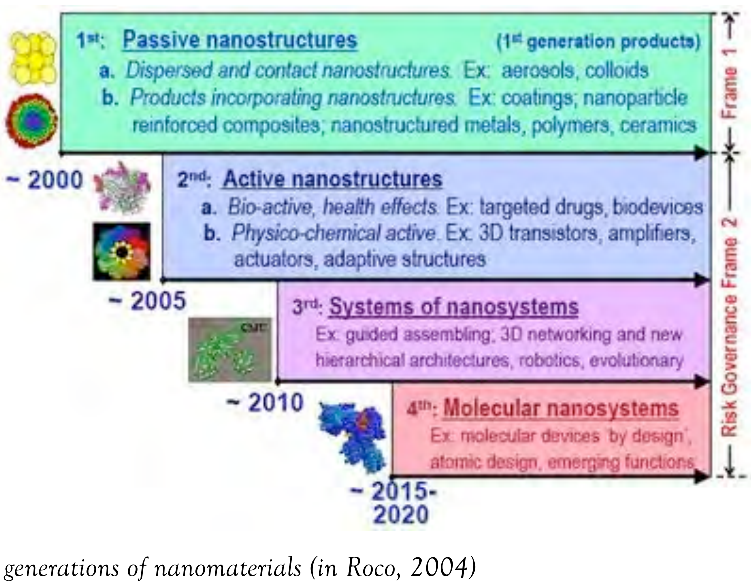

Figure 1: *Four generations of nanomaterials (in Roco, 2004)*

[1] Nanotechnology programs pursue a trend that originated in materials science (Bensaude-Vincent, 2001), and take it to yet another level, that of global funding plans for research.
[2] European Commission, *Nanotechnology Action Plan*.

The four-generation graph circulated widely. Roco displayed it at numerous academic conferences and workshops. It was presented in numerous science policy circles (such as the meetings of the ETP nanomedicine). It was used as a reference by science policy officials. Consider for instance how the person in charge of nanotechnology research programs at the French national agency for research (ANR) explained the organization of the funding plans for nanotechnology research:

Now we just crafted the new nanotechnology program (…) What I wanted to introduce – and we discussed this here with the participating scientists – is the development of nanosystems. It's Roco's fourth generation, it's the final step. This is the target, the domain we need to explore. We need to make sure the projects we will fund will get into this direction.[1]

The organization of research defined as such directs funding flows and stimulates particular trends of technological development. It is based on the constitution of networks between laboratories sharing knowledge and infrastructures[2]. It also aims to recompose the boundaries between fundamental and applied research, and among scientific disciplines[3]. The long-term objectives (economic competitiveness, transformation of research/industry collaboration, development of new medical tools) of nanotechnology programs are directly connected to the material construction of objects through the instruments of science policy. As Miller and O'Leary said about Moore's Law, these instruments "link science and the economy through acting on capital budgeting decisions, and in doing so (…) they contribute to the process of making markets"[4], as well as, one could add, laboratory practices and public decision-making processes.

Thus, constructing nanotechnology is not only constructing objects, but also constructing futures through science policy instruments[5]. The instruments that make the future of nanotechnology - funding plans, roadmaps, and science policy programs - operationalize conscious public choices, among which developing technologies for economic competitiveness, answering "social goals" (e.g. curing diseases),

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[1] Interview, Agence Nationale de la Recherche, Paris, April 22, 2009.

[2] The case of *Nano2Life* is an example. In France, one the early policy initatives in nanotechnology was a network called *Réseau Micro- Nanotechnologies*. In the U.S., the National Nanotechnology Infrastructure Network (NNIN) aims to make infrastructures available for scientific laboratories.

[3] This was translated in the very organization of the French National Agency for Research. The Agency replaced two directions of the Ministry for Research in 2005, one devoted to fundamental research and the other to industrial research. The PNANO program intended to overcome this dichotomy (interview ANR, Paris, April 22, 2009).

[4] Miller and O'Leary, 2007: 702.

[5] This perspective is close to that of the "sociology of expectations". But it is less interested in analyzing "retrospecting prospects" and "prospective retrospects" through the study of past and present discourses and the "representations of the future" they convey (Brown and Michael, 2003) than in the operationalization of expectations in actual technico-political instruments (see e.g. van Lente and Rip, 1998, and Michael, 2000 about the perfomative roles of expectations). The importance of expectations and foresight has been discussed in the case of nanotechnology, although often through a discourse-based analysis (Selin, 2007).

developing relationships between economy and industry and long-term R&D objectives (such as molecular manufacturing or molecular nanosystems[1]). This implies that nanotechnology is the outcome of collective decisions to be made about the future (e.g. allocating public money for nanotechnology research, and developing particular technological areas rather than others), which involve scientists, industrial actors, and public officials in hybrid arenas (like the nanomedicine ETP). Thus, describing nanotechnology necessarily implies picturing collective and distributed processes of decision-making.

Concerns

Discussing *Nano2Life*, Boisseau immediately mentioned the network's "strong concern for ethical issues". An "Ethical, Legal and Social Aspects (ELSA) board" had been set up since the beginning of the project – and Boisseau proudly gave to me one of its publications[2]. It was the first of its sort in Europe in the field of nanobiotechnology. It followed the requirements of the European *Action Plan* that nanotechnology's ELSA should be taken into account. The vision paper of the ETP nanomedicine devoted a section on "regulatory issues and risk assessment", and another one on "ethical issues". For Boisseau, the concerns with nanotechnology were indeed either "related to risk", or "ethical ones". The former dealt with the potential adverse effects of nanoparticles and nanomaterials for the human health and the environment. Nanotechnology research and industry produces substances bearing enhanced properties, and which, as Boisseau wondered, could also have different toxicological reactivity from their non-nano counterparts. The latter were much more vague in Boisseau's discourse: they referred to "problems of informed consent", "issues of fair repartition of benefits" and "long term issues" – by which he meant philosophical questions related to the use of biological materials for the making of (still hypothetical for most of them) nanomachines, and issues related to the use of nanotechnology for "human enhancement". While the risks of nanoparticles and the first two ethical questions were largely relevant for Boisseau, the last ethical interrogation was for him much more remote on the scale of his worries. For Boisseau, the work about ELSA that *Nano2life* produced could benefit the future making of European nanotechnology programs: the vision paper for nanomedicine indeed devoted a large part of its presentation to the investment needed in the field to the examination and treatment of nanotechnology's concerns, thereby integrating them in the making of nanotechnology's futures.

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[1] One can track back the integration of futuristic literature into the making of science policy programs. For example, graphs used in the science fiction-inspired *Age of spiritual machines* by Ray Kurzweil, are re-mobilized in reports of the U.S. National Academy of Science evaluating the National Nanotechnology Initiative (Laurent, 2010a: 41-42).

[2] *Nano-Bio-Ethics. Ethical dimensions of Nanobiotechnology*, edited by Johann S. Ach and Ludwig Sie.

That nanotechnology could raise public concerns is not surprising. By bringing new objects into life, scientific research is bound to do so. Biotechnology, for instance, produces new living organisms by genetic manipulation, transforms embryos into research objects, living material into patentable goods, and, eventually makes "life itself" a public concern[1]. Nanotechnology does not seem to be different from other domains of scientific activities for that matter. This was well recognized by Boisseau, as he explained that *Nano2Life* had felt compelled to set up an ELSA board because of the "questions nanotechnology raised, as any other technology". But as opposed to stem cells, embryos, GMOs or nuclear waste, nanotechnology "objects" are not easily identifiable. They gather medical products, chemical substances, commercial products, laboratory objects, and future developments that exist nowhere but in roadmaps and strategic plans. For Boisseau, the previous experience of past controversies and the fact that nanotechnology objects were still in the development phase forced scientist to "make it right". He meant that *Nano2Life*, and, even more, European nanotechnology policy, had the "obligation" to identify and deal with nanotechnology concerns even before problems or controversies emerged. In previous cases indeed, such as biotechnology, questions related to the risks of objects as GMOs, or ethical issues related to "messing with nature", have caused considerable controversies, whether related to risk evaluation[2], or to the reduction of ethical questions to risk evaluation[3],

Boisseau's call to "make it right" was not an anecdotal proposition formulated by one single individual scientist. When Mihail Roco and William Bainbridge, the two persons in charge of the American National Nanotechnology Initiative, organized in the early 2000s a series of meetings about the "societal implications of nanotechnology", they explicitly took in charge the concerns that nanotechnology might raise[4]. For them, it was necessary, for nanotechnology to be a success, to integrate the study of these "implications" in the very making of programs – by that they meant that the potential safety risks of nanomaterials were to be evaluated and taken care of at an early stage, and that the potential ethical issues of nano objects (such as the informed consent of patients involved in medical trials, or the question of "human enhancement" through nano devices) were addressed.

When the U.S. *Nanotechnology Act* was passed, it required that the study of the "social impacts" of nanotechnology be "integrated" within nanotechnology federal programs. The Action Plan of the European Commission also made it clear that "ethical, legal and social aspects" of nanotechnology (known as ELSA) were to be considered, which prompted the funding of numerous European projects meant to answer questions such as:

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[1] (Rose, 2001), cf. (Jasanoff, 2005; Rajan, 2005).
[2] Levidow et al., 1997
[3] Cf. (Levidow, 1997). Brian Wynne discussed how the reduction of ethical issues to problems related to risks resulted in public mistrust (Wynne, 2001).
[4] Roco and Bainbridge, 2001; 2003; 2005.

What will society look like when nanotechnology becomes more mainstream? Will the products be profitable? Are there any negative environmental or health impacts? Who controls the use of nanotechnology? How to deal with liability? Whom will the technology benefit or harm? What are the ethical problems?[1]

The last question clearly shows that the "ethical problems" of nanotechnology were then far from determined. On the contrary, the ELSA projects were expected to anticipate their emergence by exploring as early as possible the potential issues they could raise.

The "integration" of ELSA in nanotechnology programs means that research projects related to "implications" are funded as part of nanotechnology programs, some involving social scientists, others led by toxicologists or environmental scientists. In *Nano2Life*, ethicists and scientists were supposed to work closely together. In other cases, the importance of the integration of nanotechnology concerns is such that some speak about a "safety by design" approach, which would bring materials scientists, biologists and toxicologists together in the making of new nanomaterials with a collection of precisely tailored properties - among which toxicological properties[2]. Thus, the interest devoted to nanotechnology concerns in science policy programs could result in their integration in the very making of material products, as it could be the sign of the existence of separated activities gathered, without other connections, under the global umbrella of "nanotechnology".

Consequently, how the interest for nanotechnology's issues relates to the actual making of nanotechnology products and applications, and to the construction of nanotechnology's futures is a question to ask. It will be done in the following chapters. At this stage, suffice it to consider that nanotechnology is composed not only of objects and futures, but also of "concerns", part and parcel of science policy programs. Making these programs is thus also making public concerns, and ways of dealing with them. Consequently, studying the construction of nanotechnology is studying the construction and evolution of public concerns[3].

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[1] Hullmann, 2008: 7

[2] Kelty (2009) describes the development of the "safety by design" approach by the American chemist Vicky Colvin, who was actively involved in the making of nanotechnology federal programs. I will get back to this approach in chapters 5 and 6.

[3] This is a central concern of the sociology of public problems. I get back to the body of literature in the next section.

Publics

John Dewey famously argued that in a democratic society, "publics" emerged when problems are not adequately dealt with in existing institutions[1]. Whether or not Patrick Boisseau had read Dewey, the mechanism of the emergence of publics he outlined to me was not far from the pragmatist understanding of publics and problems:

Well, it's as simple as that. If there is trouble, if there is a health crisis, then the public will not accept this. It is crucial not to do the same thing as GMOs. *I think it's something everybody is aware of.*

By which he meant that GMOs had become rejected by the European public –an argument routinely used by nanotechnology proponents in administrative circles[2], which caused his cautious attention to the "public of nanotechnology". Nanotechnology's public was yet another component of the *Nano2Life* project, which included in its objectives the "education of society", and the "dialogue with civil society". The former related to training programs for students, and materials aimed to communicate the outcomes and objectives of *Nano2Life*. The latter pointed to the identification of public concerns, for instance thanks to the ethics board. The other components of the European nanotechnology policy, in heralding the "societal dimension" of nanotechnology, also insisted on the need…

to establish an effective dialogue with all stakeholders, informing about progress and expected benefits, and taking into account expectations and concerns (both real and perceived) so to steer developments on a path that avoids negative societal impact.[3]

The call for "public dialogue" and the consideration of "citizens' expectations and concerns"[4] was not limited to Europe[5]. Following the reports released by the U.S. National Science Foundation about

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[1] Dewey, 1988

[2] See for instance a report about ELSA activities in Europe written by a member of the D.G. Research (Hulmann, 2008). A frequent interpretation is the "wow to yuck" curb, which the public would be supposed to follow in its acceptance of technology. The accuracy of these understandings of public reactions can be questioned (Rip, 2008; on the perception of GMOs in Europe see Marris et al, 2001). This does not change my argument, that nanotechnology's publics are integrated in the making of nanotechnology policy.

[3] European Nanotechnology Action Plan: 8. See also (Hulmann, 2006a: 12) on the need to "take into account" "citizens' expectations and concerns" since "they present an important impact on the acceptance of new technologies on the market and can decide market success or failure".

[4] Hulmann, 2006a: 12

[5] Cf. (Kearnes and Wynne 2007; Macnaghten, *et al.* 2005) for comments about the importance of the deliberation theme in nanotechnology policy, and its consequences for the involvement of social scientists. This latter question

the "societal implications of nanotechnology", in which the need for "two-way communication with the public" had been expressed[1], the US Nanotechnology Act required that US nanotechnology programs

ensure that ethical, legal, environmental, and other appropriate societal concerns, including the potential use of nanotechnology in enhancing human intelligence and in developing artificial intelligence which exceeds human capacity, are considered during the development of nanotechnology

by

providing (...) for public input and outreach to be integrated into the Program by the convening of regular and ongoing public discussions, through mechanisms such as citizens' panels, consensus conferences, and educational events, as appropriate[2]

When integrated in nanotechnology policy, the mobilization of publics becomes part of what is to be discussed and decided about nanotechnology. It implies the construction of specific devices: instruments expected to represent nanotechnology for "the public", to "inform about progress and expected benefits" (to re-use the language of the Action Plan), and also devices aiming to "take into account expectations and concerns", which requires on the one hand to "make the public speak", and, on the other, to mobilize what the public says in ways that can be said to have taken it into account.

For Boisseau, the interest for nanotechnology's publics had a vivid significance. He had been confronted in Grenoble with anti-nanotechnology groups, who had transformed the peaceful French Alps town into the scene of violent oppositions against nanotechnology[3]. Boisseau had then participated in public meetings about nanotechnology, sponsored by the local elected bodies as a response to these oppositions. When I met him, he was skeptical about these meetings: "people did not really touch on the real problems", he said to me. He went on: "in *Nano2life*, the ethics board managed to do far better, and provide concrete outcomes that will then be brought back to the Commission". By which he meant that *Nano2Life* had discussed at length the issue of the fair repartition of nanotechnology benefits, and had voiced a cautious voice on "human enhancement" through the use of nanodevices in the human body – which was indeed later restated in other publications of the European Commission about nanotechnology[4]. The ELSA board was thus, for Boisseau, a channel for the representation of the public in order to integrate it in the making of nanotechnology programs, and, by the same token, to represent

is important, and will be discussed at further length in other parts of the dissertation (particularly in chapters 3 and 6).

[1] Roco and Bainbridge, 2001.

[2] U.S. Congress, "21st Century Nanotechnology Research and Development Act", S.189 (P.L. No.108-153).

[3] (Laurent, 2007). I will get back to this case in chapter 7.

[4] Cf. chapter 6.

nanotechnology objects, futures and concerns for the public to understand them. This was not the only way of conceiving the production of nanotechnology publics: the anti-nanotechnology activists marching on the streets of Grenoble offered a clear contrast.

As Patrick Boisseau in Grenoble, nanotechnology actors (whether public officials, scientists, or, like Boisseau, mediators between the two) struggle with the devices to be organized, the actors to talk to, and the interventions of critical groups. How to construct the devices meant to "make the public speak" and connect them to the production of concerned groups seeking to intervene in the making of nanotechnology will be an interrogation of the following chapters. At this stage, one needs to accept that nanotechnology is as much about publics, as it is about objects, futures, and concerns. For the analysis of nanotechnology, this means that the interesting question is not about the "true" representation of public opinion about nanotechnology, but about the instruments that are used to manufacture the publics that are supportive of, or involved in the making of nanotechnology, and contribute to stabilize it[1].

Analyzing the assemblage of nanotechnology

The example of *Nano2Life* shows that nanotechnology is a broad and undefined entity, which gathers material substances and products constructed in laboratories, promises of future realizations, mechanisms aimed to define public concerns and make the public speak. Making nanotechnology implies assembling material objects, decisions about the future, definitions of public concerns, and publics with roles to specify. It then follows that the analysis of nanotechnology is also an exploration of that of a political entity, "political" in so far as it is made of objects, programs, concerns and publics. This has implications for the exploration of the initial question of this dissertation, about the functioning of democracy with nanotechnology: one cannot make an a priori distinction between "nanotechnology" and its "political aspects". Accordingly, talking about nanotechnology's "implications" would prevent from accounting for exploring its treatment in democracy, as it would essentialize nanotechnology in order to examine its "consequences". This is important, as the analysis of nanotechnology I propose could appear close to other works interested in the "policy impacts" of emerging science and technology, from which I want to distance my approach. Consider for instance the following quote, from the introduction of a recent edited volume on the "challenge of policy-making for the new life sciences":

[1] This echoes the analysis of the mobilization of public opinion in the making of a historical narrative solidifying a certain reality (Cf. Gaïti, 2007; for an example about the creation of the French Fifth Republic). Such an analysis requires a close examination of the performativity of social science for the making of public opinion (Osborne and Rose, 1999; Law, 2009; for the history of opinion polling, Blondiaux, 1998).

There is broad agreement that we need new modes of governance to cope with this increased level of complexity as well as new rules of engagement in the government process for the various stakeholder groups involved (…) (since) *existing institutions are failing to deal adequately with the new regulatory issues raised by genomics. Much has been written recently about public engagement as a new tool of governance in the context of genomics.* (…) *the politicization of the life sciences has been uneven with most governance still in the form of traditional advisory structures.*[1]

There might well be "new modes of governance" needed for nanotechnology. But the "increased levels of complexity" of the field cannot be separated from its "modes of governance". Nanotechnology's "stakeholder groups" are not an unproblematic category: the European citizen, the patient groups, the researchers turned into nanotechnologists for the sake of public funding, and the future consumers of nano objects as produced by market research are all categories to be constructed, and parts of nanotechnology. That "public engagement" occurs at multiple levels in the very making of nanotechnology makes it difficult to adopt a normative stance on it. In short, adapting a statement like the previous quote for nanotechnology would solidify a separation between nanotechnology and "governance", and take for granted realities ("need for new forms of governance", "need for public engagement") propositions that are central in the making of nanotechnology programs.

Statements of a tonality close to the previous quote are numerous in the case of nanotechnology. They are voiced by the promoters of nanotechnology themselves. For instance, the director of the U.S. National Nanotechnology Initiative, Mihail Roco, wrote a paper with Ortwin Renn, a well-known specialist of risk perception studies, in which the two explained that nanotechnology was in need of "a switch from government alone to governance". Using works on governance by the authors of the previous quote, they argued that instead of "a top-down legislative approach which attempts to regulate the behavior of people and institutions in quite detailed and compartmentalized ways", what was required was a system in which "people and institutions behave so that self-regulation achieves the desired outcomes"[2]. In Renn' and Roco's perspective, the governance system was to be composed of the examination of the health and safety risks of nanomaterials at an early stage in the development of nanotechnology products, of international initiatives to promote common standards able to ensure the safety of nanotechnology objects, of permanent interrogations of nanotechnology's existing and future ethical issues through the mobilization of social scientists as well as dialogues with "the public". This required a "coordinated approach" comprising the standardization of products, training programs for both scientists and social scientists, measures of public perceptions of nanotechnology, and careful risk

[1] Lyall et al., 2009: 8-9
[2] Renn and Roco, 2006a

examination. This program does not sound surprising after the previous pages. What Renn and Roco suggested was a synthetic version of nanotechnology programs as they were being developed in Europe as well as in the U.S. The "governance system" proposed by Renn and Roco cannot be separated from nanotechnology itself, as a set of objects, futures, concerns and publics: it is a condition for nanotechnology to exist. Such a proposition needs to be considered, for anyone wishing to understand the making of nanotechnology and its stabilization within democratic societies, as a symptom to interrogate (How does such a "governance system" come to be stabilized? How do they translate in the transformation of nanotechnology into a concern for democracies? What form of democratic organization does it enact?) rather than as a ready-made solution to follow.

Thus, nanotechnology appears as an important case for both political science and science studies, as one cannot examine the construction of scientific knowledge and technical objects without exploring at the same time the intertwined production of public management approaches for new objects, decision-making processes on future developments, definitions and treatments of collective concerns, and forms of mobilization of publics. Eventually, asking the question of the functioning of democracy with nanotechnology is also asking the question of the constitution of nanotechnology itself as a political entity. The following chapters can thus be read as empirical explorations of "coproduction", to re-use a term convincingly introduced by Sheila Jasanoff[1]. They provide descriptions of the mutual production of acceptable scientific results and legitimate decisions, of science policy programs and national (or European) sovereignty, of nanotechnology and forms of citizenship. The question is then to locate the sites where these phenomena of coproduction are visible. They are the places where the functioning of democracy and the assemblage of nanotechnology are made explicit.

Sites for the assemblage of nanotechnology

The focus on the micro objects of nanotechnology leads us to explore the construction of a macro assemblage of science policy programs, laboratory and industry practices, consumer goods and expected developments, devices that make publics speak and concerns that are expected to be dealt with. The ambition of this dissertation is to consider nanotechnology as such, as an assemblage of objects, futures, concerns and publics. This is a necessary condition in order to grasp the intertwined political dimensions of nanotechnology, and, ultimately, the functioning of democracy, as nanotechnology is constituted.

The refusal to separate "nanotechnology" from its "political dimensions" has more implications than a mere methodological stance. It also means that accounting for nanotechnology is describing the

[1] Jasanoff, 2004a

stabilization of an entity that cannot be *a priori* limited. The following chapters will try to grasp nanotechnology as a fluid, large category, which develops by integrating its own "impacts"; which connects objects, futures, concerns and publics in global programs; which is heralded as the "next industrial revolution", but could well vanish in the future if the coordination instruments that make it exist are not robust enough.

For nanotechnology is an unstable category. Recall the vivid discussions involving Drexler, the scientists wishing to promote their own definition of nanotechnology, the commentators trying to eliminate the "hype" from "real" nanotechnology. This again could prompt one to define nanotechnology in a strict manner before embarking on the analysis of its "political dimensions". As it should now be clear, I choose an opposite direction: as the very stabilization of nanotechnology is the locus of interplay between various "political dimensions", I do not define from the start the boundaries of nanotechnology, in order to observe its stabilization (or, for that matter, its destabilization), as a set of objects, futures, concerns and publics. Thus, the following chapters hope to shift the attention of science studies to macro, but unstable entities, which have tangible effects – in this case, millions of euros and dollars of funding, the re-organization of scientific research, the mobilization of publics, and the production of chemical substances and consumer goods. This implies an analysis of diverse empirical sites, where objects, futures, concerns and publics are constituted.

One can consider a variety of sites where such a macro object is discussed and brought to life. Nanotechnology could be studied in the way other domains of scientific activity have been. When considering the multiple laboratories that compose the *Nano2Life* "network of excellence", laboratory studies immediately come to mind. They illuminated the processes of production of the scientific truth in the 1970s and 1980s[1]. Undertaken in the case of nanotechnology, they provide opportunities to explore the re-combinations of scientific disciplines, the hybrid nature of scientific instruments, and the integration of science policy concerns in scientific practices (for instance through the financial incentive to use the "nano" label to designate research projects, or the stress put on the "ethical and social" implications of scientific work)[2]. As industries play a central role in developing, producing, and commercializing substances and products, academic laboratories are not the only sites where nanotechnology objects are produced, and similar approaches could be conducted about industrial laboratories. Despite the value of this type of work (some of which will be undertaken in this dissertation, especially in chapter 4), laboratories cannot be the sole sites of analysis if one wants to grasp

[1] See for a canonical example (Latour and Woolgar, 1979).

[2] (Hubert, 2007); see also (Merz, 2010) about the way nanotechnology reconfigures the organization of a laboratory.

the constitution of nanotechnology as a macro entity[1]. As the example of *Nano2Life* demonstrates, laboratory objects are connected to mechanisms of representation for publics–to-be, to local planning initiatives (as in Grenoble), to standardization organizations where their "nano-ness" is discussed, and to science policy bodies organizing nanotechnology research where long term objectives and public values ("competitiveness", "human performance" or "sustainability") are made operational in roadmaps and funding plans, and where they become objects of "risks" and "ethics".

It is in the places where these connections occur that the intertwined political dimension of nanotechnology, and, consequently, where the questions that it raises for the functioning of democracy will be visible. Accordingly, the dissertation will analyze a variety of sites, in Europe and the United States, where nanotechnology is constituted as a macro entity while being defined as a collective problem. What should one look at in these sites, how to choose them, and to organize them in order to describe the mutual constitution of nanotechnology and democracy? These questions are discussed in the next section.

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[1] This move has been advocated by Jasanoff when developing the coproductionist agenda. For Jasanoff, the focus on "co-production" rather than laboratory controversies allows the analyst the re-think the issue of its reflexive engagement (Jasanoff, 1996). I will get back to this important point in the next two sections of this chapter.

Section 2. Problematizations of nanotechnology

In order to grasp the construction of nanotechnology as a macro entity and the multiple sites in which the democratic problems of nanotechnology are raised, it then seemed important to multiply the points of analysis. Hence the dissertation will consider different sites, of multiple facets: sites where nanotechnology objects are being normalized, where concerns are discussed, where collective decision-making processes are experimented, where social movements propose alternate constructions of nanotechnology.

What they have in common is that they are places where nanotechnology is *problematized*, where the construction of objects, futures, concerns and publics is at stake, where nanotechnology is made as a problem for democracy, for which solutions (be they technical, procedural, institutional, or related to social mobilization) are crafted. A central hypothesis of the following work is that the democratic treatment of nanotechnology is made visible in the places where nanotechnology is made a problem, related, in one way or another, to the political aspects detailed in the previous section. Accordingly, the following chapters analyze the *problematizations* of nanotechnology, that is, the processes that define the problems of nanotechnology and the devices to be used to deal with them. Through the study of problematizations, I intend to explore the mutual construction of objects, futures, concerns and publics of nanotechnology, to grasp, without distinguishing between them, the political aspects of nanotechnology, and, eventually, to better understand the questions it raises for the functioning of democracy. "Problematization" is not a new term. My use of it stems from various bodies of work, and differs from others. This section discusses the notion of problematization as used in political science, in Foucault's works, and in some branches of Science and Technology Studies (STS). It then refines it for further use in the following chapters of this dissertation.

Problematization and political science

The body of literature in political science concerned with the definition of public problems and ways of dealing with them seems close to my own interest in problematization. It is helpful to help focus the analytical attention to the evolution of public problems, and it prevents to consider as a given their collective dimension. However, building on this literature in order to account for the problems of nanotechnology requires making some differences explicit. Indeed, works interested in processes of "agenda building" or "agenda setting" tend to solidify elements considered as "context" (e.g. political institutions, or public values), which are then used to explain the trajectory of the problem being studied. Agenda studies analyze the mechanisms through which a problem is included in the functioning of political institutions (which are considered already known by the analyst), these mechanisms being determined by a series of social variables (e.g. values, cultural identities) considered as ready-made categories[1]. The sociology of social problems tended to adopt a similar approach. This echoes an approach to the sociology of social movements that asks how social actors mobilize resources in order to manage to impose their perspective on a particular problem to solve. The unit of analysis is, in this latter case, the individual behavior of the actor (or that of the social group), which is supposed to be linked to a certain interest (making his group grow, and "frame" the problem for that end). The analysis of the framing of public problems as it is presented in the sociology of social movements[2] thus tends to solidify the problem itself, of which only the modalities of its "framing" are modified by the actors involved, as it evolves from an individual concern to a collective issue. Similarly, works interested in phenomena of "amplification" through the media assume a separation between the "reality of the problem" and the "means of amplification". This is based on a hypothesis that contends that the problem itself bears an unquestioned reality[3], and describes the same type of linear evolution (from individual to collective concern) as the sociology of social movements.

Political science has however shed light on the trajectories of public problems, and the fact that they are different versions of the realities of a situation. This is what Joseph Gusfield did with drunk driving[4]. This body of literature suggests not to consider the "problems of nanotechnology" as a given, but to account for their stabilization. In the case of nanotechnology, this appears much more satisfactory than a "social constructionist" approach that would use social categories ("values" or "interests") as explanatory factors for the evolution of problems[5] Indeed, the separation between the "problem" and

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[1] Works looking for causal relationships among unquestioned entities ("social groups", "cultural values", "agenda",...) are pursued by authors claiming to be "constructionist", or even "post modernist", who seek to draw connections with the sociology of public problems (Rochefort and Cobb, 1994; Bosso, 1994).

[2] This stream of work was famously introduced by David Snow and has often been re-endorsed since then (Snow et al., 1986; Benford and Snow, 2000). Works in this approach describe the dynamics of social movement, and the ways (e.g. the definition, "framing", of the problem) through which a social movement manages to mobilize resources and individuals on a particular topic. For a discussion of frame analysis, see (Cefaï, 2001).

[3] Cf. the studies of the "agenda setting function of the mass media" (McCombs and Shaw, 1972), which analyze the influence of media on public opinion and/or political agenda (that is, the agenda of institutions known as "political"). Following this perspective, the "agenda setting" stream studies the causal relationships between media activities and the transformation of a question into a public problem.

[4] Gusfield, 1981

[5] Initiated by Spector and Kitsuse (2001; see Schneider, 1985 for an overview), the sociology of public problems studies the way through which actors define situations as "problematic" and contribute to their transformation into public problems. The approach is a self-defined "constructionist" one, which seeks to demonstrate how the nature of the problem and its (material and human) elements, as well as the range of possible solutions is constructed, so that it becomes possible to deal with the question as a public issue. One can read Gusfield in a social constructionist way. When he displays the processes through which actors manage to impose a definition of public problems, he also relates this process to a certain state of the public, who can react to certain stimuli and no others. Thus, in order to be accepted as a public problem, the question needs to be "staged": Gusfield speaks of "public drama", a necessary step to produce certain meanings that could align with the values of the audience (he

taken for granted social categories ("values", "culture",...) as well as other types of separation (such as that between "problem stream" and "solution stream"[1]; between "principles of selection", "culture and politics" and "organizational characteristics"[2]) raises an analytical issue that could be qualified as that of the "levels of problematization". Performing such separations would lead us to identify what is stable enough and can serve, for the analysis, as an explanatory category to account for the particular format of the problem. This is precisely a quandary I want to avoid when studying the problematization of nanotechnology: I do not want to separate "nanotechnology" from "institutions", "culture", or "public arenas", in order to describe the trajectory of the former according to the characteristics of the latter. The problematization of nanotechnology, which originates in government offices and scientific laboratories, circulates from public to private institutions, and among developed countries, cannot be easily described in terms of a linear trajectory from local concerns to collective problems. Nor can it be "explained" by the interests of some, or the cultural values of others. "Interests" and "values" are certainly at play in the making of nanotechnology. But they are part and parcel of nanotechnology objects, futures, concerns and publics. They are inscribed in instruments (such as roadmaps), are discussed in public offices or on the streets of Grenoble, and are put to test with nanotechnology. Thus, any approach separating them from the "problem of nanotechnology" in order to make them external factors would prevent from describing the intertwined political dimensions at stake with nanotechnology.

A critique of the agenda studies is formulated by Yannick Barthe, who explains that: "most of them have focused on factors one can qualify as exogenous, in that they stress the contextual modifications expected to explain the trajectory of questions"[3]. Barthe, using the example of nuclear waste policy in France, also insists on the temporal evolution of public problems, and extends the interest of political science for politicization[4] by considering the mutual evolution of technical objects and public problems. In this perspective, the analytical interest is not directed toward the trajectory of a

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illustrates this point with the case of Nixon's apologies after the Watergate scandal, Gusfield, 1981: 183-185). For a detailed comment on the genealogy of Gusfield's thoughts, and a discussion of his constructivist approach, see (Cefaï, 2009).

[1] Consider for instance the studies of the trajectories of "problems", "solutions" and "political contexts" that Kingdon (1984) proposes. For Kingdon, these three streams are disjointed, have stable existence, which the analyst can describe, and may cross and/or align in one way or another, thereby transforming an issue into a public issue with a range of possible solutions. This vision leaves little room for potential reconfigurations of social identities. It also faces obvious practical difficulties: how to define the "problem" and the "solution"? How to distinguish them from their "political contexts"? These would be tricky questions if one tried to answer them in the case of *Nano2Life*.

[2] As does the well-known approach proposed by Hilgartner and Bosk in order to explain "the rise and falls of social problems" (Hilgartner and Bosk, 1988).

[3] (Barthe, 2003: 477; my translation). The discussion of the sociology of public problems and of Snow's frame analysis has also been undertaken by authors who stress the dynamics of the "frames" themselves, and the multi-dimensional evolution (related to social mobilization, technical apparatus, and collective values) of public problems (Trom and Zimmerman, 2001).

[4] Cf. for a landscape of works in French political science (Lagroye, 2003).

problem across institutions *a priori* considered as "political", but toward the joint evolution of the technical characteristics of the objects being discussed and the modalities of collective discussions about them[1]. This extension and critique of agenda studies might ground a study of "problematization" connected to Foucault's and STS works[2]. This dissertation pursues this proposition by describing "problematizations of nanotechnology", a notion the remainder of this section discusses.

Foucauldian problematizations

In using the notion of problematization, I take inspiration from the later work of Michel Foucault. The second part of Foucault's *History of Sexuality*, the *Use of Pleasures*, is entitled "moral problematization of sexuality in Ancient Greece"[3]. As it emerges through this book, problematization is the range of ways to tackle a problem, the discursive and practice mechanisms through which a question becomes a problem, enters "the domain of true and false", is discussed and dealt with through discursive and/or institutional response. In the *Use of Pleasures*, Foucault seeks to understand how sexual behaviors enter moral, or ethical domains; how particular identities and modes of treatment are attributed to problems. The initiative is part of a reflection on the "history of thought", which opposes, for Foucault, that of "behaviors", as well as that of "representations". For writing the history of moral codes or the history of "real" behaviors means basing the analysis on a dualist approach separating the rules and the ways of applying them. Similarly, a history of representation would separate an underlying content from its "representations", and question the adjustments between the two. On the contrary, the analysis of problematization brings the two sides together: while considering the formulation of questions and the expression of their answers, in discourses, texts and power practices, it seeks to avoid separations between "reality" and "representation", or between "institutions" and "problems". "Problematization does not point to the representation of a pre-existing object, neither does it mean the creation of a previously non-existing object by discourse"[4].

Within Foucault's general project of the history of thought, the objective of the analysis of problematization is to make explicit the general shape rendering the expression of a certain range of solutions possible, and thereby constituting "objects for thoughts"[5]:

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[1] Barthe, 2006
[2] Barthe, 2006
[3] Faucoult, 1984
[4] Foucault, 2001a: 1489 (my translation).
[5] *Ibid.*

Le travail d'une histoire de la pensée serait de retrouver à la racine de ces solutions diverses la forme générale de problématisation qui les a rendues possibles – jusque dans leur opposition même; ou encore ce qui a rendu possible les transformations des difficultés et embarras d'une pratique en un problème général pour lequel on propose diverses solutions pratiques.[1]

Thus, the analyst seeks to describe the conditions of possibility of certain qualifications of questions, the way through which they can be transformed into problems, to which solutions could be proposed. As in political science works interested in the study of public problems, there is indeed a notion of trajectory in Foucault's work, that is, the trajectory transforming "difficulties into problems". But such a trajectory is not thought of as going from individual trouble to collective concern. The whole process is a collective production; it constitutes the "specific work of thought", which cannot be separated from the practices and technologies through which it is enacted. Problematization thus defines

les conditions dans lesquelles des réponses possibles peuvent être données; elle définit les éléments qui constitueront ce à quoi les différentes solutions s'efforcent de répondre.[2]

But such a formulation should not lead us to think that problematization refers to an underlying structure or episteme determining the forms of thought. As Paul Rabinow said, the study of problematization is neither a history of ideas, nor an "analysis of an underlying system of codes that shows a culture's thought and behavior", nor an analysis of a "system of thought"[3]. Rather, again in Rabinow's words, problematization refers to the processes through which a situation is seen "not as a given, but as a question"[4].

What I take from Foucault's work, more than a ready-made concept that could be "applied" to yet another situation, is an attention to the operations of definition of problems and solutions, of ways of thinking and organizing the world, which does not separate a "real" object from its "implications" or "attitudes" about it. As nanotechnology is a loose connection between objects, publics, concerns, and futures, the analytical approach cannot distinguish "nanotechnology" from its "political dimensions". Using problematization thus allows me not to posit any a priori dichotomy between "nanotechnology" and the "problems of nanotechnology", and to posit no distinction among the operations meant to construct nanotechnology as a set of material objects, expectations about the future, publics to engage, and concerns to be dealt with. This does not mean that there is no distinctions whatsoever between "nanotechnology" and its "representations", "implications" or "concerns". But analyzing the

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1 Foucault, 2001b: 1417
2 *Ibid.*
3 Rabinow, 2003: 45-46
4 Rabinow, 2003: 18

problematization of nanotechnology implies that these distinctions are outcomes of processes that need to be empirically accounted for, and which ultimately contribute to problematize nanotechnology in contingent ways.

Nanotechnology and its problems

At this point in the dissertation, it is necessary to stress that testing, exploring, and refining the concept of problematization is also an objective of the following chapters. The focus on problematization can, at this stage, ground another methodological principle I will follow in this dissertation: I will not consider an *a priori* dichotomy between "nanotechnology" and "problems of nanotechnology". There is here no interest for the separation between the "reality" of the problem and its "framing" or "amplification". Nor is there any concern for "causal factors", be they interests, values, or cultures. Problematization gathers all of these. Taking inspiration from Foucauldian problematization, I use the concept in order not to differentiate between the various components of nanotechnology (objects, publics, concerns, and futures) while exploring the stabilization of its problems. Problematization allows me not to differentiate between "modes of governance" and nanotechnology itself, study the varieties of the coproductionist idiom, and translate them into a focus on the construction of public problems. This approach pursues the concern of political science works for the evolution of problems, without adopting dualist readings of this body of work.

One value of political science is that it insists on the "public" dimension of problematization. In looking at "agendas", "public problems" or "social movements", works in political science are all, in one way or another, interested in the making of collective problems, whereas Foucault's interest in problematization does not define its public character. Rather, Foucault considers that the existence of texts, in which questions are asked and dealt with, is a sign of problematization. For instance, the multiplicity of Ancient Greek texts exploring the "love of boys" is a sign that homosexuality was problematized at the time. Hence the "public" character of problematization merges in Foucault's work with its empirical visibility[1]. At this stage, I can safely assume that the problematizations I look at are "public", in that they are made visible for the analyst himself and are explicit for the making of collective

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[1] This points here to what Deleuze sees as the overall conclusion of Foucault's work, the fact that the articulation of knowledge and "games of true and false" occur only through problematizations, as they are enacted through practices "of seeing and telling" (Deleuze, 1986/2004: 70). The public character of problematization as emerging from both the gaze of the analyst and the work of the actors leads us to interrogate the external position of the analyst. The problem of exteriority is acute in the case of nanotechnology, in which social scientists are constantly called to participate in the making of science policy programs. I will discuss this important aspect below.

organization and individual roles[1]. As I use it, "problematization" directs the attention to the reception side of the making of nanotechnology, by pointing to the work needed to construct its publics, whether collective or individual. In turn, the public dimension of problematization prompts one to ask many questions. Where are the problematizations visible? How to describe them? How to describe the production of social and technical categories through problematization processes? How to use "problematization" as an analytical category, and what does it bring to the study of democracy, in general, and to the analysis of nanotechnology, in particular? These questions can be raised (and have to be). But they cannot be answered before the descriptions I will make in the next chapters of the various sites in which nanotechnology is problematized.

The previous section has shown that science policy offices are sites where nanotechnology is defined as a program in ways that can be controversial (cf. the opposition between Drexler and the industrialists when the NNI was created). The following chapters consider three groups of sites where nanotechnology is problematized: sites where nanotechnology is represented (chapters 2 and 3), where it is administrated and managed (chapters 4, 5 and 6), where it becomes a topic of collective and scholarly engagement (chapters 7 and 8). The first part of the dissertation considers sites where nanotechnology is constituted as a topic for presentation to the public, in science museums (chapter 2), or, through participatory instruments, to a citizen for him or her to decide about the future of nanotechnology (chapter 3). As I will describe, the assemblage of nanotechnology as a common category for representation goes with the simultaneous representation of nanotechnology's publics. Chapter 2 and 3 will explore the links between the making of publics for nanotechnology and that of nanotechnology programs themselves.

I turn, in the second part of the dissertation, to sites where nanotechnology is dealt with in administrative bodies: I examine successively initiatives meant to problematize nanotechnology substances (chapter 4) and products for consumers (chapter 5) by defining their "nano-ness" and science policy activities meant to make "responsible" nanotechnology futures (chapter 6). In chapters 4 and 5, I will show that the production of nano substances and products in industries in inherently linked with the management of risk concerns, and directly connected with the making of national programs of support for nanotechnology. Standardization organizations will appear as places where the connections between the production of objects, the anticipation of future developments, and the definition of public concerns come together. By focusing on science policy initiatives meant to ensure the "responsibility" of nanotechnology developments, chapter 6 will display the connections between social science research, laboratory practices, and the making of nanotechnology programs.

[1] Considered through the lens of the making of collective and individual identities, problematizations could be described as processes that enact "anthropological problems", as used by Collier and Ong in order to "refer to an interest in the constitution of the social and the biological existence of human beings as an object of knowledge, technical intervention, politics, and ethical discussion" (Collier and Ong, 2006: 6)

The third and last part of the dissertation considers sites where nanotechnology becomes an object of engagement, questioned by civil society organizations or social movements (chapter 7), and topics of engagement for the researcher himself (chapter 8). Chapter 7 will describe the mobilization of civil society groups attempting to critique or intervene into nanotechnology programs. Chapter 8 will reflect on the forms of scholarly engagement I adopted in the fieldwork encountered in the previous chapters, and will use this to draw connections between them.

Rather than focusing on a sole type of empirical site (for example laboratories or science policy offices), I have preferred to choose diverse sites where contrasted problematizations of nanotechnology (and, by the same token, diverse connections between the making of objects, futures, concerns and publics) will appear[1]. Such an examination re-interrogates well-known categories of political science: How do actors represent nanotechnology and its publics? How do experts in administrative offices manage to work on a shapeless object like nanotechnology, try to identify the "nano-ness" of substances and products, define their risks and set boundaries between those that are acceptable and those that are not? How do social movements grasp nanotechnology as an object of mobilization? By answering these questions, the dissertation will propose an analysis of the representation of problems and publics, of the administration and trajectory of public problems, and of collective and scholarly engagement, while considering as a focal point the making of nanotechnology objects, publics, concerns and futures. The question then is very practical: what should one look at to examine the making of nanotechnology related problems? In order to answer this question, I get back to Foucauldian problematization, which I propose to mobilize through the lens of STS works.

Processes of problematization

A rapid reading could suggest that problematization, as it appears in Foucault's work, points to a stable frame that would determine the formulations of the problems relative to a given subject. Yet Foucault considered problematizations as processes, stabilized but nevertheless permanently re-enacted in order to maintain the definition of problems and devices expected to deal with them:

Foucault claims to make "a certain continuity" of the transformation of sexual behaviors into problems explicit, but also insists on the work needed to stabilize this problematization. Problematization is never a given state of affairs, but refers to something that is constantly a problem, for

[1] This means that there could be other sites to conduct the analysis of problematization. As the next chapters will make it clear, the empirical entry points chosen for this dissertation offer, if not an exhaustive landscape, at least a rich picture of the problematizations of nanotechnology.

which there is a constant need for solutions and acceptable behaviors[1]. Thus, "institutions", "precepts", "theoretical references" are necessary for problems to be "permanently reformulated". It is then possible, as Foucault describes in the *Use of Pleasures*, to make sexual behavior a problem of measures, of individual ethics, of interrogations linked to everyday practices such as food habits. Foucault demonstrates that the problematization of sexual behaviors in ancient Greece manifests itself by a constant work of writing and reflection, and considers that the production of the technologies of regulation of sexuality occurs in the same move as that of sexuality itself[2]. Consequently, the nature of problematization is an open question for research: one cannot posit that the problematization of sexual activity in Ancient Greece covers the same ground as what today constitutes sex and desire (thus, Foucault insists on the strong link between food practices and sexual behaviors in the problematization of desire as a matter of individual ethics). In this perspective, problematization is a process that shapes a question as a problem, qualifying it, links it with other domains of human activities, and defines a range of potential solutions to undertake.

Thus, the stability of problematization for Foucault is the permanently challenged outcome of a never-ending stabilization process, through which the definitions of problems, the set of potential solutions, and the repertoires of acceptable solutions are maintained. Hence, Foucault's concept of problematization pays attention to the processes that stabilize social order, that provide answers to constantly asked questions. It forces us to consider the institutional, material, and cognitive infrastructures that ensure that problems are stabilized. This has been a concern for students of public problems, particularly Joseph Gusfield[3]. This also directly relates, in the case that interests me here, to Science and Technology Studies (STS), in so far as analyzing the problematization of nanotechnology requires the description of nano objects in laboratories, new technical programs in science policy offices, emerging ethical or risk issues, or new concerned publics. The Actor-Network Theory school of STS has used the notion of problematization, and provides useful elements to ground the further explorations of nanotechnology.

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[1] Foucault, 1984: 32

[2] Considering problematization as a process to be permanently enacted is a path for the critique of the repressive hypothesis (Foucault, 1976). The repressive hypothesis contends that Christianity transformed sexual behaviors into moral problems to be dealt with by a set of constraining rules. In this perspective, Christianity would have repressed behaviors that had not used to be problematic. On the contrary, the study of the problematization of sexual behavior displayed the continuities and small displacements, and refuses the understanding of Christianity as a radical break (Foucault, 1984: 23). It considers the technologies of regulation of sexuality are produced in the same movement as sexuality itself.

[3] Gusfield links the making of the problem of drunk driving with the tests expected to measure alcohol levels.

ANT problematizations and the emergence of new issues

The description of scientific work leads Michel Callon to borrow the notion of "problematic situation" from Popper. "Problematic situation" refers to the transformation of a question into a problem through the domination of certain problematic statements. Callon uses examples related to scientific controversies to describe the proliferation of problematic statements, and the alliances and oppositions among problematic situations[1]. By analyzing the way through which actors define technical and social identities in a joint movement, one can then describe how new problems are constituted. Problematization, if one follows this line of thinking, is then the gradual shaping of a problem through mechanisms that construct heterogeneous associations. Through a series of case studies, Callon describes the mechanisms through which such associations can be stabilized, and shows how actors attempt to transform problems into obligatory passage points[2]. Hence, problematic statements and stabilization devices are related in translation operations. In this approach, problematization points to the operation defining a problem on the basis of the translation of multiple components that are brought together, it is defined as "a form of translation that posits an equivalence between two problems that require those who wish to solve one to accept a proposed solution for the other"[3]. Any actor wishing to convince others (whether human or non-human) of the validity of his or her position has no other choice than to transform a problem and its range of solutions into an obligatory passage point. In this perspective, problematization is envisioned from the viewpoint of the production of scientific work: one needs to convince, to produce robust associations gathering human and material elements – and making an appropriate definition of problems acceptable is a necessary condition to do so. The objective is not to unveil the strategic interests of an actor wishing to enroll others, but to make explicit the production of technical and social categories.

Whereas Foucault was concerned with the stabilization of problematizations, STS scholars of the ANT school are more interested in the emergence of hybrid objects[4] and matters of concern[5], which requires new technical and social arrangements to be dealt with. Following John Dewey, they have recently focused on "issues" to describe the stimulus for the constitution of concerned groups, and new forms of social uptake of public questions[6]. In this perspective, the issue originates from an entity that acts as an obstacle, as it cannot be dealt with by existing institutions. Thus, Callon proposes to "talk of an issue when the available codes, irrespective of what they are, fail to answer the questions raised by

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[1] Callon, 1980
[2] Callon, 1980; Callon, 1981; Callon, 1986
[3] Callon, Law and Rip, 1986
[4] (Latour, 1993). More recently, Lezaun described the technical and regulatory infrastructures needed to define biotechnology entities as "objects of government" (Lezaun, 2006).
[5] Latour, 2003
[6] Marres, 2007

this issue"[1]. In this perspective, the issue then causes the production of new "concerned groups"[2]. To the proliferation of problems is thus added the proliferation of concerned groups, created for, against, and/or with emerging issues. Problematization appears as the joint result of the mobilization of actors and the evolution of issues, as much as it shapes both of them in turn. Hence the connection with political science: at stage here is the trajectory of problems and their entry in the sphere of public discussion.

Problematization, if one follows this approach, refers to the qualification process through which an issue becomes "economic", "technical" or "social", and technical and social categories are redefined. The qualification process has little to do with the linear trajectory that connects individual concern with collective problems. Rather, it points to the diversity of breaching points, sub-problems, qualifications and re-qualifications. In this perspective, problematization describes the continuous work needed to transform new issues into public problems, and their successive evolutions. How to account for these non-linear trajectories? Faced with a new issue, not taken care of by existing institutions, experiments are introduced in order to make it a public problem for which a range of solutions can be defined. These experiments can be participatory instruments, market devices, price determination tools, or insurance mechanisms. As scientific experiments, they require a material apparatus. As loci where issues are qualified, they are sites of problematization.

The analyst's task may then lie in the description of the modalities of the experiments that qualify the problem to be solved. One can then connect this version of problematization with the study of the various components of nanotechnology as a political entity, as described in the previous section. By directing the attention to the recompositions, the enrolment and translation work needed to interest new actors, the study of problematization, as conceived by the ANT school of STS, will lead us to analyze in details the processes through which actors manage to make "nanotechnology" a collective problem – in the case of *Nano2Life*, a problem of "reduction of fragmentation", of European research policy, of scientific disciplines, of nanotechnology and its concerns and publics. Following this trend of thought, one can rethink the locus of the political, not in terms of "subpolitics" that would be "behind" technical practice or the use of expert knowledge, but as the very action of producing matters of concern[3].

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[1] Callon, 2009: 542

[2] Callon et al., 2009

[3] The discussion of the various meanings of the "political" that Latour proposes as a response to DeVries' arguments about "subpolitics" (DeVries, 2007) is meant to introduce the study of the trajectories of "issues" (Latour, 2007). This is not the path I am following in the description of problematization of nanotechnology. I am far less interested in discriminating across varieties of the political than in accounting for the variety of problematizations.

Beyond the old/new dichotomy

Nanotechnology forces us to be cautious about the use of "trajectories" of problems – even in a non-linear fashion. For nanotechnology is not an "obstacle", a single and new "issue" that would face existing institutions. It is made of distributed programs, various decisions in multiple places. It gathers objects, publics, concerns and futures. It solidifies through the circulations of substances, people, concerns and instruments, but could as well disappear if the infrastructure able to maintain the "nano-ness" of objects is not robust enough, and the links between science policy instruments and laboratory practices not tight enough. It is at this point that Foucault's use of problematization is interesting, since it does not attempt to locate the initial impetus of problematization. Whereas it is the key topic of interest for the ANT school of STS, the appearance of new problematizations is never made explicit in Foucault's work, which is much more interested in their stabilization and gradual evolution.

By acknowledging the difference in the points of interest of these two traditions of scholarly work, my aim is not to reproduce this dichotomy. Consider for instance the case of *Nano2Life*. A description of this project in terms of the "novelty" of nanotechnology opposed to "existing institutions" would force us to enter the discussion of the "reality" of the field – a discussion that cannot bring much, as seen above, since it prevents from grasping nanotechnology as a heterogeneous entity in the making. In the meantime, it is also obvious that nanotechnology mobilizes scientific instruments, technological practices, researchers and industrialists, in the making of "new" objects (in the case of *Nano2Life*, nanovectors, nano implants, or nanoparticles used for imagery). Rather than an "emerging technology" facing existing institutions, nanotechnology is better understood as an entity in the making, gathering objects and projects rebranded as "nano", new substances developed through new instrumentation and original forms of collaboration across disciplines, and science policy instruments. "Problematization", as I use it, is a way not to take for granted the separation between "new objects" and "old institutions", between "old problematizations" and "new ones", in order to account for different grades in the stabilization of nanotechnology[1]. This is a way, to paraphrase Luc Boltanski, of "escaping from the illusion of intemporality as well as from the fascination of the 'new'"[2]. Taking inspiration from both Foucault and STS work, I use problematization as an analytical category that allows me to displace the

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[1] I am therefore reluctant to use the term "events", as Rabinow proposes, in stating that "problematizations emerge out of a cauldron of convergent factors (economic, discursive, political, environmental, and the like). Such an emergence is an event. For example, the Greek problematization of pleasure and freedom or the modern problematization of life and governmentality lasted for centuries. Hence, their emergence and articulations is an event of long duration, one that sets events of different scales in motion". (Rabinow, 2003: 55). In order not to be caught into the old/new opposition, I prefer not using the idea of event of problematization, which would force me, as Rabinow does, to distinguish among "scales" of analysis, separating, for instance, problematization from "assemblages" of a shorter temporality (Rabinow, 2003: 56).

[2] (Boltanski, 1979: 75; my translation). Boltanski's critique of the sociologists "fascinated by novelty" grounds his study of the gradual stabilization of the "cadres" category (Boltanski, 1979; Boltanski, 1987).

"problem of the novelty" of nanotechnology. I am interested in sites where the objects, concerns, and futures of nanotechnology are displaced, questioned, re-stabilized or destabilized, and it is to illuminate such processes that I use the notion of problematizations.

Reconstructions

An objective of the dissertation is to examine the construction of nanotechnology as a problematic macro entity. The diverse and uncertain character of nanotechnology makes such an objective quite a challenge. Consider for instance the case of *Nano2Life*. The project is composed of dozens of laboratories scattered all across Europe. It is connected to the offices of the European Commission in Brussels and to the European Parliament, where the future of nanotechnology is discussed, and inscribed in science policy instruments such as roadmaps and funding plans. It produces objects and experimental products (nanovectors for drug delivery, carbon nanotubes for brain implants) the regulatory existence of which is uncertain. Its coordinating research institution in Grenoble is the most important partner in local development projects that attempt to make nanotechnology a key engine of economic growth. Problematization is at stake there: nanotechnology is transformed into a problem of "responsible development", associating ethical work and risk examination for the development of nanotechnology products, while ensuring both local growth and European integration. But how can one recompose global problematizations of nanotechnology from the discrete examinations of empirical sites?

This concern is widely shared by nanotechnology actors. When inscribed in indicators, figures, graphs and statistics, nanotechnology becomes an object of national government, international benchmark, and a stake in a "race" among developed countries wishing to invest in a promising technological domain. When science museums represent nanotechnology for the public, they perform a reconstruction work and contribute to the stabilization of the entity. Empirical examples examined in Part 1 of the dissertation will describe actors attempting to gather the various components of nanotechnology into consistent pictures, and separate nanotechnology from its representations. Other places are devoted to the assemblage of nanotechnology, among which standardization institutions, such as the International Standardization Organization (ISO) or the Organization for Economic Cooperation and Development (OECD), which connect the reconstruction work of nanotechnology with the material production of substances and products by attempting to define common categories for the qualification of "nano" substances and products. Looking at the assemblage of nanotechnology in such sites, as it will be done in Part 2, will lead me to explore how nanotechnology is problematized through the making of standards and classifications. Such devices, through the mobilization of metrology infrastructures, are powerful instruments for the shaping and stabilization of technical and social realities[1]. On the one hand, they raise issues of national and international forms of collective action, related to the relationships between standardization and the construction of national and international regulations. On the other hand, they attract interest to the circulation of reference materials, technical instruments for the characterization of substances, scientists and experts across laboratories and administrative offices, and standardization instruments[2]. Eventually, reconstructing nanotechnology connects its different elements – objects, publics, concerns, and futures. Are "publics" expected to have a say on decision-making, or to witness decisions taken by others? In what ways is the material construction of objects connected to the making of science policy instruments that describe the future of nanotechnology? Such questions are raised, for instance, in the science policy offices where the making of "responsible" nanotechnology programs is discussed, and I will consider them in the last chapter of Part 2. Answering them enacts nanotechnology as a global program: analyzing the reconstruction of nanotechnology is describing the stabilization of arrangements between the objects, futures, concerns and publics that compose nanotechnology.

Thus, making problematizations of nanotechnology explicit is, on a first level, observing the actors assembling nanotechnology, in sites such as science museums, standardization organizations, or science policy offices, and describing the controversies emerging from attempts to propose alternate reconstructions. The other side of this work is to follow trajectories across sites where nanotechnology is problematized. For instance, *Nano2Life* is connected to the making of European science policy through the circulation of scientists, administrators, and European officials. In the meantime, concerns and expectations about the future circulate between Europe and the U.S., while objects are discussed in regulatory bodies at national and European levels, and international standardization institutions. One can follow objects, as they are produced in scientific laboratories or R&D units, bought by other companies, subjected to regulatory concerns and standardization attempts. Chapter 4, for instance, will follow carbon nanotubes being produced in the South West of France, commercialized to an American industry, discussed in normalization arenas such as ISO and international organizations like OECD. From Grenoble to Brussels, and from Washington to Paris, one can also follow the circulations of scientists, officials, activists, as well as those of science policy instruments.

This echoes recent works in anthropology, which, by paying attention to the flows of objects, people, and money, are interested in the production of the "global"[3]. This trend of work has studied the "global spaces" produced by these circulations[4], the manifestations of "capitalism" or "modernity" that

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[1] See (Bowker and Star, 1999) about classification

[2] O'Connell, 1993; Mallard, 1998.

[3] Cf. Marcus's comments on multi-site ethnography as based on the study of circulations (Marcus, 1996)

[4] Appadurai's "scapes" are examples of spaces made of circulations of people, objects, money or concerns. Appadurai's scapes are "building blocks of imagined worlds" (Appadurai, 1990: 33), and differ according to the

they enact, and the joint production of the "local" or the "unconnected" with the global[1]. These approaches are of interest for any study that does not consider the "global" (or any type of geographic space) as a given, but seeks to explore the construction of spaces, connecting, for instance, industrial production, standardization of products, and scientific research[2], or local infrastructure project in third-world countries, the World Bank rationalization of environmental development, and (de)stabilization of national sovereignty[3]. By following the trajectories of nano substances and products, experts in ethics and risk management, concerns, and instruments, the exploration of the construction of nanotechnology as a (fractured) global entity can be read as an anthropology of the "global". But I feel compelled to stress that I have much more mundane objectives than identifying the manifestations of capitalism[4], late modernity, or "global forces, circulations and imaginations"[5], as the anthropologists of the global do. In considering the question of the "global", my aim, in this dissertation, is entirely practical: the concept is explored as long as it allows me to describe the problematizations of nanotechnology.

That being said, the analysis of the problematizations of nanotechnology will indeed lead me to account for the production of global spaces, throughout the reconstruction work performed by actors involved in the making of nanotechnology, and out of circulations of objects, instruments, concerns and people. Some of the assemblages of the components of nanotechnology will be shown to be "global" in that they attempt to define, for instance, "international" or "European" nanotechnology independent from local contexts of development[6]. In other instances, the boundaries of the nation-state will appear to be re-stabilized, even though public concerns or participatory instruments circulate from one country to another. In all cases, studying the problematizations of nanotechnology is asking questions related to the production of common spaces: of standardization, of science policy initiatives, of legitimate and sovereign public action. It requires the investigation of connections between the production of small-scale objects in laboratories and private companies, the making of science policy programs endowed with hundreds of millions of dollars and euros, and the construction of shared imaginaries for citizens who will participate in, engage in, voice their concerns or celebrate the development of new scientific domain

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type of entity that is considered (e.g. "financescape" for money, "mediascape" for media information). My concern for the "global" stems not from the differentiation among the circulating objects, but from the reconstruction of problematizations gathering heterogeneous entities, as does for instance a regulatory space, or, in Andrew Barry's language, a "technological zone" (Barry, 2001) that defines common standards, vocabularies, instruments of measure, and professional competences. The geographical analysis that emerges from the study of problematization will be discussed throughout the following chapters.

[1] For an in-depth review, see (Tsing, 2000).

[2] Cf. for instance the standardization of genetic testing (Lakoff, 2005), or the standardization and circulation of pharmaceuticals (Petryna et al., 2006).

[3] Goldman, 2001

[4] Rajan, 2006

[5] Burawoy, 2001; Gille and O'Riain, 2002

[6] Cf. (Collier and Ong, 2006) about "global assemblages".

and the introduction of new consumer goods on markets[1]. The types of space problematizations produce will be explored in the following chapters. At this stage, one can merely be cautious not to separate the "technical" question of the construction of standards from the "social" question of political spaces.

Among these common spaces, those that shed light on the making of national problematizations, where "civic epistemologies", to make use of an expression Sheila Jasanoff introduced[2], are at stake, are of particular interest. In Jasanoff's understanding, civic epistemology is an analytical category that points to the processes of construction of credible knowledge-making and legitimate public decision-making in national contexts. Rather than using "civic epistemology" as a ready-made category, I consider the notion as an impetus for the examination of problematization of nanotechnology in national and international spaces. Once the dichotomy between "new" nanotechnology and "old" "national institutions", or "policy cultures", is refused, it is then possible to describe the displacements, trials, stabilizations and destabilizations that make nanotechnology "national" or "international". Therefore, my aim is not to grant a priori unity and explanatory power of "national political cultures", but, following a perspective opened by Jasanoff, to use sites in different countries – France, the United States and the European Union - to illuminate the variety of problematizations of nanotechnology and the connections among them.

Engaging in the problematization of nanotechnology

In the perspective outlined in the previous paragraphs, the reconstruction of nanotechnology is an outcome of the analysis, as I describe actors doing the re-construction work. Among them, social scientists play a central role, as they are explicitly asked to contribute to the making of nanotechnology[3]. *Nano2Life*'s ethics board, for that matter, is just one site of scholarly intervention in nanotechnology projects among many. Numerous research projects are funded by the European Commission or the U.S. National Nanotechnology Initiative, while social scientists also participated in the organization of public dialogues, forums, and other participatory instruments (some examples will be provided in this dissertation).

Faced with such an intervention of social science, the analyst can observe the work of social scientists at a distance, describe the variety of their positions and the modalities of their participation in

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[1] This use of the term "imaginaries" stems from Anderson's work on state and citizenship (Anderson, 2006). The relevance of the concept for STS work has been explored by Sheila Jasanoff (Jasanoff, 2010; Jasanoff and Kim, 2009).
[2] Jasanoff, 2005b
[3] MacNaghten et al., 2005

the solidification of problematization[1]. For instance, one can look at public perception studies, and the "political science" they are based on[2], that is, the way they solidify a separation between unquestioned scientific results and equally stable social groups. Scientometrics is another area of interest in the case of nanotechnology, for it participates, with figures, indicators, and benchmarks, in the solidification of nanotechnology as a global program. Analyzing the intervention of the social sciences at a distance would allow me not to take side in the problematization of nanotechnology. But it is not entirely satisfying either, for very practical, and more theoretical reasons. As I was interviewing him about *Nano2Life*, Patrick Boisseau repeatedly told me that that what I did "could be useful". Throughout my research, I had multiple contacts with actors (in ways that will be described); I was engaged in policy works about nanotechnology, and with civil society organizations mobilizing on nanotechnology. This is not surprising, as proponents of nanotechnology programs wishing to integrate nanotechnology concerns are eager to engage social scientists in the making of "more democratic" nanotechnology. But it causes practical difficulties for the conduct of a scholarly inquiry that would hope to maintain its exteriority, as the actors being studied are very much willing to benefit from its outcomes, or even to take part in it.

There are other reasons, more theoretical, for giving up the stability of the external analytical position. If I were to put social scientists at a distance, there would be no reason for someone else to describe what I am doing when trying to analyze the problematization of nanotechnology (or myself, if I was to adopt a reflexive approach). Once the external position is assumed, it automatically drifts into never-ending introspection. For of course, the production of knowledge I propose, the connection I draw among sites, the problematizations I make explicit may contribute to the solidification of nanotechnology. Yet the external position supposes that the reconstruction work is somehow already done, that the social scientist can unproblematically put it at a distance – at the price of endless examinations of problematizations as reconstructed by successive social scientists, each being examined at a distance.

Considering these difficulties, a way out is to deflate the exteriority problem, and to get back to the practicalities of empirical work[3]. In particular, one could consider that the distance between the analyst and the entities he wants to describe is not given from the start, but that it is to be stabilized,

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[1] I undertook this with Erik Fisher, when looking at the roles of social scientists as defined in nanotechnology-related policy documents: we identified a "neo-determinism discourse", which contends that nanotechnology development is unescapable, but that society should invest in training and "preparation" in order to "keep pace"; a discourse inspired by STS, which promotes reflexivity and deliberation; and a dominant approach that contends that the "social" and the "technical" components of nanotechnology have to be adequately represented in order for a common ground to be settled (Laurent, 2010a: 58-60).

[2] Jasanoff, 1998; for examples about nanotechnology, see Laurent, 2010a: 84-89.

[3] Cf. Latour's infra-reflexivity as a response to the problem of the "reflexivity loops" (Latour, 1988a). I will get back to this point in chapter 8, after having described the modalities of my own engagement through the empirical examinations of the dissertation.

alongside the other components of the problematizations of nanotechnology. And if the reconstruction work is supposed to be the outcome of the empirical and analytical work, then one cannot posit an external relationship from the start. For that matter, connecting the problem of exteriority with the focus on problematization is easier if one gets back, once again, to Foucault. In commenting on Nietzsche and reflecting on the exterior position of history, Foucault provides some directions of thought for the analysis of problematizations that reformulate the question of exteriority[1]. Foucault's reading of Nietzsche on the question of history makes a critique of the external position of traditional historians explicit [2]. Contrary to them, the genealogical approach he advocates "turns history upside down". It uses fine-grain historical material in order to produce a situated knowledge, which originates from the concerns of the researcher himself, and the contemporary problems he is interested in. Hence, genealogy refuses the separation between subject and object. It does not seek to be (like archeology before it) a discourse putting its topic of inquiry at a distance. Thus, genealogy forces us to consider that reconstruction has more than an analytic component: more than a mere description of the world "as it is", it is also a scholarly reconstruction and a transformation of stable realities into research questions.

This is why the notion of "problematization" as Foucault uses it interests me. On the one hand, problematization is, for Foucault, the state of a discussion at a given time, the ways of defining a problem and the range of possible solutions. On the other hand, problematization is also the outcome of scholarly work, which contributes to introduce in public discussions a particular topic that is thereby de-naturalized. Thus, speaking about prison and the role of the *Groupe d'Information sur les Prisons* (G.I.P.), Foucault explicitly linked activist action and problematization:

> *Le G.I.P. a été je crois une entreprise de « problématisation », un effort pour rendre problématiques et douteuses des évidences, des règles, des institutions et des habitudes qui s'étaient sédimentées depuis des décennies et des décennies.*[3]

These two sides of problematization are not opposed: they are two aspects of the same reality. A dialogue between Foucault and Deleuze offers an illustration of this position. Deleuze links Foucault's work on prison with his own engagement in order to show that the relationship between "theory" and "practice", between "academic work" and "political engagement", is not an issue in Foucault's perspective. Speaking about Foucault's engagement in the G.I.P.:

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[1] Foucault, 2001c
[2] Whether or not this "traditional historian" exists today is not what matters for my argument here.
[3] Foucault, 2001d: 1507

il n'y avait là ni application, ni projet de réforme, ni enquête au sens traditionnel. Il y avait tout autre chose: un système de relais dans un ensemble, dans une multiplicité de pièces et de morceaux à la fois théoriques et pratiques.[1]

Thus, accounting for problematizations is also problematizing: the study of problematizations is not a representation of problems independent of the work of the researcher but leads him to connect the successive modes of problems' formulation, up to those that belong to the "concern for the self" of the analyst[2]. The question of exteriority can then be rephrased: the analyst is part of the world, and the social scientist looking at problematization is inevitably engaged. But this is not something the social scientist should feel sorry about, and expiate through painful reflexive exercises through which he could locate the "influence" of his "personal interests" on the studies he did. Rather, it allows the researcher to enrich the analysis of problematizations by bringing into the description yet another political dimension - that of his own engagement - and by connecting scholarly work with its normative charge. Accordingly, I am much willing to follow a tradition in STS that asks the field to move "beyond epistemology" by questioning the way it can and should intervene in the world[3]. As I will describe in the following chapters, the analysis of the problematization of nanotechnology is a way to do so. By the same token, it also compels to ask a number of questions: how does the engagement of the social scientist empirically play out? How does it contribute to the stabilization of problematizations, or destabilizations of others? How to characterize, eventually, the "political" quality of the analysis of the problematizations of nanotechnology, whether in the terms of the various dimensions of the political described above, or through a specific descriptive vocabulary that would have to be crafted to account for the forms of scholarly intervention in the problematizations of nanotechnology?

This will be explored through the empirical examinations conducted in the following chapters. At this stage, I consider that no a priori distinction between the work of the social scientist and that of the actors being studied can be made. This does not mean that the scholarly intervention (mine for that matter) and that of the actors involved in the making of nanotechnology are exactly aligned, follow the same logic and pursue the same objectives, but that any difference is the result of the work of description and engagement. Hence, the descriptions of the problematizations of nanotechnology are also descriptions of the analyst's engagement in them. Accounting for the variety of scholarly

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[1] Foucault and Deleuze, 2001: 1175

[2] Deleuze reformulated the argument in his *Foucault*: "Finalement, c'est la pratique qui constitue la seule continuité du passé au présent, ou, inversement, la manière dont le présent explique le passé. Si les entretiens de Foucault font pleinement partie de son œuvre, c'est parce qu'ils prolongent la problématisation historique de chacun de ses livres vers la construction du problème actuel, folie, châtiment ou sexualité" (Deleuze, 1986/2004: 122).

[3] Jasanoff, 1996. See also (Wynne, 1996; Woodhouse et al., 2002; Pestre, 2004) for discussions of potential "normative" approaches for STS scholars. Chapter 8 will show how the empirical analysis of the problematization of nanotechnology contributes to these discussions.

engagement in the problematization of nanotechnology requires openness to the empirical situations: not only will the types of sites be diverse, but so will be the formats of engagements. Throughout the following chapters, I will describe the processes through which the reconstruction of nanotechnology occurs, not from the outside, but within the conduct of the description work and through the situations of trials I am engaged in.

Section 3. Technologies of democracy

Democracy

The following chapters will examine sites where nanotechnology is problematized, and, by the same token, takes shape, as an assemblage of objects, futures, concerns and publics. The previous section has provided elements to conduct the analysis of problematization, especially the types of sites where it is visible, the stabilization processes that are to be looked at, and the issues related to reconstruction and engagement. This section of this chapter discusses the entry point for the analysis of the problematization of nanotechnology.

Following the path opened by Foucault and the ANT school of STS, I will analyze nanotechnology through the study of the devices that problematize. After the previous sections, it is now clear that these instruments also define the objects, futures, concerns and publics of nanotechnology. They define the problems of nanotechnology and the ways of organizing collective ways to deal with them, involving actors that can oppose each other. Thus, they are the instruments that make democracy function. Throughout the dissertation, I will use the term "technologies of democracy" to describe these instruments. I will discuss below my use of the term "technology". But first, the way I use the term "democracy" needs to be clarified.

"Democracy" is a difficult term to use. It has descriptive and normative dimensions. I do not want to define it in such a way that I could evaluate which arrangements are "democratic" and which are not – I am interested precisely in the analysis of their constructions and the kinds of collective order they produce[1]. After the discussion of the notion of problematization, I hypothesize that "democracy" is at stake in the places where problematizations of nanotechnology are made explicit, where the tension between their proliferation and the need to stabilize collective orders has to be managed. This is a minimal definition that considers democracy as a category in the making, and which is not intended to be operationalized in criteria that could discriminate what is "democratic" and what is not. Rather, it is meant to help me point to the sites where democracy with nanotechnology / nanotechnology with nanotechnology is at stake. This minimal definition does not follow the understanding of democracy as a permanent gap between never to be reached "democratic ideals" and real political practices. Yet it is not foreign to theoretical reflections on democracy as a political format organizing "the healthy and overt expression of conflicts of interest and differences of judgment" and defining processes for "choices

[1] This can be read as an extension of the symmetry principle introduced by the social studies of knowledge. Emilie Gomart and Maarten Hajer made this point, in calling for an STS approach to the study of politics (Gomart and Hajer, 2003).

to be made opinions to be selected, and conflicting interests to be reconciled"[1]. It also echoes Claude Lefort's understanding of democracy as the political form that both institutionalizes oppositions and ensures the indeterminacy of the evolutions of collective life[2].

"Technologies of democracy", then, designate the instruments, more or less stabilized by expert knowledge, that define public problems and ways of dealing with them, and consequently reduce the diversity of problematizations. Technologies of democracy enact "democratic orders", that is, they allocate roles and responsibility and determine the range of manageable public problems and their potential solutions. I introduce the notion of technology of democracy with the aim to analyze the instruments that both stabilize democratic order and problematize nanotechnology. But at this early point in the dissertation, my objective is not to solidify an analytical format for the concept of technology of democracy. Rather, it is to direct the attention to what will be the focus of the empirical exploration, namely the instruments, devices, and mechanisms, through which nanotechnology is problematized, that is, through which democratic societies attempt to cope with nanotechnology's objects, futures, concerns and publics[3]. This section discusses the notion of technology of democracy and identifies the questions that will be the focus of the analysis in the following chapters.

Instruments of problematization

My use of technologies of democracy builds on two related trends of work. First, the analysis of policy instruments, as proposed by Pierre Lascoumes and Patrick Le Galès is an important resource. For Lascoumes and Le Galès, a policy instrument is:

a device that is both technical and social, that organizes specific social relations between the state and those it is addressed to, according to the representations and meanings it carries. It is a particular type of institution, a

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[1] Rosanvallon, 2011: 119

[2] Lefort, 1986: 25-30. Locating democratic activities as such echoes the perspectives of scholars such as Chantal Mouffe, who contend that the political is to be found in oppositions and antagonisms (Mouffe, 2005). The many potential "political" dimensions of nanotechnology (cf. the previous section) make the term uneasy to use. My interest lies, at any rate, in the practice of democracy rather than in the making of the "political". Consequently, I will avoid using the term "political", and will focus on the construction of democratic orders.

[3] The connection I draw between technologies of democracy and problematization echoes Rose' and Miller's interest in "government" as a "problematizing activity", and in the "technologies of government" that render "government at a distance" possible (Rose and Miller, 1992). Technologies of governement are ways for Rose and Miller to shift from a theory of the state to an analysis of the forms of governmentality. But I am less interested in "governmentality" as the analytical lens through which the distribution of power can be described, than in the mutual constitution of nanotechnology and its problematizations.

technical device with the generic purpose of carrying a concrete concept of the politics/society relationship and sustained by a concept of regulation.[1]

Hence, the focus on policy instruments paves the way for a public policy analysis that considers the devices through which the State conducts its actions as entry points. Thus, Lascoumes and Le Galès' instruments are "institutions" in that they "determine the way in which the actors are going to behave". I share the interest of Lascoumes and Le Galès for the devices that allow public policy to be performed, and some of the technologies I am interested in could indeed be described as "policy instruments". Yet I do not want to limit my work to the analysis of public policy, and of the…

relations between political society (via the administrative executive) and civil society (via its administered subjects), through intermediaries in the form of devices that mix technical components (measuring, calculating, the rule of law, procedure) and social components (representation, symbol).[2]

My interest is both more specific, and more general. It is more specific because I am interested in the devices that problematize nanotechnology (and not policy action in general). It is more general because I do not limit my understanding of the political to the spheres of public policy activities (cf. the various "political dimensions" of nanotechnology I described in the first section of this chapter).

A second body of literature I am building on focuses on "market devices"[3]. Based on actor-network theory, it proposes to study processes of "economization", that is, processes to qualify and attribute values, through the analysis of "agencements". Agencements allow the analyst to shed light on distributed agency: there is not one single actor, but agencement, shaping markets, and, more generally the economy. Studying market devices is a way of "contributing to a pragmatic turn in economic sociology" by allowing to "tackle materiality and point to the distributed nature of economic actions and skills"[4]. In studying the problematization of nanotechnology, I am not primarily concerned with their economicization (although such a process may play a part in problematization). But as economization can be described, as the ANT scholars do, through the analysis of market devices, problematization can be described through the analysis of technologies of democracy[5]. Considering market devices as agencements allows the analyst to avoid a description in terms of "pure instruments in the hands of pure

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1 Lascoumes and LeGalès, 2001: 4
2 Lascoumes and LeGalès, 2001: 7
3 Muniesa et al., 2007
4 *Ibid*: 10
5 Therefore, I do not use the notion of "processes of politicization", defined by Muniesa and Linhardt, as "processes, situations or modes of actions in which the arguability of issues is emphasized and in which, consequently, decisions and resolutions are exposed to their political determination" (Muniesa and Linhardt, 2009: 11).

agents", which would "reproduce the idea of pure objects in the hands of pure subjects"[1]. Similarly, the technologies of democracy I am interested in are not passive instruments for policy-makers to meet particular goals, but agencements performing the realities of nanotechnology, that is, material objects and citizens, public concerns and plans for the future[2]. My use of the word "performing" echoes the interest of this trend of literature for the "performativity" of economics. Understood in the terms of agencements, the performativity of economics is to be conceived less as the mechanical translation of "economics" in the "economy" than as the construction of economy through agencements[3]. In the cases that interest me in this dissertation, there might be performativity of some forms of policy expertise (of participatory mechanisms for instance). But what matters the most is that technologies of democracy perform problematizations of nanotechnology.

Diverse empirical sites

Technologies of democracy are the material, empirically visible loci of problematizations. They are the agencements that problematize. These agencements, made of made of material, cognitive and human elements and sustained by more or less formalized expert knowledge, can be participatory procedures, museum exhibits and accompanying public opinion measures, processes for the examination of nanotechnology's ethical issues, risk management methods, and forms of social mobilization. The diversity of technologies of democracy, in the sense of the concept as I use it, is intentional. Consider for instance the *Nano2Life* project. In this project, many technologies were meant to organize democracy with nanotechnology: it sets up dialogue devices for a European public to talk to and listen to, and local publics to convince and discuss with; it is involved in standardization attempts gathering public and private actors at European and international levels; it contributes, through its ethics board, to the making of ethical European nanotechnology programs; it is directly involved in the construction of the European nanotechnology policy. It is therefore my ambition in this dissertation to treat in the same terms a variety of fieldworks and devices through which the objects, futures, concerns and publics of nanotechnology are constituted. Thereby, I attempt to shed light, through the analysis of technologies of democracy, on the making of collective organizations and individual identities, public roles in the construction of a democratic order and individuals expected to take part in it. Thus, I

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[1] Muniesa et al., 2007
[2] Michel Callon extended his use of agencements to political situations as well, as he commented on Andrew Barry's *Political Machines*, and particularly on a chapter on science exhibits (Callon, 2004; Barry, 2001). Science exhibits will be described as technologies of democracy in chapter 2 of this dissertation.
[3] Cf. the discussion in (Callon, 2007a).

pursue the empirical examinations of the devices that produce citizens of liberal democracy[1], rational economic agents[2], or informed consumers[3], and, more generally, a trend of work stemming from STS that contends that political categories such as citizenship, legitimacy or sovereignty are at stake when knowledge is produced, represented, or mobilized for decision-making[4].

This approach can be read as an extension of the (now numerous) analyses of "public participation in science and technology", especially those making explicit the production of specific devices, the political organization that they imply, and the way they manage to be sustained[5]. For instance, Alan Irwin's article on the "politics of talk" argues that participatory mechanisms are not ready-made instruments that scholars can evaluate according to their democratic quality, but sites where the public relationship between science and society is enacted through the active, albeit, in some cases, controversial, making of citizens able to talk within particular devices[6]. I will follow a similar approach for the study of technologies of democracy. Thus, I will consider participatory and deliberative devices as instruments that problematize, and, thereby, produce democratic orders that need to be interrogated.

My position on "public participation in science", however, is wary, and I do not want to limit my analysis to the study of "participatory procedures". This would require an a priori identification of the scope of "public participation" that does not interest me. It would prevent from drawing links among devices that nonetheless produce nanotechnology, its problems and publics, albeit in no "participatory" formats. To be sure, the descriptions I provide in the next chapters will consider "participatory" instruments, and will be, in many respects, contributions to the study of "deliberative" or "participatory" democracy. But they will not be limited to it. And, in any case, I am not interested in classifying procedures according to their "participatory" or "deliberative" nature[7].

Consequently, the "technologies of democracy" I am interested in are diverse. They comprise participatory instruments, such as consensus conferences, public debates, and forums organized in science museums. They also extend to science policy instruments such as codes of conduct, ethics reviews, or focus groups used as part of a research project in the ethics of nanotechnology, and meant to provide insights for decision-makers. In so far as they define the problem of nano substances, ways of

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[1] Rose, 1999
[2] Callon and Muniesa, 2005
[3] Miller and Rose, 1997
[4] Jasanoff, 2005b
[5] Some commentators have spoken of an "imperative for deliberation" (Blondiaux and Sintomer, 2002) or of the "new spirit of democracy" (Blondiaux, 2008). The novelty of the contemporary insistence on "participatory" and "deliberative" democracy can be nuanced by historical studies (Bacqué and Sintomer, 2011). For a historical example of a deliberative form of decision-making involving expert engineers see (Graber, 2007).
[6] (Irwin, 2006). Another notable example is (Lezaun and Soneryd, 2007), in which the authors describe "technologies of elicitation", that is, instruments expected to make publics speak. See also (Felt and Folcher, 2010) about "machineries for making publics".
[7] For an example of such a typology, see (Rowe and Frewer, 2005). See (Fiorino, 1990; Rowe and Frewer, 2000) for attempts to provide criteria expected to assess the democratic character of citizen participation mechanisms.

dealing with it, and allocate roles and responsibility in the making of "safe nanotechnology", I also include risk management devices in technologies of democracy. At this stage, one can wonder about the specificity of the notion of "technology of democracy" applied to the case of nanotechnology. Indeed, the most common device of liberal democracy, the electoral system, could well be regarded as a "technology of democracy". It is based on a heterogeneous apparatus, including material elements[1]. It operationalizes the political theory of citizenship and democratic legitimacy[2]. It defines ways of dealing with collective problems and the oppositions that they imply. It has been successively applied, through the elections of representatives, on a variety of different issues[3]. The case of nanotechnology, however, is more complicated. No ready-made technology of democracy can be applied to it. As an issue involving scientific questions, it raised the problem of the modalities of the representation of both humans and non-humans[4]. As a heterogeneous entity based on distributed decisions involving individual and collective actors, and national and international bodies (see section 1 of this chapter), it multiplies the territories of political action and the potential channels of delegation. Thus, nanotechnology is a case for the analysis of democracy that forces to de-naturalize the instruments of democratic life. This implies that the possibility to isolate ready-made "technologies of democracy" to "apply" to nanotechnology should not be considered as a given, but as the outcome of processes in which the actors themselves are involved.

Technologies of democracy and nanotechnology

The first section of this chapter stressed the fact that there is no separation to be made between nanotechnology and its political dimension, between nanotechnology and the ways of managing it. A consequence is that there is no *a priori* separation to be made between nanotechnology and the technologies of democracy that are used to deal with it. This does not mean that it is not possible to separate technologies of democracy from specific questions or issues (in this case, nanotechnology). Consider also, for instance, well-established participatory devices (like the consensus conference) or risk

[1] Alain Garrigou has analyzed the historical evolution of the material technologies of voting, such as ballot boxes and voting booths, and described the ways in which they were designed in order to operationalize the theoretical principles at the heart of democratic organization (Garrigou, 1988; Garrigou, 1992; see also Ihl, 1993). The 2000 U.S. presidential election was a privileged site for the examination of the material devices on which voting is based, and their potential failures (Lynch, 2001; Miller, 2004).
[2] The history of electoral representative systems is particularly useful to make this point (Manin, 1997; Rosanvallon, 1992).
[3] The reproductions of the electoral system should not be considered unproblematic though. The referendum is an example of an electoral device whose scope is frequently discussed (see (Morel, 1992) for a review of the debates on the topic). The success of the electoral system should not hide the fact that other mechanisms of democratic representation were experimented, among which sortition (Sintomer, 2007).
[4] For a discussion and propositions about this problem, see (Latour, 2004a; Callon et al., 2009).

assessment methodologies: they are mastered by experts, circulate from one place to another, and are applied to nanotechnology after having been mobilized on other technical questions. They are tools meant to be external to nanotechnology, but nonetheless participating in its problematization. Yet what interests me is precisely the work needed to distinguish them from nanotechnology, or to tailor them to the specificities of nanotechnology. Accordingly, I do not accept beforehand the separation between "technologies of democracy" and "nanotechnology" in the analysis that I will perform in the following chapters. I will thus study how technologies of democracy relate to the questions being asked, how they are, in some cases, isolated, or how they "stick" to the making of nanotechnology.

Consequently, if there is a separation to be made between technologies of democracy as an analytical tool and nanotechnology, it will be the outcome of other attempts to stabilize the concept and use it for other cases. But before developing a concept that might be used in other cases than nanotechnology, the main objective of technologies of democracy in the dissertation is to help me describe the problematization of nanotechnology, that is, the construction of assemblages of objects, futures, concerns, and publics. And considering technologies of democracy as an analytical entry point offers a practical approach for the study of problematization. For when conceived as instruments made of expert knowledge, material components, discursive elements, and practices, technologies of democracy can be analyzed with the tools and approaches developed by STS on scientific instruments. Rather than ready-made instruments, technologies of democracy can then be envisioned as the outcomes of processes of associations among heterogeneous elements (pretty much as scientific results are[1]). They are to be experimented, used as demonstration devices[2], and may be subject to failure – these are all cases where their components are exposed[3]. They are stabilized by expert knowledge, formalized and possibly replicated from one issue to another[4].

Through the successive analysis of sites of representation, administration and mobilization on nanotechnology, the three parts of the dissertation open paths for an analysis of technologies of democracy that follows major themes of investigation of STS research, among which the analysis of demonstrations and experiments. Part 1 explores the production of expertise about technologies of democracy, and the possibility to separate them from the issues to which they are applied. Chapter 2 analyzes nanotechnology exhibits as sites where democratic orders are performed, and chapter 3 describes more or less successful attempts at the replication of participatory devices aimed to serve as a demonstration of the value of "lay contribution" to nanotechnology. In both chapters, the representation of nanotechnology will appear as the outcome of operations undertaken by the actors themselves meant to separate technologies of democracy from nanotechnology. Part 2 considers

[1] Latour, 1989
[2] Shapin and Schaffer, 1985
[3] Jasanoff, 1990
[4] See (Collins, 1974; 2004) on the replication of scientific experiments.

constructions of, and controversies about technologies of democracy used as boundary-making devices, between "nano" and "non nano" substances and products (chapter 4 and 5), between "responsible" and "non responsible" nanotechnology futures (chapter 6). In this part, the making of nanotechnology substances, products and programs will appear to be based on complex (and controversial) technologies of democracy, mobilized in administrative offices and standardization institutions. Part 3 focuses on contestations of, and experimentations with technologies of democracy that raise the issue of activist (chapter 7) or academic exteriority (chapter 8). By describing cases of mobilization "against", or "within" nanotechnology, this last part will shed light on the processes of destabilization of, and engagement in technologies of democracy. Therefore, technologies of democracy are the empirical entry points for an empirical study of democracy that builds on STS.

Trials

A common feature in these explorations is an attention to be directed to situations in which the making of technologies of democracy is made visible to the analyst. Controversies, discussions, and failures are opportunities to do so. In any case, the focus of the analytical interest lies in sites where technologies of democracy are questioned, where their moral, technical or institutional components are questioned, experimented on, or recomposed. Hence, the analysis is to be directed to "situations of trial". The way I use "trial", in this acceptation of the term, is similar to the French "épreuve", as Latour uses it when he contends that "whatever resists in trials is real"[1]. As I propose to conduct it, the analysis of nanotechnology is a study of the stability of problematizations of nanotechnology, that is, a study of the robustness of technologies of democracy in situations of trials. "Trials" are the exact complementary side of "problematizations". Remember that problematizations exist because they are made explicit, re-stated, or displaced[2]. As I use it, following Latour, trials point to all the situations in which the stability of technologies of democracy is questioned, and consequently, problematizations are made visible. When looked at through the lens of situations of trials, where the stabilization of technologies of democracy is at stake, the question of novelty gains empirical footage: it is now possible to analyze the displacements (or the re-solidification) in the constructions of nanotechnology. Analyzing the trials that technologies of democracy face when constituted and/or contested within the processes that assemble nanotechnology is a path for the description of the stabilization of problems and acceptable solutions.

[1] Latour, 1988b: 158

[2] Thus, "trials" point to much more than a "war" between the scientist, the objects in her laboratory, and his or her colleagues to be convinced, as critics of Latour's description of the scientific activity have it (Amsterdamska, 1990).

Through the study of situations of trial, one can thus explore the making of democracy with nanotechnology.

In Latour's formulation, "trial" relates to all the dimensions of the real: cognitive, material, or ethical. Latour's phrase about the resistance to trials leads us to inquire about the reality of nanotechnology itself, as a program that gathers objects, futures, concerns and publics. This is an open question, and a tricky one, because of the dispersed nature of nanotechnology. What is, for instance, the "reality" of the *Nano2Life* project? One could argue that it lies within the connections between the construction of programs for future technological development and the actual making of objects in laboratories, and through the transformation of researchers into nanoscientists, European citizens into interested publics of nanotechnology, and the European Research Area into a space devoted to the development of nanotechnology. Within such a project, the material existence of nanotechnology objects is just on component of a wider ensemble. At this stage, the best thing to do is to be modest about how to deal with the question of the "real", by not assuming different "levels" of reality, but exploring the stability of the material, cognitive and discursive infrastructures on which the problematizations of nanotechnology rely. This means that the material existence of substances, as much as the other components of nanotechnology, is not given from the start, but considered as something to be stabilized, either through the replication of techniques (laboratory practices, standardization devices, classifications...) or the experimentation of new ones (which could, for instance, characterize materials as "nano").

Reconstruction and engagement

Through the description of sites where problematizations of nanotechnology are made visible alongside processes of construction of, and controversies about technologies of democracy, my hypothesis is that the constitution of nanotechnology as a combination of objects, futures, concerns and publics will be made explicit. By the same token, technologies of democracy will offer a way forward to address the problems of reconstruction and engagement.

About the problem of reconstruction, I follow Callon' and Latour's argument that the production of the macro is not different in substance from that of the micro, as it is about enrolling actors and stabilizing heterogeneous networks[1]. By looking at the circulation of technologies of democracy and their gradual stabilization, one can reconstruct the zones where nanotechnology is problematized. Thus, technologies of democracy will allow me to study the assemblage of nanotechnology and the mutual geographic constructions that are enacted by its stabilization.

[1] Callon and Latour, 1981

The analysis of the problematization of nanotechnology forces us to be agnostic about technologies of democracy. Pretty much as sociologists of science describe the winners and losers of scientific controversies in the same terms and do not disqualify actors who would be "un-scientific", I do not *a priori* consider that some technologies of democracy – or some versions of a technology of democracy – are more democratic than others. This is consistent with the agnosticism about democracy on which I base my use of the notion of technologies of democracy. This does not mean that my own engagement is not at stake in the analysis of technologies of democracy (the short story that opened the dissertation is a clear sign of it). The genealogical analysis redefined the problem of exteriority, and renders impossible, at any case, an *a priori* position at a distance, from which the analyst could have hoped to describe the world "as it is". This is, after all, more of an asset than a liability. For in describing technologies of democracy "at a distance", while being agnostic about democracy, in conducting, in Gomart's and Hajer's terms a "symmetrical anthropology of politics"[1], one risks to lose the possibility of both critique and action about the organization of democracy[2]. Studying the problematization of nanotechnology does not mean that any concern for the democratization of nanotechnology is left aside. But rather than providing "opinions", "advice", or "recommendations" after the description, the form of engagement that I propose is not separated from the description of technologies of democracy. This implies that my own attachments to the technologies of democracy I describe are to be accounted for. My positions, values and interests are also part of the trials I will analyze in the next chapters. Only then will I be able to identify the value of the engagement in the problematization of nanotechnology, and the potential paths for the democratization of nanotechnology.

Toward an analysis of the problematization of nanotechnology

The following chapters will explore the making of new objects, the inscription of future perspective in policy instruments, the management of public concerns, and the construction of various publics. Thereby, they will describe sites where nanotechnology takes shape as a political entity. This analysis of nanotechnology has both theoretical and practical implications. It raises theoretical questions because it suggests to interrogate the location of the sites where the common world is produced, the places where collective action and individual engagement can occur. It also raises, in the very same process, practical questions, because it incite us to craft methodological approaches meant to account for the undefined object that is nanotechnology, to make its specificity explicit, and to identify the

[1] (Gomart and Hajer, 2003: 55). The expression is borrowed from Latour's "symmetrical anthropology" in *We have never been modern.*
[2] This is a concern voiced by Dominique Pestre in his comments about the evolution of science studies (Pestre, 2004).

means through which one (that is, the social scientist or any another actor) can engage in its solidification and critique.

The description of problematizations of nanotechnology through the analysis of technologies of democracy will render the mutual constitution of nanotechnology and democratic orders visible. This will allow me to question the making of representations, the administration of problems, and the conduct of social mobilization and scholarly engagement, and how they are displaced, re-stabilized, and/or transformed "with" nanotechnology. In order to do so, I propose to follow a methodological approach that does not a priori differentiate "nanotechnology" from its "political dimensions". Consequently, I do not determine *a priori* boundaries for nanotechnology, nor do I *a priori* differentiate "nanotechnology" and "the problems of nanotechnology". By studying problematizations of nanotechnology, I intend to make their mutual constitution visible. I will explore the problematization of nanotechnology by focusing on technologies of democracy, that is, the heterogeneous instruments, more or less stabilized by expert knowledge, through which problematizations are enacted, and their potential diversity managed. The focus on technologies of democracy allows me to undertake an analysis inspired by STS: I will examine the experiments in which they are engaged and their mobilization for public demonstrations. Doing this implies that I do not take for granted the distinction between "nanotechnology" and "the ways and means to deal with it". Rather, both are to be examined in situations of trials – situations that also engage the position, values and interests of the analyst. This methodological approach makes it clear that "technologies of democracy" and "problematization" are not ready-made instruments to "apply" to nanotechnology. Rather, they are to be tested, refined, and developed in the course of the dissertation. Thus, the exploration of the construction of nanotechnology as an entity on which to make democracy function is also an exploration of how to analyze the making of a democratic order.

PART I. REPRESENTING NANOTECHNOLOGY.

Stabilizing and replicating technologies of democracy.

What does representation mean concerning nanotechnology? The first part of the dissertation focuses on cases where the nanotechnology is problematized as it is represented. I use "representation" in a deliberate broad meaning: I want to examine sites where nanotechnology is displayed through various channels. The next two chapters focus on science museums and participatory devices, and make it clear that these examples connect the representation of nanotechnology with that of its "publics". Therefore, the representation of nanotechnology is related to the political representation of publics.

Accordingly, the term "representation" allows me to connect a central concern of political philosophy about the organization of democratic life with an important interest of science studies. Rousseau's political theory as pluralist theories of democracy both rely on representation: whether it is the general will or the various stakeholders' interests that are at stake, representation is central in the philosophical understanding of democracy. STS has shown that scientific and technological innovations require speaking for the non-humans: scientific tools and instruments can ensure this, and the representation of nature by science and people by politics can be studied in the very same terms[1]. In both cases, representation processes enact scientific (technical knowledge) and social (collective interests) realities. Both scientific and political representations rely on instruments, techniques, or devices able to make "nature" or "society" speak. Scientific instruments and electoral processes, technical devices and deliberation techniques perform representations. One can even be more innovative, and consider cases where "matters of concern" are represented[2]. Institutions such as the International Panel on Climate Change thus proposes precisely to represent the Earth's and the nations' interests without separating between the two[3].

The next two chapters follow up on these approaches to the study of representation. They consider representation of "science" and "society" but do not necessarily separate between the two, as they focus on technologies of democracy that attempt to construct representations of the various dimensions of nanotechnology. I consider in chapter 3 the case of museums of science staging exhibits on nanotechnology. I describe examples in France, Europe and the U.S., and contrast three forms of democratic organizations enacted through nanotechnology exhibits. In the chapter 4, I focus on participatory devices aiming to make nanotechnology's publics speak while also representing for them the objects, futures and concerns of nanotechnology. Considering replications of the consensus conference, and the production of "policy expertise" on nanotechnology at the Organization for Economic Cooperation and Development, I examine the work needed to replicate technologies of democracy and stabilize them by expert work.

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[1] Callon, 1986
[2] Latour, 2004a
[3] Miller, 2001

In the cases analyzed in both chapters, representations require investments in order to stabilize technologies of democracy. In many cases, representing means separating technologies of democracy from the topic to which they are supposed to be applied. This is needed in order to ensure an external position allowing the science museum to display nanotechnology and its publics, and technologies of democracy such as consensus conferences to be replicated on nanotechnology after having been used on other technological domains. As I will describe, constructing this separation is not an easy task, as nanotechnology "sticks" to participatory procedure, and public policy programs directly involve science museums in the making of nanotechnology's futures, concerns and publics. The objective of separating technologies of democracy and nanotechnology fails in some cases, and is completely redefined in others, as, for instance, French science centers craft technologies of democracy specifically targeted to both the display and practice of the "debate" about nanotechnology. In all cases, I will explore the ways in which the representation of nanotechnology and its publics contribute to the assemblage of nanotechnology objects, futures, concerns and publics.

CHAPITRE 2 : REPRESENTER LES NANOTECHNOLOGIES ET LEURS PUBLICS DANS LES MUSEES DES SCIENCES

Ce chapitre se penche sur les représentations des nanotechnologies que construisent des musées des sciences européens et américains. Il montre que ces lieux sont autant de sites où l'assemblage des nanotechnologies organise le fonctionnement démocratique. La première section est fondée sur la description de la construction d'une exposition dans un musée grenoblois. La représentation des nanotechnologies se révèle un exercice nécessitant certaines innovations permettant d'associer description à distance et action sur les entités représentées. Sont ainsi associés objets, futurs, enjeux et publics. Le « système représentationnel » ainsi construit propose une forme démocratique au sein de laquelle le visiteur est censé participer directement à la représentation des nanotechnologies, au sein d'un espace (le musée), lui-même isolé de la fabrique de la politique scientifique. Ce système est instable : il est contesté par des acteurs scientifiques, mais aussi par des critiques du développement des nanotechnologies, qui tous proposent des formes démocratiques alternatives.

La seconde section du chapitre suit les acteurs rencontrés dans les musées français jusque dans les projets européens de communication scientifique auxquels ils participent. En particulier, le projet *Nanodialogue*, un des premiers projets européens relatifs aux « aspects éthiques, légaux et sociaux » des nanotechnologies permet de mettre au jour la construction d'une réponse européenne au problème de la représentation des nanotechnologies. Il apparaît que « l'ambition démocratique » du projet est central, pour ses concepteurs comme pour ses financeurs issus des institutions européennes. Le projet apparaît comme une première étape dans la construction d'un programme européen de communication des nanotechnologies insistant sur les « implications éthiques » et sur la « compréhension scientifique du public » censée alimentée la fabrique de la politique scientifique.

Les projets européens sont discutés en dehors des frontières de l'Union, et notamment aux Etats-Unis, où les musées sont appelés à contribuer au programme fédéral de développement des nanotechnologies, notamment via le *Network of Informal Science Education* (NISE). Le NISE rassemble des musées scientifiques américains dans l'objectif de transmettre au citoyen les outils nécessaires à la bonne compréhension des bases scientifiques des nanotechnologies, afin que l'électeur, le consommateur ou le travailleur puisse contribuer au développement du domaine. La perspective est donc très différente de celle des musées français et européens. Néanmoins l'impératif de « dialogue » se manifeste pour certains membres du NISE, et se traduit par le soutien à un mécanisme délibératif (le « forum »). La contradiction entre l'objectif de transmission de connaissance et les fondements théoriques de la critique du « *public understanding of science* » est résolue par la construction d'une expertise relative aux formats de délibération dans le musée. Standardisée, évaluée et distribuée par le NISE, elle devient un élément de la vie démocratique du musée américain.

Chapter 2. Representing nanotechnology and its publics in the science museum[1]

Nanotechnology programs involve specialists of the representations of science. Science museums, in particular, are central institutions in the representation of nanotechnology for the public. This chapter explores representation of nanotechnology in science museums, and, going from the actual making of exhibits to nanotechnology programs in the E.U. and the U.S., it contrasts nanotechnology communication policies. It thus examines how science communication experts and policy makers represent a field that has neither unity nor disciplinary consistence, and, in some cases, visitors' expectations and concerns, in a context where science museums are urged to participate in nanotechnology programs. The modalities of this participation will be described in this chapter. This will allow me to analyze the involvement of science museums in the problematization of nanotechnology, and, thereby, in the theory and practice of democracy. Thus, museum exhibits will appear as technologies of democracy. They are more or less stabilized by science communication experts and more or less separated from the components of nanotechnology that they seek to represent. But, in all cases, they define public problems to be dealt with while representing nanotechnology, and reduce the variety of ways to do so.

Nanotechnology is a difficult case for representation in science museums. Science museums, being included in nanotechnology policy programs in ways that I will describe, are not in a straightforward, at-a-distance position, from which they could unproblematically display a stable picture of nanotechnology to an unproblematic public. Therefore, I describe in this chapter the processes through which museums produce representations of nanotechnology without considering as a given the distance between the museum and a "reality" it would display. Rather, I consider it as the outcome of processes to be described. This implies that the description extends to that of the construction of heterogeneous chains of mediators through which scientific and political representations can be performed[2].

Important scholarly works has described the role of the museum in the representation of social and political categories[3]. Rather than considering that science museums represent existing social entities, or produce false representations of minority sectors of society, I focus in this chapter on the democratic formations that they enact. This was Andrew Barry's approach in an analysis of interactivity in the

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[1] This chapter uses a text previously published in an edited volume about the science museum (Laurent, 2010b), as well as a conference paper given at the 2010 Science and Democracy Meeting in Milton Keynes, UK (Laurent, 2010c).

[2] Callon, 1986; Latour, 1995.

[3] See for instance: (Duncan, 1995; Gable, 1996; Macdonald, 1996). Bennett has described the museum as a place where national power can be displayed (Bennett, 1995).

science museum. Comparing the cases of a French and a British museums, Barry identified two democratic formations associated with the problematization of science and society relationships:

At the Exploratorium (...) interactives were conceived of as ways of disseminating a sense of scientific experimentation to the wider public. In turn, the capacity to be an experimenter was taken to be equivalent to democratic empowerment. At La Villette, the idea and technology of interactivity connects together, in an ambitious project, the body of the individual visitor with a fantastic vision of a technological nation.[1]

Similarly, I consider contrasted democratic constructions based on the problematization of nanotechnology and its relationships with various publics. This chapter does not look for "false" or "hidden" representations of nanotechnology and/or power relationships in the science museums. Nor does it take for granted the claim that the science museum would participate in the "democratization" of science by virtue of involving visitors in the making of exhibits. Rather, it goes into the actual machinery of the work of science museums in order to interrogate the making of technologies of representation of nanotechnology and the realities they perform. In particular, I analyze the role they play in the production of nanotechnology as assemblages of objects, futures, concerns and publics, and, consequently, how they problematize nanotechnology and its relationships with society.

Using archives of an exhibit on nanotechnology at the Grenoble *Centre de Culture Scientifique, Technique et Industrielle* (CCSTI), direct observation when it was on display in Bordeaux, and interviews with members of the organization team (in Grenoble, Paris and Bordeaux), I will describe in some details the making of nanotechnology exhibits in several science centers in France and the representations they produced (section 1). Following the staff of the Grenoble CCSTI as they work on other projects, I will explore the European nanotechnology communication policy (section 2), and will eventually focus on American science museums involved in the representation of nanotechnology (section 3). In the French case, visitors are expected to be actively involved in the exhibit, to the point that they end up participating in the making of objects to be displayed as material representations of nanotechnology. The European case is of a different scale, for the communication of nanotechnology to the public is a topic of concern for the European Commission, which hopes to shift away from public understanding of science. Rather, science museums are called for to provide a "scientific understanding" of the European public. Eventually, the American science museums are called by the federal nanotechnology policy to provide relevant information to individual consumers and voters, while the concern for "two-way communication" that some museum staff voice displaces this central focus.

All of these examples have in common a critique of what they describe as a "traditional way" of representing science in the museum, based on the need for the public to "understand" a repository of

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[1] Barry, 1996: 113

scientific facts. The critique of the "public understanding of science" model (PUS) has been developed over the past years by sociologists who analyzed public trust toward science not in the terms of the better or worse understanding of unquestioned scientific results mastered by experts but on the different framings of the issues at stake[1]. The critique of PUS is now heard in many science museums, and connects with recent attempts at rethinking the role of the visitor in the exhibit[2], or at including communities in the design of exhibits that directly concern them[3]. The examples considered in this chapter are thus illustrations of a "post public understanding of science" era in science-society relationships. But rather than trying to evaluate them according to ready-made democratic criteria, I use them to explore the representation of nanotechnology the museum enacts, and the democratic arrangements it performs.

[1] The classical case study and subsequent theoretical discussion is (Wynne, 1992).
[2] For instance, Riegel describes an exhibit where the position of the visitor is challenged by moving him/her to the place of the represented other (Riegel, 1996).
[3] See (Macdonald, 2003; Clifford, 1997).

Section 1. From representation at a distance to representational systems

The nanotechnology exhibit in the Grenoble CCSTI

The Grenoble *Centre de Culture Scientifique, Technique et Industrielle* (Center for Scientific, Technical, and Industrial Culture, CCSTI) is a relatively small science center. About twenty people work full time for the CCSTI, which relies on external partners for the making of exhibits. Laurent Chicoineau is the director of the Grenoble CCSTI and belongs to the youngest members of the association of the directors of the French science centers[1]. Trained in communication studies and in regular contact with natural and social scientists, he has a clear vision of the Grenoble science center:

So many museums are repositories of objects for the visitors to admire. It is not how I imagine the mission of the science center. For me, the science center is a place where people think about, interact with, and participate in scientific research.[2]

His enthusiastic vision was translates into organizational and institutional decisions for the Grenoble CCSTI, implying close partnerships with local administrative bodies, local private companies and research institutions. The self-presentation of the center in a working document shows that the "new space of scientific culture" that the center is expected to be is based on tight partnerships with local actors:

This strategy translated into pluri annual programs about topics that local scientific and industrial actors work on: information science, biotechnologies, and nanosciences. This choice has allowed us to develop (…) our partnerships. It has strengthened our link with local elected bodies, and showed how the cultural program developed by the Center can participate in the development of the local area. Eventually, this strategy has allowed us to reach new publics, to deepen our links with educational institutions, and to foster a bigger "scientific democracy" at the local level.

As it appears from this excerpt, the CCSTI expects to be part of local economic development, and an actor in the democratization of science. What this democratic ambition means is not detailed in the

[1] L. Chicoineau gave me access to the archives of the Grenoble CCSTI. Unless otherwise specified, the quotes in this section are excerpts from this material, which I translated from the French.
[2] Interview L. Chicoineau, Paris, May 2009

previous quote. At this point suffice it to notice that it was a central element of the activities of the CCSTI concerning nanotechnology.

The Grenoble CCSTI has proposed several nanotechnology projects to institutional funders (above all, the regional council) since 2003. In 2004, it launched a project first called "*Nanotechnologies et sociétés: exposition itinérante et débats publics*" (Nanotechnologies and Societies: itinerary exhibit and public debates). The Paris *Cité des Sciences et de l'Industrie* and the Bordeaux CCSTI (called *Cap Sciences*) were co-partners, and expected to display the exhibit after the Grenoble CCSTI. The exhibit was eventually called "Expo Nano" in Grenoble and at the Cité des Sciences, and "Nanomondes" in Bordeaux. In the following, I refer to it as the "nanotechnology exhibit". One of the very first steps of the project was to find financial support from private companies and research bodies. In Grenoble, the *Commissariat à l'Energie Atomique* (CEA), a public research body and a central actor in nanotechnology research in France in general, and in Grenoble in particular[1], was a natural partner, since it had previously cooperated with the CCSTI.

Sponsoring the exhibit in Grenoble was a crucial stake for public and private local actors. For nanotechnology was a hot topic in Grenoble. Large-scale research nanotechnology projects had been led by the CEA since the end of the 1990s, and had been met by highly visible contestation[2]. Hence, the exhibit was explicitly conceived as an answer to the local anti-nanotechnology activism among other communication initiatives. The deputy director of CEA Grenoble was a scientific advisor for the exhibit. He explained in an interview:

Nanotechnology has been badly pictured by a small group of activists in Grenoble. People need to understand what the real applications are, what the real concerns are. Communicating nanotechnology is crucial.[3]

That nanotechnology had been opposed in Grenoble rendered it necessary to provide representations that scientific and industrial actors considered more correct. But what exactly was to be represented was not clear. For instance, a Grenoble-based electronics company reluctantly sponsored the nanotechnology exhibit whereas its employees considered that "micro and nanoelectronics had nothing to do with the futuristic visions of nanotechnology development"[4]. The ambivalence toward the association with nanotechnology eventually led this company to refuse to appear as a sponsor, whereas it did contribute financially to the exhibit. But this was not the sole possible strategic choice. Compare the situation with that of A***, a chemical company, which was a partner of the Bordeaux exhibit. This

[1] Chapter 7 will explore the particular situation of Grenoble at further length.
[2] Laurent, 2010a: chapter 6.
[3] Interview, D. Grand, Grenoble, July 17th, 2009.
[4] Phone interview, corporate press relations manager, ST microelectronics, July 23rd, 2009; phone interview, D. Thomas, ST microelectronics, July 24th, 2009.

company, which we will encounter again in chapter 4, was a producer of carbon nanotubes. It added several panels to the original exhibit, in which it explained why its production of carbon nanotubes was indeed applied nanotechnology, and what its choices were in order to ensure that the production met safety criteria[1]. The participation to the nanotechnology exhibit had thus different modalities. But in all cases, it was a strategic decision for research centers and private companies.

The opposition to nanotechnology implied, for the designers of the exhibit, that science centers were to represent scientific results and the "public debate". This dual objective was expressed as soon as the exhibit project started. The following of this section analyzes the answers that the designers of the Grenoble nanotechnology exhibit proposed in order to meet it.

Implications for the making of the exhibit

The concern for the representation of nanotechnology and the stress put on debate first translated into a linear design of the exhibit. The preparatory documents suggested that:

The only orientation of the path of the visitor would be a logic of acquisition of information, in order for him to be able to participate in the dialogue on nanotechnology

Hence, in this initial vision, the exhibit was supposed to provide a faithful representation of nanotechnology, and then, once the visitor had become knowledgeable enough about nanotechnology, to offer opportunities for visitors to participate in a discussion about it with various stakeholders. The exhibit was indeed planned to be accompanied by various public meetings and debates. The Grenoble CCSTI was involved in the organization of public meetings in Grenoble in 2006, which were held at the same time that the exhibit was displayed. At the *Cité des Sciences*, in Paris, the exhibit was displayed in connection with a two-day event conceived as a response to the "solicitation of the minister of Research and the minister of Industry", which was itself a follow-up of the then prime minister de Villepin's call for a "national dialogue on nanotechnology[2]". During this event at the Cité, the opinions of various stakeholders were presented and discussed with actors from the nanotechnology research and policy landscape.

The challenge of the exhibit was then to represent the "infinite small", stimulate "debate" while controlling the "phantasies". A series of internal documents listed the challenges that the CCSTI

[1] I will get back to the case of this chemical company in chapter 4.
[2] Press kit (*Dossier de presse*) of the nanotechnology exhibit, Paris, Cité des Sciences et de l'Industrie.

needed to overcome in order to display nanotechnology[1]: they comprised the fact that "few applications" existed, that "the infinite small was still abstract", that decision-makers had a "performative discourse" on nanotechnology, and that there was an "increasing suspicion of public opinions toward new technologies". Thus, the CCSTI was confronted with the problem of representing material objects, futuristic explorations, and science policy programs, while also feeling compelled to "understand public opinion" and "concerns".

So the linear model in which a debate would have followed a phase of information could not be easily followed. The exhibit was to represent "publics" and "debates", "concerns" and "programs", and could not limit itself to a "scientific reality" that could have been represented at a distance. The issue was to link in single representations the various dimensions of nanotechnology. This is what a physicist at Grenoble Joseph-Fourier University who was an advisor to the nanotechnology exhibit explains:

With nanotechnology, the design of an exhibit faces important difficulties. For instance, consider quantum effects. No one knows how to represent them in such a way that their specificity be visible, different from what we are used to (...). Then we do not know how to link the representation of this knowledge and that of the deep questions that are associated with it, such as uses, potential risks, life cycles, etc. But this is the very objective: being able to connect the representation of the making of nano objects with that of the questions for public debate.[2]

Hence, the exhibit was to represent the material reality of nanotechnology *and* the public concerns linked to them, while allowing participants to "debate". The problem that the previous quote raises is precisely that of the representation of nanotechnology as a combination of objects, futures, concerns and programs. The following section analyses the solutions that were crafted to answer this problem.

Techniques of representation in the nanotechnology exhibit

The nanotechnology exhibit consisted in four "modules". "Step into the nanoworld" (*entrez dans le nanomonde*) was designed in order to explain the differences among physical scales. "Manipulating atoms" (*Manipuler les atomes*) focused on technologies of manipulation of matter at the nanoscale. "There're already there" (*Elles sont déjà parmi nous*) dealt with the current and potential applications of nanotechnology. "Does the future need us?" (*L'avenir a-t-il besoin de nous?*) quoted Bill Joy's critical article

[1] A seminar was held in Grenoble to explore the possibilities of the exhibit. During the seminar, attended by about twenty researchers and industrialists from Grenoble, the concept of the exhibit was discussed, and the main difficulties raised by the representation of nanotechnology were made explicit.

[2] Interview, J. Chevrier, Grenoble, July 17th, 2009.

– *the future doesn't need us*[1]- and raised questions about the future of nanotechnology. The seemingly clear distinction between "scientific facts", "industrial applications" and "social values"[2] echoes the linear perspective that was originally pursued (informing, and then participating). But it does not capture the multiple representations that were performed within the exhibit, as the following descriptions will demonstrate[3].

<u>*Nanomanipulator – Seeing through touch*</u>

The organizing committee wanted to display "what nanotechnologies do rather than what they are"[4] in order to "involve the visitor" in the exhibit, and not to be "in a public understanding of science" model. The third module of the exhibit was indeed conceived as a display of many potential applications of nanotechnology, as well as examples of natural occurrence of nanomaterials. The nanotechnology exhibit was not only based on visual representation but also insisted on "seeing through touch"[5], and "seeing and manipulating the invisible"[6]. For the physicists involved in the scientific committee, nanotechnology was above all a set of techniques used to manipulate matters at the atomic scale, such as the scanning probe microscope, which pictures individual atoms by displacing them. Acting at the atomic scale implies coping with physical forces that have different properties than at the macroscale. Therefore, representing nanotechnology was, for the physicists involved, representing how these forces apply.

Therefore, interactive devices were used in the nanotechnology exhibit, some of them quite simple, others more sophisticated. Examples of the former included a boxing glove to be used by visitors to move lego-like colored objects. They could thus feel what it was like to manipulate matters while being hindered by physical constraints similar to those researchers faced when working at the nanoscale. A more sophisticated tool was a so-called "nano-manipulator" which consisted of a screen on which users could see the moves of a virtual scanning probe microscope, and a joystick that visitors could use to move the tip of the microscope, and feel the resistance of the atoms thereby displaced – this

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[1] Joy, 2000

[2] This seems of a much simpler design than other examples of science exhibit. For instance, Yaneva at al. explained that the display of science in the museum might involve reshaping the museum's space in order to stage science in the making, with its difficulties, pitfalls, shortcomings and controversies (Yaneva et al., 2009). The details of the exhibit's components will show that these initial separations could not be sustained.

[3] An additional point lies in the fact that the material layout of the modules was not linear. The modules were conceived as independent from each other, and although the available space at the Grenoble center forced to display the modules in line, the other displays of the exhibit got away from the linear progression among modules. At the *Cité*, there were 2 possible entries; in Bordeaux, the visitors could enter the exhibit through each of the modules.

[4] Quotes in this paragraph are excerpts from internal preparatory documents of the Grenoble CCSTI.

[5] As one of the preparatory documents of the CCSTI stated ("voir par le toucher", état d'avancement du projet au 19/6/2006)

[6] "voir et manipuler l'invisible" 10/07/2006

resistance being quite different to that of macroscale objects, because of quantum effects. The nano-manipulator (fig. 2.1) had been developed by scientific researchers interested in the control of instruments for use at the nanoscale. They describe the interest of the instrument as follows:

The force feedback feeling given by our instrument appears much more relevant than the simple observation of an approach-retract curve, since the user can interact in real time with the surface, and thus perform a complex action: modulate the speed, stop the movement, approach or retract with a real time dynamic response, events which cannot be done without this specific architecture. (…) The introduction of a simulator between the manipulation instruments existing in user space and the manipulated nano-scene increases the online efficiency: the operator is able to interact with the virtual scene so as to study its properties and to rehearse the actions he plans to undertake, subsequently, on the real scene.[1]

For its designers, the nano-manipulator was supposed to enact a representation of nanotechnology that was not based on the passive representation of nature, but gets into the actual manipulation of objects. As such, the nanomanipulator was not a mere educational tool for exhibit visitors, but it was also expected to be used by students and experimenters. It was the object of numerous scientific publications[2], and was circulating in laboratories, as a device expected to train students and scientists into the manipulation of scanning probe microscopes.

In the nanotechnology exhibit, the nanomanipulator was not a game-like and somewhat childish activity, which could have been understood as "yet another object onto which celebratory high-tech fantasy can be projected"[3]. There, interactivity was the necessary condition to represent nanotechnology objectivity: it is about building, with constraints, trial and error. The representation of nanotechnology that the nano-manipulator enacted meant both displaying and practicing nanotechnology as a scientific activity[4]. It could also connect the display of nanotechnology (as a scientific practice), and that of nanotechnology "public issues". As the visitor could use the nanomanipulator, he would

notice that nanotechnology was about building, that it was not (…) about picturing reality but really constructing new ones, new applications[5].

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[1] Marlière et al., 2004: 251

[2] Among which (Marchi et al., 2005; Marlière et al., 2004)

[3] Barry uses this expression to account for one of his case studies (Barry, 2001: 111). The nanomanipulator is closer to his second case, that of the London Exploratorium, where interactivity is described as a tool meant to give visitors "a sense of scientific experimentation" (Barry, 2001: 112).

[4] Daston and Galison's analysis of the move from "representation" to "presentation" in the last, nanotechnology-focused chapter of their book on objectivity directly echoes the type or representation of nanotechnology performed by the nano-manipulator (Daston and Galison, 2007).

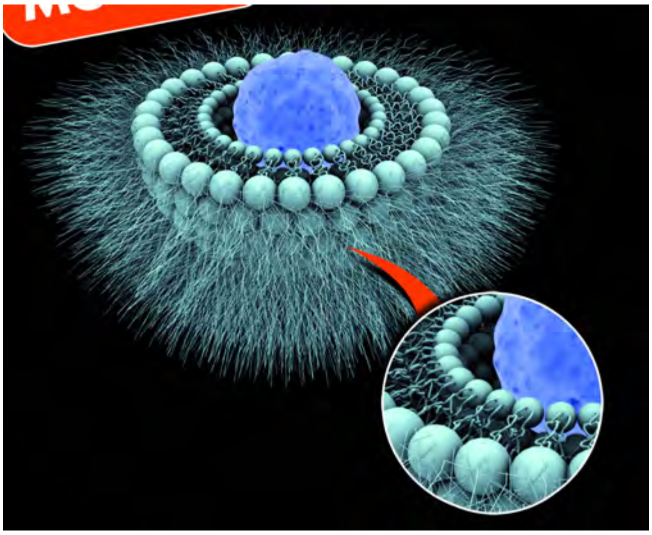
[5] Interview, J. Chevrier, Grenoble, July 17^{th}, 2009.

For its designers, the nanomanipulator was expected to make visitors realize that practicing nanotechnology meant directly impacting the world. As such, it could connect the representation of nanotechnology practices with an interrogation about the potential uses of nanotechnology applications. The visitor was thus expected to "learn" and to initiate his or her reflection about nanotechnology's related concerns. This task required more than the representation of physical processes: it was linked with representations of other components of nanotechnology, and mobilized multiple other channels of representation.

<u>Figure 2.1</u>: Photograph of the nano-manipulator

<u>Spectacular representations</u>

A major idea for the design of the exhibit was that visitors should experience the "nano-world" through various "sensorial channels", like touch for the nanomanipulator. Elsewhere in the exhibit, visitors could listen to sounds and touch things. For instance, visitors entered the first module after passing a curtain made of white and rigid threads. Thereby, the exhibit was supposed to bring the visitor "into the nanoworld". This latter argument was important for the Bordeaux organizers when they decided to add several large scientific pictures of nanoscale devices, which were displayed in the entrance corridor of the exhibit (Fig. 2.2). For them, it appeared necessary to add a visual and spectacular dimension that was not present enough in the interactive representation of nanotechnology.



<u>Figure 2.2</u>: "Spectacular representation" of nanotechnology at the Bordeaux CCSTI. The picture represents a molecule transferred by a "nano-vector".

The motivation for this addition was not that spectacular pictures were more exact representations of nanotechnology. Rather, the Bordeaux organizers felt it necessary to add another channel in the multiplicity of representations the exhibit was supposed to perform:

For us staging an exhibit means using all possible means, including art. Because our scientist friends didn't see that! (He refers to the picture in fig.2). *First, there's no color at this scale. Second, it's a mere reconstitution that represents what was worked upon by the scientist. And true, it brings something. One can say: "Wow, this is great". You're suddenly moved into a world, and then you can start understanding there're constructions of atoms.*[1]

"Spectacular vision" – as one could label this channel of representation – was one medium among others. It was conceived as another channel to enter the exhibit in addition to the nanomanipulator. For the Bordeaux organizers, this addition was not just about adding pretty pictures to please a visitor supposedly craving for exoticism. Rather, it displayed an additional dimension of nanotechnology, that of a program aiming to future development. As a science policy program, nanotechnology was…

supposed to attract funding… and it's through pictures like these that our scientist friends can display the value of what they do to science policy officials.

[1] Interview, Bordeaux CCSTI, December 2009. Quotes in this paragraph are excerpts from this interview.

Hence, the spectacular representations could also represent nanotechnology as a program that intrinsically needed to be *on display* in order to be continuously sustained.

Applications of nanotechnology

As seen above, representing nanotechnology was also about representing potential future technological developments, and expectations and concerns of various publics. These questions were raised early in the preparation of the exhibit. Eventually, several industrial applications of nanotechnology (e.g. electronic chips, high performance ceramics, provided by the private companies that were partners of the exhibit) were displayed in the third module, alongside "natural" nanotechnology (e.g. lotus leaves that do not absorb water because of their nanoscale structure). Representing what "nanotechnology does", in order to have "the visitor reflect on potential futures", was conceived as a way "not to be in a public understanding of science model", and not to do "mere vulgarization"[1]. The idea of the exhibit planners was, in the continuity of the nanomanipulator, to use applications as entry points to make visitors think about the future they envisioned.

Albeit uncertain at the beginning, this objective was eventually worked upon through collaborative work involving the CCSTI staff, social scientists, and private companies. Both private companies (France Télécom and Essilor) and research laboratories specialized in the use of technology[2] were interested in cooperating with the CCSTI on exploring the expectations and concerns of visitors regarding potential nanotechnology applications. For them, the exhibit could be used as a laboratory to test the expectations of visitors regarding future technologies. Sociologists from the companies and CEA partnered with the CCSTI in order…

… not only to present the "nano-inside" applications, but also to present them in a context of use, so that the public can voice an opinion on potential uses.[3]

The collaborative work with sociologists from public and private research centers led to design a questionnaire called "homo nanotecus" – the pun "homo nano takes us" was intended, if not of the best taste. It dealt with "nano-inside applications", which were considered as an "improvement of existing technologies or promises for a more or less distant future"[4]. Scenarios were written beforehand in order to contextualize potential applications. They were based on previous works led by the sociologists involved, which had resulted in a classification of technology users according to their "relationships with

[1] These expressions were used by the director of Grenoble CCSTI in an interview.
[2] Such as a CEA research laboratory called "Ideas Laboratory" (Laurent, 2011).
[3] Meeting report, internal document, June 26th, 2006.
[4] Preparatory documents, "homo nanotecus".

technological innovation"[1]. For instance, within a scenario about "new chip for the coordination of all home electronic devices", visitors were told that:

> *All your usual data are transmitted and verified automatically by this "super controller". They are immediately archived in your P.C., which is permanently connected to the Internet.*

Then a scenario like this one was supposed to be the basis for questions that visitors were invited to answer through an interactive screen.[2]. They would be asked, for instance, if they preferred being woken up by daylight, or by a machine able to tell them the schedule for the day. They could then be told to what category they belonged: "detractor", "humanist", "utilitarist", and "fan". Figure 2.3 is an example of the "detractor" category, to which the Grenoble anti-nanotechnology activists supposedly belonged. The pipe-smoking, José Bové-like character considers nanotechnology as "a further threat for human beings". Another example is the "fan", an "admirer of new technologies" [3].

Figure 2.3: *The "detractor" category, one of the possible results of the interactive questionnaire*

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[1] Mallein et al., 2003;

[2] E.g. the following questions: *Do you think ICT: A- Prevent true social relationships; B- Allow to participate in social networks; C- Are useful tools to increase the efficiency of social relationships; D- Are but possibilities among others to weave links with others.*

[3] At that point could be introduced some of the "representations of (social) imaginaries" that preparatory works to the exhibit had identified as necessary for the representation of nanotechnology. Two Grenoble sociologists had been commissioned to write a report in order to elucidate the "imaginaries" through which local stakeholders constructed different "nanoworlds" (Combes and Le Quéau, 2006).

As it represented nanotechnology through examples of possible applications, the interactive questionnaire thus displayed a representation of society shaped by social science through the study of people's relationship to technological innovation. Simultaneously, the interactive questionnaire also offered a way for the visitor to practice debate: the visitor was expected to reflect on his own attitude towards innovation and the future developments of nanotechnology[1].

Displaying public concerns

Public concerns related to nanotechnology were displayed in the exhibit. Panels presented the ethical questions related to the potential transformation of the human specie by the possible future development of nanotechnology. This was not uncontroversial. The deputy director of CEA Grenoble, who was a member of the organizing committee, explained during an interview that "at first, the exhibit insisted far too much on the visions of the American nanotechnology programs"[2]. He meant that the reference to science-fiction, and to the future convergence of nano-, bio- and information technologies, heralded as the obligatory future in the American NNI reports, was too visible, as compared to what was happening in France, and particularly in Grenoble. For him, the exhibit had to make it clear what the research and industrial practices were in the local area, and not so much stress the long-term concerns related to the transformation of the human specie through technology, which the exhibit did through the display of science-fiction books and themes. But this was precisely the role of the multiplicity of levels of representations (industrial applications, nanotechnology issues, science-fiction, social expectations through the opinions of the visitors themselves). This could make sure that the various dimensions of nanotechnology were taken into account, and eventually display nanotechnology as both a local research program in Grenoble and a transhumanist-inspired American program.

Representing nanotechnology concerns was also delegated, in module four of the exhibit, to two philosophers and two physicists discussing in video recordings the democratic control of nanotechnology, and its potential ethical and safety issues. Through these interviews, the exhibit made it possible to raise issues about the role of the science museum itself, and its democratic mission. Thus, one of the interviewees explained that "nanotechnology is a case for the regeneration of democracy through participatory systems". But from this perspective, the interviews included in the exhibit questioned the own activities of the science museum, encompassing a critical dimension directed towards the very meaning of the display of nanotechnology:

[1] The results of the questionnaire were then supposed to be studied by the team of people that had designed it. This was eventually not done.
[2] Interview D. Grand, Grenoble, July 17, 2008.

The problem today is that all the efforts in popularization… are propaganda! And this is scandalous! They use imaginaries or concerns of the public, and respond by marketing approaches instead of fostering reflections.

These opinions were part of the display of the "nanotechnology debate" that the Grenoble CCSTI had been so concerned about. They question the exhibit itself, which thereby integrated yet another form of distance into the entities it represented as they voiced concerns for the display of nanotechnology (the very objective of the exhibit).

The intertwinement between nanotechnology and the debate about it is also visible if one considers how the exhibit was presented by animators of guided tours, especially to groups of students[1]. Animators would describe the potential "scenarios" according to which nanotechnology could develop. They would mention, for instance, the storage of personal information using nano-electronics, "improving human nature" (e.g. "to see in the infra-red domain"). These discussions, mostly held by graduate students in scientific disciplines, could be held at various moments during the visit of the exhibit. They were means through which the museum people could "make sure that some issues were heard"[2]. For instance, organizers in Bordeaux could insist on the uncertainties surrounding potential risks of nanoparticles for the environment and human health, which they thought was not sufficiently made explicit in the content of the exhibit.

In so doing, the nanotechnology exhibit displayed the "concerns" that were considered parts of nanotechnology in a way that is different from what is described in current scholarly work as the "representation of scientific controversy"[3]. The idea was not to represent, in a somewhat impartial terrain, the variety of positions within a scientific dispute. The difference was drawn by the organizers themselves:

We had done in the past an exhibit about prehistoric man (…). And there was a controversy there. With some people, I mean scientists, having different views, different understandings of the nature of the evolution of man. So we had to display two constructions of the evolution of man in the exhibit. The case was different in the case of nano. The point was more about the "pervasive uncertainty about how the domain could evolve, and what issues would be the most important"[4]

This follows directly from the previous discussions. Less than a well-structured scientific controversies, nanotechnology comprises objects to be acted upon in order to be represented, and public concerns that are enacted in the science museums as in other public places. This implied that the exhibit

[1] I observed one of these tours in Bordeaux in December 2009. Quotes are excerpts from my fieldwork notebook.
[2] Interview, Bordeaux CCSTI, December 17, 2009.
[3] Yaneva et al., 2009; Meyer, 2009
[4] Interview, Bordeaux CCSTI, December 17, 2009.

made use of several channels of representation - representation of nanotechnology by objects (applications) and the social as made of technology users expected to belong to social categories according to their various relationships to innovation (as represented by social science), representation made by literary work of science/society relationships, representation of nanotechnology issues through the opinions of spokespersons, and through guided tours - and participate explicitly in transforming nanotechnology into an entity supposed to be debated. Hence, nanotechnology was neither a case for the unproblematic representation of science at a distance, nor a case for the representation of controversies. Rather, it challenged the very logic of representation at a distance. The "debate" that was added to the exhibit was another opportunity to do so.

Displaying and practicing debate

The visitor of the nanotechnology exhibit was not supposed to acknowledge passively the representation of the nanotechnology issues. For the Grenoble organizers, the exhibit was supposed to turn visitors into "debating citizens", possibly participating in one of the many public meetings that were held as the exhibit was presented. "Making a debating citizen" directly followed from the expectations of the designers of the other parts of the exhibit: understanding that nanotechnology was based on the construction of objects at the atomic scale, reflecting on the spectacular components of nanotechnology and discussing one's own relations to technological development were supposed to contribute to the transformation of the visitor into a participant in public discussions about nanotechnology. Other techniques supposed to collect the opinions of the visitors themselves were expected to transform visitors into "debating citizens". One of them was a card game named *PlayDecide*, adapted from a device called "democs" and developed by the *New Economic Foundation*, a British think tank. Democs claims to be a

new way to help people to talk about politics. It's a game-like process which gives players all the information and structure they need to share ideas on difficult ideas[1].

PlayDecide is an adaptation of democs that focuses on technological issues. It has been distributed through the web across Europe and some other countries. The Grenoble CCSTI was a member of a European project involving several European science centers (it will be discussed in the next section), and was encouraged to use *PlayDecide* along with the other partners. *PlayDecide* was an integral part of the exhibit in Bordeaux, as a special module was added in which visitors were invited to use the game. *PlayDecide* is based on a set of characters that are supposed to be played by the participants. Each of

[1] http://www.neweconomics.org/projects/democs (accessed December 30, 2009).

them receives a card describing the character he or she is supposed to embody. For instance, one of the cards reads:

"*I am a transhumanist. I anticipate a convergence of genetic, stem cell, brain, cybernetic and nanotechnology research, which will open up permanent human genetic changes and much else. These would not only eliminate genetic diseases but also enable enhancements.*"[1]

Participants are then expected to defend the positions of their respective characters, while listening to the others. Eventually, the group is supposed to vote for or against four "policy positions", going from "rapid nanotechnology expansion, minimum regulation" to "no nanosciences unless specifically and publicly agreed" and might add a fifth one. The results of the votes can then be uploaded in the *PlayDecide* website. Through the use of *PlayDecide* in the nanotechnology exhibit, visitors actively participated in the representation of both nanotechnology and society. The exhibit could thus provide living representations of nanotechnology concerns and publics, and eventually a living display of the "debate" itself – all of them being enacted by visitors.

Another technique for the making of "debating citizens" was a device called *petits papiers* ("little notes") by the organizers. Paper sheets were provided at the end of the exhibit for visitors to leave written notes (figure 6), answering these three questions:

To sum up in one sentence what you think now, you would say that nanotechnologies are…
As you see things, the main reason for pursuing research and development of nanotechnologies is…
In your opinion, the main danger of nanotechnologies is…[2]

The notes were then hung on a wall, and could be read by other visitors (cf. fig. 2.4).

[1] Excerpts form the *PlayDecide* guidelines.
[2] The questions were translated into English in the exhibit. I kept the original formulation.

Figure 2.4: *The "little notes". Visitors could leave written notes in module 4.*

A sociologist who was an advisor to the exhibit explained during an interview:

> *Laurent* (the CCSTI's director) *was all about debate... "This is an exhibit about issues", "this is an exhibit about the nanotechnology debate"... And I said "here we are", this is the debate... There was this debating community created, and you could see it, hanging there on the wall.*

The modest device was thus a way for the organizers to render the practice of the debate possible, and in the same time, to display it along the other parts of the exhibit. Yet the paper sheets could not speak for themselves and answers needed to be re-elaborated to represent the visitors. A team of sociologists[1] analyzed them in order to study

> *the ways in which visitors of this kind of exhibit are ready to take part in debates on social issues with scientific components, such as the future of nanotechnology research*[2].

Therefore, their analysis was more than a study of the "opinions of the visitors of the exhibit"[3]. It could be used as a tool to understand how and why people participate (or not) in a "large public debate on science/society issues". An important matter was the fact that

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[1] The social scientists who intervened in the design of the interactive questionnaire specialized in the study of technology users. The social scientists who studied the written notes were linguists and sociologists.
[2] Ancel and Poli, 2008: 1
[3] *Ibid.*

people responded to each other. At that point I said 'there's something like a debate'. I realized people were answering each other... Somebody would write a note saying, like, "research should be monitored by citizens" and would refer to the research activities of CEA, here in Grenoble... and others would directly refer to this first note: "you can't have scientific research without freedom of research" and would provide examples of innovations...[1]

The little experience of the exhibit organizers was significant, and proved, for them, the importance of the "debate" about nanotechnology. But the actual content of the discussion was not what mattered the most. The "discursive community" which was formed was the main outcome of the last part of the exhibit. The little notes had managed to create the "debating citizen" that was looked for, and the director of CCSTI considered them as the main success of the nanotechnology exhibit. They were at the same time the display and the practice of the "nanotechnology debate".

Representations of, by and for the visitor

The nanotechnology exhibit answered its democratic ambition through a "representational system" made of a diversity of channels of representation (nanomanipulator, spectacular visions, interactive tests, interviews about public concerns, "little notes") that connected nanotechnology's objects, futures, concerns and publics. This way of doing representation with nanotechnology implies a very fluid and undefined "nanotechnology", as much a scientific practice as a set of industrial applications, a public policy program, an umbrella term for a series of public issues, and a matter of "public debate". It problematizes nanotechnology as an entity in the making, open for the intervention of visitors not in the realm of public decision-making but in the space of the science museum.

Students of public engagement in science and technology often evaluate mechanisms according to their bearing on decision-making[2]. The example of the nanotechnology exhibit compels to refrain from adopting this evaluating position in order to account for the multiple ways in which the science exhibit might be a representation of the social as well as it is a representation of science. Multiple ways for the exhibit to be a "public engagement" device may thereby be considered. As a social scientific instrument to study the public, an inquiry into the expectations of people for future exhibits, an opportunity to make visitors think about their personal opinions about nanotechnology or a role playing device in which visitors are included, the exhibit does "public engagement". Yet one has to accept the fact that the science exhibit might not fit into a model in which engagement mechanisms are sorted

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[1] Interview with one of the authors of the report, Grenoble, July, 17th, 2009. The following quotes in this paragraph are excerpts from the same interview.
[2] For an example about science centers, see (Kurath and Giesler, 2009).

according to their "impact" on decision-making processes[1]. In the representational system of the nanotechnology exhibit, the science museum does not occupy an external position from which it could relay the voice of the public to policy makers. Rather, the "democratic role" of the science center consisted in displaying and practicing the nanotechnology "debate" in the protected space of the science museum, with no objective of acting upon the making of public decisions.

This is even more visible in latter projects led by the Grenoble CCSTI, which attempted to realize what the director of the Grenoble CCSTI had attempted to do with the nanotechnology exhibit – i.e. the "total inclusion of visitors" in the making of the exhibit. As he recalled during an interview, "the nanotechnology exhibit was participatory", yet "one more step was needed" in order "to involve people more directly" and "have them think about nanotechnology". For instance, *NanoYou* is a European project that was launched in 2009, still ongoing at the time of writing, of which the Grenoble CCSTI was an active promoter. *NanoYou* is based on the idea that potential visitors are themselves users of technology. Therefore they are expected to contribute to the design of potential applications of nanotechnology (mostly in the field of ICT): their contribution can then ground the construction of actual prototypes, or more simple three-dimensional representations of potential applications. The process is made of several rounds of a contest involving students from design and engineering schools. Prizes were then awarded in March 2010 at the Cité des Sciences[2] in Paris to the best projects – movies, prototypes, etc…, the "best" projects being those that were able to "raise issues", to "make people think about nanotechnology"- which were later included in the display of the follow-up new nanotechnology exhibit in the fall of 2010. For instance, one group of students showed a short animated movie that described a space "without technologies", protected from any nanoelectronics device and products using nanoparticles and nanomaterials. This project got a prize: it was, for the jury, a "really nice way of displaying a complex technological world", and the "issues with the pervasiveness of nanotechnology".

In such a process, the visitors themselves conceive the exhibit. It is supposed to display representations of the future applications of nanotechnology and their associated issues, as produced by their potential users. Here the museum is not a place where passive, at-a-distance representation of an already made science is performed. Rather, it draws on multiple distances to represent at the same time the future of nanotechnology and the social expectations and concerns about it. The position entails that the science center loses the potentiality of exteriority: it has to be part and parcel of the construction of nanotechnology future, industrial applications or public concerns.

[1] Arnstein, 1969
[2] I observed this meeting. Quotes in this paragraph are excerpts from my fieldwork notebook.

Contestations of the exhibit's representational system

The democratic ambition of the nanotechnology exhibit was not a universally accepted conscious choice. It relied on the construction of techniques of representation able to display nanotechnology's objects, futures, concerns and publics, and make visitors act on them. The representational system thereby enacted faced contestations. I consider in the following two of them, one linked to an addition to the exhibit at the Paris Cité des Sciences, which the Grenoble and Bordeaux exhibit designers did not approve of, the other related to the external critique of anti-nanotechnology activists.

A totem for nanotechnology

After its initial presentation in Grenoble and before it moved to Bordeaux, the nanotechnology exhibit was displayed at the Paris Cité des Sciences. The Cité added at the center of the exhibit a "totem", a kind of tower with large-scale pictures of nanotechnology applications, illuminated from the inside (figure 2.5).

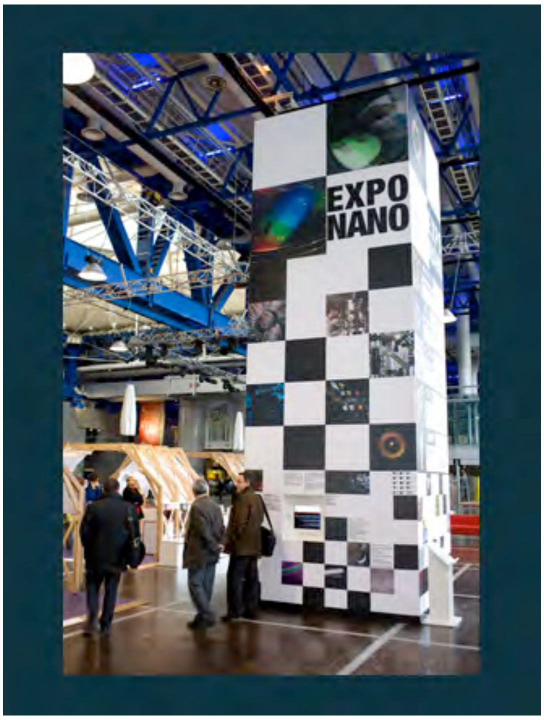

Figure 2.5: The totem of the exhibit, at the Paris Cité des Sciences et de l'Industrie

The presentation leaflet of the exhibit at the *Cité* spoke about a "sensitive immersion into the world of the infinite small" and explained that "two of the totem's sides allow the visitor to familiarize himself or herself with the intriguing scales of the nanoworld, through a series of landmarks."[1] The Grenoble members of the organizing committee were dazzled by this addition to the exhibit. One of them thus explained during an interview:

It was a sort of big totem, a very big and thick stuff, very esthetic, very attractive. There were gels inside, things you wouldn't see, but it was so beautiful. I guess it was just about this: the visitor was hypnotized by this big thing, by the beauty and might of science [2]

The awe-inspiring vertical totem of science was erected in front of a rectangular piece of water, where lotus leaves represented "an example of complex natural molecular assemblages"[3]. Hinting, willingly or not, at the easy-to-make sexual interpretation, the same informant said that:

they also had something like the lake supposed to represent Nature... a broad, watery thing... very quiet, very peaceful: nature at the front of this big thick thing.

This two-part addition to the original exhibit led the visitor to be puzzled by the beauty of nature, and even more by the mythical power of science, able to transform nature and make it realize its otherwise silent potentialities. Such an addition to the exhibit could have been conceived as yet another channel of representation of nanotechnology. But for the member of the staff of the Bordeaux science center who was involved in the making of the exhibit, the totem contradicted the very principles of the nanotechnology exhibit. He considered that "people from the Cité did not get the logic of the exhibit"[4]. One can indeed contrast the perspective that the Bordeaux exhibit chose to follow – multiplying the channels for representations, putting them on an equal basis, and insuring that visitors ask themselves questions about science – and the representation of science that the two-part installation at the Cité constructed. In this latter case, the exhibit was situated at an objectifying distance from both nature and science, as it was a mere physical place where the passive beauties of the former and the active marvels of the latter were to be displayed. The totem can be seen as an attempt to reduce the complexity of the representational system to a simple mirror-like and faithful representation of nanotechnology as a scientific discipline able to master the potentiality of nature. For the Bordeaux and Grenoble people, it lessened the quality of the exhibit, and was eventually the sign of reductionism in the representation of nanotechnology that ended up enacting a different democratic arrangement, in which the citizen was expected to watch passively the miracles of science and nature.

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[1] Cité des Sciences, 2005, *Exposition nanotechnologies. Dossier de Presse*.
[2] Interview, Grenoble, July 17th, 2009.
[3] Presentation of the nanotechnology exhibit, Cité des Sciences public document.
[4] Interview Bordeaux, December 17th, 2009.

Voicing a critique

A second case of displacement of the nanotechnology exhibit's representational system is external to the making of the exhibit. It deals with the anti-nanotechnology activists CEA wanted to respond to when participating in the making of the exhibit. They had released texts on the Internet that directly targeted the CCSTI and the communication policy of CEA. They had criticized other dialogue experiments that the Grenoble local elected bodies had attempted to organize, and had set up demonstrations on the construction site of a research center expected to be a major nanotechnology center in Europe[1]. The director of the CCSTI, who expected potential demonstrations, requested "special protection" for the opening ceremony of the nanotechnology exhibit, as he "feared for the safety of the guests"[2]. Numerous policemen were present during the official opening event of the exhibit. The activists reacted by pointing to the material display of the connection between the Grenoble science center and public bodies that, according to them, were supporting nanotechnology development without democratic control[3].

When displayed at the Paris Cité des Sciences, the nanotechnology exhibit was accompanied by a two-day public event, organized as a dialogue on the opinions of various stakeholders. During this event, a group called *Oblomoff* intervened right before the final speech of the then minister for industry, François Loos. They showed up on the podium and read a pamphlet, in which they claimed that "more and more people refuse the pursuing of economic development and research, empty words of an empty future (*futur sans avenir*)". They concluded by claiming that the people gathered at the Cité "did not represent anything", but wanted to "make nanotechnology be accepted by the population". They unfolded a banner which read "the futuristic vision triumphs but we do not have a future" (*le futur triomphe mais nous n'avons pas d'avenir*). To that François Loos replied in his speech that science was to be properly understood and scientists trusted[4]

The Grenoble CCSTI was directly targeted in the fall of 2009[5]. Red paint was projected on the walls of the CCSTI, and leaflets were left on the front of the door. Signed by a "collective for citizen debate" (*collectif débat citoyen*), they explained that the CCSTI was targeted since it was "a symbol of the

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[1] Cf. (Laurent, 2007; 2010a: chap.6). I will discuss anti-nanotechnology activists' forms of mobilization in chapter 7.

[2] Letter of CCSTI's director to the *préfet* chief of staff.

[3] In (PMO, 2007), the activists speak of the "propaganda" that CCSTI performs.

[4] This intervention made a strong impression on the members of the French administration involved in nanotechnology policy. Three years after it had happened, the chair of the French delegation to the OECD Working Party on Nanotechnology told me that she "would do anything to avoid something like what happened at La Villette".

[5] A national debate about nanotechnology was being held throughout the country at this time (see the foreword, chapter 3, and chapter 7)

acceptabilization campaign orchestrated around nanotechnology", meant to "prevent social mobilization" against a technological domain which caused health risks and was developed for economic or military interests. The director of the CCSTI answered on his blog, and clearly situated the locus of the confrontation. For him, being "anonymous", as the collective was, and using "violence" (albeit without much consequence for anyone), was a "curious method for the defense of democracy"[1]. Democracy was, for him, precisely what his science center was doing. Hence the confrontation: for the activists, the activities of the French science museums could not pretend in any way to ensure a democratic appraisal of nanotechnology. The democratic model that the nanotechnology exhibit was constructing, based on the production of representations by visitors themselves, and on the display and practice of debate within the exhibit or in close connection to it, was not accepted by the activists, who considered that their role, as engaged citizens, was to perform a critique of nanotechnology from an exterior position.

I will develop the social mobilization that the anti-nanotechnology activists propose later in the dissertation. At this stage, these examples are useful to stress that French science museums are places where representing nanotechnology means defining a problem of democratic organization. For the Grenoble and Bordeaux CCSTI, the various channels of representation of objects, futures, concerns and publics were ways of representing nanotechnology as a composite entity, and to involve visitors in its display and practice within the museum space. Both CEA's totem and the anti-nanotechnology activists' interventions restored an exteriority: that of the museum for the former, where the visitor would be turned into a citizen watching passive Nature and active Science, that of the radical critique for the latter, deemed necessary to opposed the transformation of the museum in a component of nanotechnology.

[1] Blog L Chicoineau, October 27, 2009.

Section 2. From public understanding of science to scientific understanding of the public

A project for the European approach to nanotechnology

The nanotechnology exhibit was not the sole experience with nanotechnology that the Grenoble CCSTI had. The science center also intervened in several European research projects devoted to nanotechnology and society. A project called *Nanodialogue* was running at the same time as the nanotechnology exhibition was designed. *Nanodialogue* was one of the first European projects in the "Ethical, Legal and Social Aspects" (ELSA) of nanotechnology. Only one among many ELSA projects, *Nanodialogue* was an early initiative in this area, which directly inspired the making of further nanotechnology communication policy. In the following, I will focus on this project in order to shed light on the question of representation of nanotechnology as it is asked in European science museums, and, more generally, by policy actors in the European Commission[1]. The example of *Nanodialogue* will lead me to describe the evolution of the European nanotechnology communication policy from "public understanding of science" to the "scientific understanding of the public".

Nanodialogue, which was conducted at the same time as the nanotechnology exhibit, was, in the terms of the Grenoble CCSTI, "a unique opportunity to collaborate with colleagues from European museums"[2]. Indeed, 8 institutions across Europe participated in the project, which consisted in designing and staging an exhibit about nanotechnology. This "unique opportunity" eventually proved a bit disappointing for the Grenoble CCSTI's director, who considered that there was "not enough time and resources" to participate effectively in this European project. I am less interested here in exploring the challenges of working with long-distance partners in the making of an exhibit, than, again, in the question of the representation of nanotechnology. For *Nanodialogue* raised the same kind of questions as the Grenoble nanotechnology exhibit. The case thus allows me to contrast the representational systems built by the Grenoble CCSTI with what would be the first step of a European representation of nanotechnology in the science center.

As in the case of the nanotechnology exhibit, questions of democracy were directly raised by the science centers and museums involved in *Nanodialogue*. The project was launched as part of the sixth Framework Program. It was funded in response to the nanotechnology call for projects, and, in

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[1] I had access to the archives of the project at the Grenoble CCSTI. I conducted interviews with 5 people involved in the project, in science museums and the European Commission.

[2] Laurent Chicoineau, the director of the Grenoble CCSTI project mentioned *Nanodialogue* in numerous presentations to local and national institutional actors in order to demonstrate the commitment of the Grenoble science center to nanotechnology.

particular, under the ELSA objective[1]. *Nanodialogue* was one of the first two projects about nanotechnology ELSA that were funded within the sixth framework program, and the only one involving science museums[2]. The full title of the project was "ENHANCING dialogue on nanotechnologies and nanosciences in society at the European level" – thus emphasizing "dialogue" for the whole project[3].

Nanodialogue's coordinator, the Naples-based *Citta Della Scienza*, expected the project to do more than mere science communication. Consistent with its European funding program, "ethical, legal and social implications" were to be the focus of the project. Whether these "implications" were to be displayed in science centers, or voiced by the visitors themselves, remained vague at the beginning of the project. One of the members of the team at the *Citta della Scienza* thus explained during an interview:

The EC was pushing for projects on science for society… they wanted participatory projects. Especially on nanotechnology… And I suppose we were interested in trying to do something in that. That happened in a context where participatory projects had been undertaken.[4]

Indeed, *Nanodialogue* was part and parcel of the European initiatives on nanotechnology that followed the *Nanotechnology Action Plan*, released by the Commission in 2004. The *Action Plan* required the implementation of "an integrated and responsible strategy on nanotechnology at EU level"[5]. In this strategy, the "integration of the societal dimension" was a key concern. Such an integration was expected to "address expectations and concerns". Under the societal dimension chapter, the Action Plan urged the E.U. to "create the conditions for and pursue a true dialogue with the stakeholders concerning N&N".

Together with the concern for the "ethical issues" which were supposed to be taken care of by dedicated bodies of the European science policy organizations[6], the stress put on "dialogue" makes nanotechnology a case among many others in the European science policy landscape. As a presentation leaflet of *Nanodialogue* explained:

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[1] This was the third "priority" of the 6th Framework Program: "priority 3 NMP. Priority title: 3.4.1.5 Applications in areas such as health and medical systems, chemistry, energy, optics, food and the environment; ethical, legal, social aspects of research in nanotechnology".

[2] Other projects comprised *Nanologue*. The motto of this latter project – "we need to talk" – also emphasized dialogue as a central concern.

[3] The Grenoble CCSTI's favourite term was "debate" whereas the European project focused on "dialogue". The difference should not be overemphasized, as "débat", in French, has a less confrontational tone than its English counterpart.

[4] Phone interview G. Maglio, April 9, 2009

[5] Nanotechnology Action Plan, 2004, introduction by Janez Potocnik, European Commissioner for Science and Research.

[6] Such as the European Group on Ethics (cf. chapter 6).

engaging citizens in dialogue and discussions about science and technology has been recognized by the European Commission as a fundamental component to create the knowledge economy and the basis of the European Union's Lisbon agenda[1]

The Lisbon agenda had indeed called for the transformation of Europe into a "knowledge-based economy", and of the European public into a "knowledge society". In this approach, "dialogue" was an important component, made explicit in the *Science-society Action Plan*[2].

Democratic ambitions for European nanotechnology

Was there a specificity of *Nanodialogue* related to nanotechnology then? The question was asked by the participants in the *Nanodialogue* project. At the *Communicating European Research* conference in 2005, a session on nanotechnology asked what "made nanotechnology so special". Gugliemo Maglio, from the *Citta della Scienza* participated, as well as Angela Hullmann, the European civil servant in charge of the coordination of EU-sponsored research activities in nanotechnology and society (and thus of *Nanodialogue*). The outcomes of the discussions were later presented to the organizing committee of *Nanodialogue*[3]. The participants insisted on the "anticipatory dimension" that made it necessary to take into account "at an early stage" the potential negative effects of still undefined nano substances and products. For the partners in the *Nanodialogue* project, this was a characteristic of a European approach to nanotechnology. The early involvement was part of a democratic ambition for the project, meant to be a response to the shortcomings of "traditional modes of government". As opposed to "hierarchical, state-led decision-making processes", *Nanodialogue* was based on a call for "new forms of governance":

based on networking among stakeholders, on the integration of interests, on the involvement of citizens and consumers in the implementation of policies.[4]

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[1] "The Nanodialogue project: an integrated approach to communication"

[2] The *Science-Society Action Plan* was written by the Science and Society Unit at the D.G. Research. The unit gathered European officials coming from various academic fields, some of them scientists, others ethicists and science study scholars. It had been pushing for a "new partnership" between science and society, consisting in "transparency" of the research activities, and the "continuous dialogue" between the two. The stress put on "dialogue" complemented initiatives meant to better know how European publics understood science. Thus, the nanotechnology Action Plan mentioned both "dialogue with society", and the fact that "special Eurobarometer (EB) surveys should study the awareness of and attitudes towards N&N across member states" in order to assess "the effectiveness of different approaches across Europe" and to provide "early warning of particular concerns" (Nanotechnology Action Plan, 2004: 9). The connection between "dialogue" and the study of "perceptions" will be discussed below.

[3] Minutes of a meeting in Brussels Nanodialogue project.

[4] *Nanodialogue* project description: 4

The project was based on the hypothesis that public participation had value, in a context described as that of great public concern for the potential implications of scientific research. *Nanodialogue* was expected to "guarantee the application of a democratic process", and ensure the "full consideration" of the opinions of "researchers, politicians, industrialists, social organizations, citizens" in the definition of "research trends"[1]. The evaluators from the European Commission appreciated the emphasis put on the democratic ambition of the project. But at that stage, the various members had no definite idea of how to implement it.

In the first months of the project, participants would thus gather a wide range of academic papers, press articles, books, conference calls broadly related to science and society issues, while exploring in a conceptual bricolage what could be the forms of participation of publics in nanotechnology[2]. Specialists of public participation in science were called to contribute. The Italian coordinators of the project invited a team of sociologists, led by Simon Joss, to participate in the project. Joss was at that time dean for research of U.C. Westminster, and an internationally known specialist of public participation[3]. He had written on consensus conferences with John Durant, and was participating in another European project called CIPAST, which aimed to train officials and academics in the practice of public participation in science and technology[4]. Although CIPAST had provided opportunities for Joss to interact with science museum people, *Nanodialogue* was the first time that he had worked with science centers. Joss was interested in the democratic ambition of the project:

At the time I thought 'well this is really innovative' (...) It's a knowledge transfer project where educationists, museum specialists, social scientists, and technology experts come together and try to explore the development of new types of interaction. (...) I thought 'it's exciting, you can do something. Maybe you can work on, you know, democratizing nanotechnology.[5]

So when the project started, it was evident for everybody (whether partners within the project or program officers in the European Directorate for research) that "democracy on nanotechnology" was to

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[1] *Nanodialogue* project description: 6

[2] Thus, there were academic articles, science policy reports, and numerous press articles devoted to "public participation in science" in Chicoineau's personal archives.

[3] See for instance his work on consensus conference (Joss and Durant, 1995a; 1995b) and participatory technology assessment (Joss and Bellucci, 2002).

[4] CIPAST was coordinated by the Paris *Cité des Sciences*. Members were science museums and academic research centers. CIPAST was funded within the program "Structuring the European Research Area" of the European Commission.

[5] Interview S. Joss, London, Sept. 17, 2009.

be constructed, in a process that was conceived as not separate from the examination of the "ELSA" part of nanotechnology.

Designing the exhibit

Nanodialogue was conceived after a couple of meetings involving the participating science centers, the team of sociologists, the program officer from the DG Research, and members of an advisory committee made of people proposed by the various partners[1]. The main event in the process was a three-day workshop in Naples in March 2006, during which the "scenarios" of the future exhibit were crafted. The democratic objective was discussed among the project members:

We should make people realize that they are taking part in a democratic process, and this could be done through the website, but we should try to have also other instruments into the exhibition module, to enforce the physical interaction. In order to achieve this, the design, the colour, the writings on the module should be such as to encourage visitors to stop, read, act and reflect."[2]

Here again, the interactivity of the exhibit was explicitly linked with its democratic ambition. During these discussions, interactivity was extended to the organization of the whole exhibit:

A common starting point and different directions departing from this common start and going through different paths according to the way visitors react to different questions/points of view[3].

Associated to that was the idea of a spherical layout - which could be "some kind of agora" for many partners, including the Grenoble one, who could then restate their concern for the "nanotechnology debate" – at the center of which discussions would take place about nanotechnology issues:

And I remember visualizing maybe some kind of a spherical or circle space where you could have maybe two or three experts debating with visitors the issue and around it maybe you would have different moveable walls where

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[1] In Grenoble, two members of the nanotechnology exhibit team were proposed to participate in the *Nanodialogue* advisory committee, the deputy director of CEA-Grenoble, and one of his colleagues. According to the director of the Grenoble CCSTI, the advisors eventually played a limited role in the design of the exhibit.
[2] Minutes, Naples workshop
[3] *Ibid.*

you could maybe bring in the medical aspect of nanosciences and if the topic changes you could bring in the environmental, technology side of it.[1]

The exhibit was indeed supposed to be less about the reality of scientific practice than "an exhibit about issues"[2]. Nanotechnology concerns were to be represented, and transformed into topics for public discussions.

For all the concern about the display of issues and the involvement of the visitor within the exhibit, the final design chosen by the coordinator of the project was "much simpler than what had been envisioned"[3]. The "reality of nanotechnology" was first distinguished from its "imaginary" but meant to be closely linked to futuristic explorations.

Section 1. Imaginary and reality: The visitor is introduced into the nanoworld through familiar pictures present in movies, comics and science-fiction novels. Each of these pictures will be linked to an application, in order to connect the fantasy to the actuality of research. For instance, close to the picture displaying a nanorobot cleaning an artery, the visitor will find pictures of nanocapsules for drugs in their contemporary and future presentation.

The last module of the exhibit offered the visitor the possibility to voice his opinion on nanotechnology:

Section 7: Your opinion: This section focuses on perceptions and viewpoints of the European public. A multimedia terminal connected to the Nanodialogue website will allow the visitor to voice an opinion, to consult the previous comments and to access complementary information.

The concern for the "European public" was not anecdotal: the exhibit was meant to gather the European public and represent nanotechnology for him, as much as it sought, through devices such as the "multimedia terminal", to represent the opinion of the European public. I will get back to this important point. But before that, it is interesting to discuss the representations of nanotechnology that the *Nanodialogue* exhibit eventually proposed. The final layout "had the merit of clarity" as G. Maglio explained, and allowed the coordinator to negotiate time and financial constraints. Yet it did not satisfy many of the other partners. The representative of the Deutsches Museum was concerned about the original focus on the "societal implications" of nanotechnology. He explained in a message sent to all the partners:

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[1] Interview S Joss, London, Sept. 17, 2009
[2] This was the opinion of the participants from Barcelona Museum of science (email correspondence)
[3] Phone interview with Alison Mohr, who participated with Simon Joss in the sociological part of the project.

Generally: This is a nice introduction into nano in the classic style of science popularisation: but I can't recognize so much the dialogue-oriented approach we are heading for. There is virtually no discussion of risk, of ethical-legal-social aspects, neither an integration of visitors' views nor a representation of controversial topics (the feedback terminal just added at the end looks somewhat alibi-like).[1].

These concerns (which were not limited to the German partners, and also voiced by the French ones) eventually led the designers of the exhibit to add panels on the "risks" and "ethical" issues of nanotechnology. This was not entirely satisfying for all the participants in the project, particularly the social scientists. But for others, nanotechnology ELSA was far too visible in the exhibit. The Italian coordinator thus explained in an interview[2]:

We had contacts with scientists. For instance those we work with here. And many of them thought it was way too much about the risk and ethical issues. (…) Cos', you know, … all the exhibit would say: "there are biomedical applications", and then "and there are all these ethics questions"; "there are these daily life applications, like energy storage", and then "but technology might have safety risks"… And for many scientists, that was just too much insistence on the "ELSI" part, it was not about nanotechnology at all.

My point is not to determine whether or not "ethics" was a major component of the exhibit. Rather, it is to stress that the integration of the "issues" in the exhibit was based on the separation between the representation of a scientific content and that of associated ethical issues. The separations that grounded the organization of the exhibit (description of nanotechnology's principles, description of industrial applications, and presentations of the ethical issues) determined the type of discussion that followed: isolating ethics from the representation of nanotechnology led the participants to discuss the "appropriate level of ethics" in the design of the exhibit. At this stage in the dissertation, this should alert us to the importance and the ambivalence of the mobilization of the European "values" on nanotechnology. How to craft a European approach to nanotechnology that would be based on the collective discussion of the "ELSA"? This was not an easy task for the designer of *Nanodialogue* who eventually separated the representation of science from that of ELSA. Other examples, later in the dissertation, will provide additional illustrations of the operationalization of the European values in technologies of democracy.

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[1] Email, Nov 21, 2005

[2] The director of the Grenoble CCSTI voiced the same opinion: "We were always talking about ethics, the whole exhibit was about ethics! Even for visitors, it was too much. There were many people who would come and tell us "but what is this stuff?" They would get out completely threatened… There were telling us "we just want to learn things" (Interview, Grenoble, July 17th 2011).

Assembling a European public

For the Grenoble CCSTI, *Nanodialogue* was initially considered as another component of the "democratization of science" program that the nanotechnology exhibit was meant to enact. A member of the Grenoble CCSTI staff thus presented *Nanodialogue* in an internal note as follows:

The exhibit will be accompanied by public conferences, meetings with citizens, consensus conferences, which will offer the opportunity to bring final recommendations to the European Commission. These recommendations will be presented and discussed in a large European conference that experts, decision-makers and civil society representatives (consumer groups, patient associations, environmental movements…) will attend.[1]

Nanodialogue was supposed to construct representations of the opinion of the visitors to the exhibits, and, thereby, of the European public. When the member of the Grenoble CCSTI wrote the internal note quoted above, the devices through which these representations were to be performed were still undefined. Eventually, focus groups were organized. They were conceived as a way of ensuring that the "recommendations" that they would produce could be "transferred to the European Commission". The organization of the focus groups was to be done by the team of sociologists, in order to present the "viewpoint of the European citizen on nanotechnology" to the European Commission[2]. From the start, the "recommendations" were evaluations of the opinions of visitors on both nanotechnology and the exhibit itself, as the presentation of the objectives of the focus groups in an internal document shows:

What is the aim of the focus groups?

- *to obtain qualitative, in-depth information about participants' knowledge of, and attitudes towards, nanoscience and nanotechnology*
- *to obtain information about participants' experience and views of the Nanodialogue exhibition*
- *to encourage an invited group of participants to share their thoughts, feelings, attitudes and ideas on nanoscience and nanotechnologies.*[3]

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[1] Introductory note, *Nanodialogue* projet, CCSTI Grenoble, 8/12/2005
[2] The expression was used in a preparatory document ("nano et société. Exposition itinérante et débats publics").
[3] Preparatory document (Dec. 2005).

Thus, the focus groups pursued on the separation between the representation of nanotechnology and that of its "societal implications". They were social scientific tools meant to construct "European publics" who could provide a representation of the "societal issues" that were the most pressing.

As none of the partners had experience in the conduct of focus groups, the team of sociologists distributed guidelines, which provided practical advice – such as "provide the participants with tea/coffee and some nice biscuits/cakes". They also defined the topics the discussions should raise. For instance, they advised to…

… provide tables on which to indicate "the aspects of N&N which (participants) feel positive about, those aspects you feel less positive about and those aspects which you have negative feelings about".

Such tables were devices through which separations between the aspects of N&N, and the opinion about them could be produced. Then, the European publics gathered in focus groups were able to provide opinions on stable scientific applications.

In spite of all the work of the social scientists involved, the representation exercise proved to be difficult for the organizers, who were eventually "not confident enough to use the data as a social science research" but considered it as a *snapshot* of the European public opinion on nanotechnology[1]. The infrastructure that sociologists had proposed was weak indeed. The team was based in London, and met the partners from the European science centers only a couple of times. They distributed the guidelines in English, and had to rely on local actors for translation. None of the members of the team was present during the actual conduct of the focus group. Here again, they had to rely on the local organizing staff, and were uncertain about the quality of the facilitation process in each of the sites.

In Grenoble, the director of CCSTI conducted the focus groups[2]. Participants touched on a variety of topics: they asked questions about nanotechnology, expressed concerns about its potential risks, and commented on the role of technology in their lives. Receiving questionnaires and focus group verbatims, the sociologists of the project could then present the "citizens' feedback" to the European Institutions, during a public conference held at the European Parliament. The opinion of the European public was entirely consistent with the very principles that were at the origin of *Nanodialogue*: there was a "prevailing view", which "was that of seeking ways to balance scientific freedom with risk-averse regulatory parameters", that the public "should be involved in decisions related to research and development, regulation and commercialization of nanotechnology", and that "more information should be made available to the wider public"[3].

[1] Phone interview, A. Mohr, September 2009.
[2] I only had access to the transcripts of the focus groups that were held in Grenoble.
[3] Nanodialogue final conference, tapescripts: 11.

The questionnaires and focus groups enacted a European public that sought to be involved in the making of nanotechnology programs, who had expectations and concerns about various areas of nanotechnology research, and whose opinion was to be considered by policy-makers in a shared context for "responsible innovation"[1]. The European public opinion thereby produced, could not be based on a stabilized (social) scientific instrumentation. But it also served in the shift of interest from the representation of nanotechnology to that of the European public and its concerns. This required a stronger infrastructure able to measure the opinion of the public. Accordingly, some of the concluding remarks of the final conference of *Nanodialogue* put the emphasis on the necessity to know the public better:

I think it is important to develop notions of the publics, in plural terms, to recognize that the public comes in different forms and shapes and that therefore developing governance modes needs to recognize there's a plurality of the public, that is the first point. The second point is that publicity, the process of governing in a way which achieves publicity again has to be conceived of in a pluralistic fashion. So publicity I think has to include a number of related components, including the construction of understandings, or social imaginations, in our cases, of nanosciences or nanotechnology.[2]

Hence, the *Nanodialogue* conclusions considered that the "pluralism" of the European public, in terms of its "forms" and the "imaginations" on which it was based, forced to know the public better. *Nanodialogue* thus performed a series of displacements. It shifted the representation of nanotechnology to that of its "implications", separated from science practices and technological objects. It then shifted the representation of the "implications" to that of the various publics, whose various "imaginaries" and "perspectives" composed the whole European landscape of public opinion on nanotechnology. The science museum thereby became a central component of the construction of the European democratic space: it was expected to participate in the representation of no less than the European public. *Nanodialogue*, for that matter, appears as a small-scale experimentation of what was to become the core concern of European nanotechnology communication policy.

Nanodialogue as an experiment for the European nanotechnology communication policy

Contrary to the representational system that the French nanotechnology exhibit produced, *Nanodialogue* proposed separated representations of nanotechnology, its ELSA, and of the European

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[1] On a detailed analysis of the realities that a European-wide survey enacts see (Law, 2009).
[2] Nanodialogue report: 34.

public. This latter representation was not based on a stabilized social scientific instrumentation, but it contributed to reflections about the ways of dealing with the problems of the relationships between nanotechnology and society at the European level. The *Nanodialogue* project is of particular interest since, as one of the very first European projects in both nanotechnology communication and nanotechnology "societal implications", it acted as a rehearsal of the European strategy in nanotechnology. The *Nanodialogue* experience circulated widely in the communication of the "nanotechnology and converging technology unit", in charge of European initiatives in nanotechnology at the DG Research of the European Commission. *Nanodialogue* was repeatedly presented at international conferences on science communication, and various European initiatives made use of the project. For instance, the CIPAST training program in participatory instruments had its participants discuss *Nanodialogue* under the supervision of Simon Joss. At this point, the project had become the topic of a typical case that could be used as an example presented to would-be organizers of participatory devices. Later on, the coordinators of the *Nanodialogue* project were mobilized by the DG Research as evaluators for the 7th Framework Program, and had regular contacts with officials at the DG Research about the nanotechnology ELSA projects[1].

The link between *Nanodialogue* and the European policy on nanotechnology communication was even more direct. The conclusions of the project were supposed to feed the further construction of the EU policy on nanotechnology. Indeed, the idea that ELSA issues deserved due examination was prevalent after *Nanodialogue*, as was the insistence on the representation of the "needs and concerns of the public". The participants in the *Nanodialogue* project were called to contribute to the definition of the "European strategy" towards "nanotechnology communication and outreach". Immediately after the final conference of the project, a workshop was held in Brussels, which gathered participants in *Nanodialogue*, European officials, and experts in science communication. The workshop resulted in a working paper entitled *Strategy for Communication Outreach in Nanotechnology*[2]. The *Strategy* was later refined and developed into an official document of the European Commission about *Communicating Nanotechnology*[3], which presented the "communication roadmap" that was to frame the strategy of the European Commission on the communication of nanotechnology.

The main themes of *Nanodialogue* were restated ("dialogue", "transparency", "good governance", "social acceptance") in the *Strategy* working paper. The further refinements of the European nanotechnology communication policy were drawn by Renzo Tomellini, who was at that time the head of the nanotechnology and converging technology unit at the DG Research, and, as such, in charge of European funding for nanotechnology research. In the *Strategy* working paper, Tomellini explained:

[1] Phone interview G. Maglio, April 9, 2009.
[2] *Strategy for Communication Outreach in Nanotechnology*, Brussels, February 2007.
[3] *Communicating Nanotechnology*, Brussels, March 2010.

Clearly, a new mood of communication is required, based on dialogue: instead of the one-way, top-down process of seeking to increase people's understanding of science, a two-way iterating dialogue must be addressed, where those seeking to communicate the wonders of their science, also listen to the perceptions, concerns and expectations of society. (...) This should enable to settle a sound basis for reaching consensus, achieving sustainable governance and social acceptance for nanotechnologies and nanosciences.[1]

In this perspective, *Nanodialogue* was a first experiment of the European strategy for the communication of nanotechnology, which involved "dialogue" and evaluation of "perceptions, concerns and expectations of society". The approach that emerged from *Nanodialogue* and which is made explicit in the previous quote relied on "dialogues" between separate worlds, those of science, publics, and European decision-making: science provides the facts, the public voiced its expectations and concerns, and the European institutions aimed to manage the representations of both nanotechnology and society.

From "public understanding of science" to "scientific understanding of the public"

The later report on the communication on nanotechnology was directly inspired by the previous documents and activities. It was written by Matteo Bonnazzi, an E.U. official who succeeded Angela Hullmann (the *Nanodialogue* program officer) in the coordination of the "nanotechnology and society" activities at the D.G. Research. Bonnazzi had attended and coordinated the workshops and meetings that followed *Nanodialogue*. He presented the report as a foundational document. It was to provide a "roadmap" that aimed to consider science communication "as part of the research process itself". This point was emphasized and considered

particularly important for communication on nanotechnology, as uncertainty, risk, social perceptions, concerns and expectations play a crucial role for building social acceptance or rejection of nanotechnology[2].

That nanotechnology communication was "part of the research itself" was rendered possible – at least institutionally – by the fact that the mandate to the European Commission defined a "double role for the Nano and Converging Sciences and Technologies Unit" (the expression was Bonnazzi's[3]) in the

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[1] Strategy for Communication Outreach in Nanotechnology, Brussels, February 2007: 10.
[2] *Communicating Nanotechnology*: 76.
[3] Phone interview, May 2010. Quotes in this paragraph are excerpts from this interview.

Action Plan. The unit was expected to define calls for scientific research project, and, at the same time, had to work on communication. Crafting communication coming "from the very core of research" implied that the nano and converging sciences and technology unit at the DG Research was also in charge of "science and society" topics[1].

The roadmap defined the "goal of communicating" as a "gain in EC image", particularly as far as "transparency, credibility and accountability" were concerned[2]. The hope was that the "consensus-based support to EU policy-making on responsible nanotechnology within society" could be increased[3]. In order to do so, the roadmap proposed extremely simple messages to convey:

- *Nano is:* ***not*** *magic ;*
- *Nano is:* ***a new phase of technology*** *exploiting nanoscale effects ;*
- *It deals with new:* ***beneficial applications and markets****, impacting on* ***health, safety, privacy, ethics and the socioeconomic divide*** *;*
- *It:* ***must and can*** *be controlled and driven conscientiously* [4]

For all their simplicity, these messages also insisted on some of the main focuses of *Nanodialogue*, namely the ELSA of nanotechnology, and the fact that nanotechnology was a program open to conscious direction. The latter point is important. It directly relates to the "democratic ambition" that was pervasive in *Nanodialogue* and in the European nanotechnology policy all together. But rather than entering into the complexity of the representation of an uncertain object, as the Grenoble nanotechnology exhibit had done, the roadmap did not discuss at length what was to be communicated. A few pages of the report developed the message further, and identified four topics to be focused on: "nanomedicine", "nanotechnology in tools, devices, processes for sustainability", "nanotechnology and Information & Communication Technology", "uncertainties, hazards, risks and associated ethical, legal and societal aspects". The fourth part was said to raise the most difficult questions, because of the "very novelty of nanotechnology"[5]. But eventually, the content of the "main message" was not the most problematic point of the roadmap, which considered nanotechnology as either a set of scientific objects and domains that could be described, or a source of potential uncertainties that raised ELSA aspects. Rather, all the work to be done was to identify potential "targeted audiences" (e.g. "youngsters", "media" or "NGOs"), potential communication techniques (of which "two-way methods" such as "dialogue" and "participatory" devices were the main ones), and linked the first with the second. Instead of developing

[1] There was a Science and Society Unit within the D.G. Research, which adopted an approach that differed from the "scientific understanding of the public". I will get back to this in chapter 6.
[2] *Communicating Nanotechnology*: 71.
[3] *Ibid.*
[4] *Communicating Nanotechnology*: 106, emphasis in the original.
[5] *Communicating Nanotechnology*: 36.

the ways in which nanotechnology could be represented in science museums, the bulk of the "communication roadmap" was about distinguishing between types of audiences (e.g. "children", "youngsters", "scientists", "NGOs", ...). It could then provide synthetic tables of European initiatives in the communication of nanotechnology, which were assessed according to their adequacy with their "targeted audiences". From *Nanodialogue* to the European roadmap, the main concern had shifted from the representation of science to that of the publics.

Thus, implementing the roadmap required an explicit shift from "public understanding of science" to "scientific understanding of the public". This move was meant to answer the failure of the deficit model:

The EC has already looked further into changing a traditional science and technology communication approach called the 'deficit model', according to which the public must understand science in order to accept it. This model is no longer working well, and seems completely obsolete. This change can be summed up by saying that for communicating science and technology the 'scientific understanding of public' has now become more important than the 'public understanding of science'[1].

This move implied that the public was to be scientifically known, but in ways that also allowed "dialogue" and "exchange of information". Dialogue, in this model, was not supposed to question the "main message" to communicate to the public, but expected to be used in order to get knowledge about the public and be attentive to its "expectations and concerns". Hence, the "scientific understanding of the public" appeared as an approach meant to tailor the activity of representation not towards nanotechnology anymore, but to a European society that needs to be made interested in nanotechnology. For the head of the Nanotechnology and Converging Technologies Unit at the D.G. Research, what was to be constructed through the "scientific understanding of the public" was nothing less than "technical democracy":

These tools will allow a technical democracy platform to be put in place: public opinion will be monitored on a continuous basis through Web-based measures that could be picked up by other media. (...) (They) will make the platform one of the most appropriate means to monitor what people really think about nanotechnologies and promote evidence-based dialogue.[2]

[1] *Communicating Nanotechnology*: 34.
[2] *Communicating Nanotechnology*: 152.

Here, the "evidence-based dialogue" is not problematic because of the representation of nanotechnology but because of that of "the public". Indeed, one of the key issues, made explicit by the head of the nanotechnology unit, is that

If public opinion has been misguided by a bad event, or by false assumptions, it can be also rightly guided towards understanding the right things, which are based on facts.[1]

"Continuous monitoring" can thus be conceived as a solution to the "problem of representation" (an expression used by an E.U. official during an interview) that EU officials have regarding the organizations from civil society that are in contact with:

That's an issue here, it's always the same kind of people, over and over again. We do a meeting open to civil society, we request comments... And we can guess in advance who's going to show up. They're always the same, Friends of the Earth, maybe Greenpeace,... And what we want is talking to the European public, to the real European public.[2]

Defining the "real European public" of nanotechnology and the infrastructure able to make it speak to the European institutions is thus an important issue. It problematizes nanotechnology in ways that define who is entitled to speak to the European institutions, and for what results. For that matter, the European civil servant in charge of nanotechnology who voiced this concern for the "real European public"[3] was skeptical about the value of dialogue, if it was to be held with established stakeholders. What made the public "really European" was, for him, less the fact that that participants in dialogue knew and mobilized on nanotechnology, than their being "as diverse as the European society is".

The ongoing process intended to provide "continuous feedback of public opinion on nanotechnology" has several objectives. The DG Research hopes to be able to correct the misrepresentations of the public, but also to develop certain areas of nanotechnology rather than others. Talking about a call for project he was crafting (called NODE), a EU official at the DG research recently explained during an interview[4]:

If we are not able to give the possibility to the public that is participating in the dialogue to really see that what they are dialoging on is put into concrete policy action, there's no need. So if at the end of the story we have a book, it's a failure. So the condition I'm putting in this call is the following one: that the successful projects for

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[1] *Communicating Nanotechnology*: 68-69.
[2] Interview, EC civil servant, DG enterprises, Paris, January 2009.
[3] *Ibid.*
[4] At the time of writing, the call for projects has been released and applications are being reviewed.

NODE will provide evidence that there is a link between what is being discussed and what is going into the changing, or re-addressing, or reinforcement of the current EU policy. That means on current funding lines for nanotechnology. I'm putting this as a condition, it's something quite new that engages not only the public but also ourselves, the regulators. (…) *So, for sure, the main input of this will be on funding research. So if the public, or those publics, or different member states, say to us "please don't do research on nanofood", we will not spend any single euro on nanofood.*[1]

Nanotechnology forced the DG Research to refine the representation of nanotechnology: as a science policy program defined by the amount of funding it was granted, as a topic of potential public sensitivity, the issue with the representation of nanotechnology became less that of the representation of science than that of the correct representation of public opinion. It is in that sense that nanotechnology is an opportunity to construct a "technical democracy". In this technical democracy, the scientific understanding of the public (rather than the negotiation among stakeholders) is expected to contribute to the making of European nanotechnology policies. In this process (and one can trace it back to the early European project on the "societal implications of nanotechnology"), the scientific representation of the public is built on the exact same theoretical basis as public understanding of science: the problem is to ensure the faithful, at-a-distance representation of an object the existence of which is not problematized[2]. Thus, the initial interrogations about the democratic ambition of nanotechnology policy that were made explicit during the *Nanodialogue* project appear to be solved: the scientific understanding of the public is expected to connect the European nanotechnology policy with its publics, and the whole process implies shifting from the representation of nanotechnology to that of the European public. The democratic ambition thereby translates into the production of new channels of political legitimacy: the representation of nanotechnology and its implications need to be ensured, while the scientific representation of the public is expected to ground the formation of a European polity. Hence, it is now possible to better understand the idea of integrating nanotechnology communication "at the core of scientific research". This implies that the European nanotechnology policy has the capability to react once a sign of social concern is perceived, either to commission risk studies, or to redirect funding to certain areas rather than others. In the whole process, dialogue is supposed to render the monitoring of

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[1] Phone interview, DG Research, May 2010

[2] Brian Wynne points to the continuous reconstruction of the deficit model within "public engagement" initiatives, and the refusal to question the very framing of the issue at stake (for instance, the need for particular technological developments in the first place). Wynne thus contends that institutions "hit the notes" of public engagement, but "miss the music" (Wynne, 2006). At this stage, I voluntarily refrain from evaluating "the notes" according to the more desirable "music" of public engagement. The normative implications of the analysis of the democratic orders enacted with nanotechnology will be discussed in chapter 8.

public opinion more effective[1]. Thus, the overall nanotechnology communication policy of the European Commission linked a concern for "dialogue" with the need for monitoring public opinion[2].

European representations

The "scientific understanding of the public" is still in need of a technical infrastructure able to make the European public speak. Yet it already proposes a democratic formation, in which the bases of nanotechnology programs are not discussed, but already defined by the Lisbon strategy, and where the question is then about how to do responsible innovation. The European representations of nanotechnology and society are components a science policy program that seeks to construct "European publics", identify their "concerns" and "expectations" and relate them to the orientation of funding. The representation exercise is that of a scientific domain, that of ethical issues, and that of European publics expected to voice their concerns for the future construction of nanotechnology programs. In that respect, the nanotechnology communication policy is eventually not different from the nanotechnology policy itself. Consider, for instance, the public and online consultation led by the European Commission before the revision of the Nanotechnology Action Plan. Participants were invited to identify themselves (e.g. as "NGO" or "industry"), and evaluate the "risks" and "benefits" of a series of domains of application for nanotechnology. They were asked to label as "very high", "high", "modest" or "none" the risks and benefits of "areas" such as "agriculture", "aerospace", or "health". The results were then presented in a graph included in the *Action Plan Consultation Report*, which displayed the perceptions of nanotechnology risks by domains of application and by social groups. They constructed a vision of nanotechnology divided into several domains of application, for which "risks" and "benefits" could be perceived as more or less important by different categories of "publics" (e.g. NGOs or research organizations, see fig. 2.6). Thereby, it followed the very same approach as that of the scientific understanding of the public in science museums, in that it separated a technical reality that was perceived by social groups in order to evaluate the nature of these perceptions.

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[1] The overall objective of the NODE project is, according to the author of the call, to develop a "dialogue platform on which people will be able to record what they think". The same person linked during an interview the NODE project to previous European projects meant to map scientific controversies.

[2] Cf. for instance the following request: "Implementing a more direct, focused and continuous societal dialogue; and monitoring public opinion and issues related to consumer, environmental and worker protection" (Nanosciences and Nanotechnologies Action Plan. Second Implementation Report 2007-2009: 11). That the scientific understanding of the public was "part and parcel of the whole nanotechnology development" did not mean that other communication projects stopped being funded. Projects such as "nanoTV" provided "Video News Releases (VNRs) for the general public and young people, on the basis of key research results" (Commission staff working document, Accompanying document to the Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee, Nanosciences and Nanotechnologies: An action plan for Europe 2005-2009, Second Implementation Report 2007-2009. COM(2009)607 final: 71)

Section 3. An expertise in informal science education

The stress put on the dialogue between science and society in Europe did not go unnoticed elsewhere in the world. The last case I want to focus on in this chapter is that of American museums involved in communication policy. They offer another example of a democratic construction resulting from the representation of nanotechnology[1]. In this last case, the "democratic ambition" of the science museum is still present, albeit not expressed in the same terms than those of the French representational systems or those of the European scientific understanding of the public.

Representing nanotechnology through the NISE network

Numerous contacts exist between European and American museums. Museum staffs meet at conferences (such as the ECSITE - the European network of science centers and museums – annual conference), and refer repeatedly to each other. The European reports that I analyzed above stress the necessity to collaborate with American museums. But the tone among their American counterparts sounds different. The coordinator of a network of American science museums sharing resources to develop nanotechnology exhibits – the NISE network, which I will explore at further length in this section - thus explained during an interview:

"In Europe, there is Nanodialogue… and policy-makers want to listen to what people say. Science centers have a real grip on nanotechnology governance (…) and the E.U. wants them to help them (…)identify what people's concerns are. We don't have, for instance, Nanodialogue where the EC set that up and asked for recommendations about policy. That's the missing link in the U.S., we have no feedback mechanism to policy-makers. I mean we can present (stuff) to them, but then they'll have to listen. And they're not asking. The difference is that nobody has asked us".[2]

The difference between the NISE network and the European approach to the role of science centers in nanotechnology policy seemed clear for her. Whereas European policy-makers were funding science museums to represent nanotechnology for the public, as well as, if not more, to represent public

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[1] Material for this section is based on interviews at the Boston Museum of Science conducted in January 2007 and June 2008, observations of a 3-day internal meeting of the NISE network in Boston in January 2007, an interview with the coordinator of the NISE network in Washington DC in March 2009, and public documentation.
[2] Interview M. Glass, Washington, March 2009.

concerns and expectations for policy-makers, she felt that the American science centers were isolated from the actual making of American nanotechnology policy.

This does not mean that the U.S. nanotechnology programs voiced no concern for the representation of nanotechnology to its expected "publics". On the contrary, reflections on the representation of nanotechnology occurred at an early stage in the construction of US nanotechnology policy. But the enrolment of the public of nanotechnology, and the expected representations of nanotechnology were indeed different in Europe and the United States. The following of this section thus describes another democratic construction the science museum is expected to perform through the making of representations of nanotechnology.

Creating the NISE network

In September 2004, a workshop organized by the National Nanotechnology Initiative (NNI) was held in Arlington to explore the "opportunities and challenges of creating an infrastructure for public engagement in nanoscale science and engineering"[1]. The workshop gathered about 15 science museum representatives, and NSF high-level staff, including the director of the NNI, Mihail Roco. "Public engagement" was indeed considered a "priority" for the federal program, since the "societal issues" make it "critical for NSF" to "engage public audiences"[2]. Indeed, the whole workshop was structured around the various audiences that needed to be taught about nanoscale science and engineering ("teachers", "K-16 students", "general public", "workforce", "community and public leaders" and "scientists"[3]). The division according to "audiences" is familiar: we already saw it at play in the case of the European nanotechnology communication roadmap. Yet the perspective is quite different here: the workshop mobilized the various concepts of the so-called "deficit model" that the European actors were keen not to use. The objective was to "reduce irrational fears", foster "nano interest" and "nano literacy", in a context where the American nanotechnology program needed students, workers, and consumers[4].

This definition of the problem of public engagement in nanotechnology was consistent with the objective of a network of museums specialized in "informal science education". In 2003, four museums of science (the Boston Museum of Science, the Exploratorium in San Francisco, the Science Museum of Minnesota and the Oregon Museum of Science and Industry) gathered within the *Network for Informal Science Education* (NISE), received $750,000 of funding for the following fiscal year, with the objective to

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[1] *Opportunities and challenges of creating an infrastructure for public engagement in nanoscale science and engineering*, A National Science Foundation Workshop September 2-3, 2004, Washington.
[2] *Opportunities and challenges*: 4
[3] *Opportunities and challenges*: 7
[4] *Opportunities and challenges*: 7

promote public understanding of nanoscale science and engineering concepts, scientific processes, and applications to society. The purpose of these efforts is to ensure that the public is kept abreast of advances in the field.[1]

The focus on public understanding of nanoscale science and engineering led program officers at NSF to raise issues about how to represent nanotechnology in the science center. They insisted on the work needed to represent "how size can make a difference in the properties of materials", but also to "appreciate the interdisciplinary nature of nanoscale science and engineering"[2].

Other partners then joined the four NISE initial members. In 2009, about 20 museums were involved in the activities of the NISE network, which had received more than 20 million dollars from the National Science Foundation for five years of funding[3]. Contrary to the projects we have encountered so far, the NISE network was not conceived around the collaborative design and staging of exhibits. NISE is above all a coordination device that allows American science centers to share exhibit modules about nanotechnology developed by some of the partners, and methods and tools for "public engagement in nanotechnology". The network also distributes ready-made layout of oral interventions, such as an "introduction to nanotechnology" speech, with the associated power point presentations. Each of the components of the NISE production is accompanied by standardized evaluation grids, which, once filled out, are used by the network to refine its offers. The most important common event organized under the umbrella of NISE is the annual *Nanodays*, during which activities and exhibits are organized throughout the country in science centers. During this week-long event, which involved about 200 science centers across the U.S. in 2009, nanotechnology applications are displayed in museums, children activities are organized (e.g. building a human-sized model of carbon nanotubes), public conferences are held, and stickers reading "I'm made of atoms" are distributed in science centers (the coordinator of the NISE network gave me one when I interviewed her). *NanoDays* are an answer to the objective of "reaching out" to the whole country. They are devices through which museums and research centers can collaborate, and the whole American population can be in contact with nanotechnology.

NISE was funded, within the NNI, through the Nanoscale Science and Engineering Education Program[4]. Alongside "formal education", the "informal" one was an important area of activities for the NNI. This is what a brochure edited by NISE argued:

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[1] Nanoscale Science and Engineering Education (NSEE) Program Solicitation NSF 03-044.
[2] *Ibid.*
[3] Interview with L. Bell, Boston, January 2007.
[4] NISE was funded within this program alongside other educational projects, such as "Instructional Materials Development" which "supports development and rigorous testing of prototype instructional materials that

One benefit of a more scientifically literate public is increased support for funding of research. A substantial majority of Americans support government spending for scientific research, including basic scientific research. The better our research and its implications for society are understood, the better the general public can make responsible decisions about public funding. (...) Another motivating factor is to encourage the next generation of scientists. We need children to consider and pursue careers in science and engineering. [1]

Hence, "informal science education" could transform the visitor into a potential supporter, as future scientist, consumer, or elector, of nanotechnology. This implied crafting specific devices to make sure it could happen.

Representing nanotechnology for a responsible citizen

The first task of the members of the NISE network was to identify the "important messages". Crafted with the help of a group of scientific advisors, the "messages" were eventually the following:

Nanoscale effects occur in many places. Some are natural, everyday occurrences; others are the result of cutting-edge research.

Many materials exhibit startling properties at the nanoscale.

Nanotechnology means working at small size scales, manipulating materials to exhibit new properties.

Nanoscale research is a people story.

No one knows what nanoscale research may discover, or how it may be applied.

How will nano affect you?[2]

They do not seem to be revolutionary at all. Yet they are more interesting once they are compared with the multiple representations of the Grenoble nanotechnology exhibit, and the stress put on the ethical, social and legal implications of nanotechnology in the European projects. They did not hint at the diversity of nanotechnology (industrial applications, science policy programs, public concerns, debates) represented through the multiple channels of representations in the Grenoble exhibit. Nor did they focus on the ELSA the European science museums were so concerned about. Indeed the

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promote student learning and interest in nanoscale science, engineering, and technology materials", and "Nanotechnology Undergraduate Education", which aims to "introduce nanoscale science and technology through a variety of interdisciplinary approaches into undergraduate education".

[1] Crone, Wendy, *Bringing Nano to the Public. A collaboration opportunity for Researchers and Museums*, Washington DC, NISE.

[2] NISE presentation brochure.

"messages" developed and supposed to be transmitted through the NISE network partners were all about "what nanotechnology really was" in order for the visitor "to make up his mind and act as a responsible citizen"[1]. The reality of nanotechnology then, was about the "nanoscale": nanotechnology was only characterized by the atomic scale of scientific observation and action. Therefore, it made no sense in this perspective to inquire into the collective construction of objects and concerns (as in Grenoble) or into the direction of science policy programs (as in Europe). The nanoscale was a domain explored by scientists ("a people story") who entered a new world where "no one knew what would be discovered".

Accordingly, what was supposed to be provided for the citizen was reliable scientific information, rather than reflections on the potential impacts on nanotechnology[2]. Consequently, the productions of the NISE network (which are rather those of each separate partner of the network) focused on the correct description of nanotechnology research practice and industrial applications. For instance, the Boston Museum of Science, one of the initiators of NISE, was particularly active in the construction of collaborations between scientific research centers[3]. The collaboration with science laboratories was heralded as a key objective of the nanotechnology "informal science education", both for scientists to use expertise about how to communicate to the public, and for museums to make sure the scientific content of their exhibits and activities was consistent. Ready-made exhibition components were proposed to the NISE members, with all the descriptions and instructions provided on the NISE website. They were peer-reviewed by external scientific advisors, and evaluated by the partnering museums through the web platform. They could then ensure that "learning goals" were met. For instance, the "introduction to nanotechnology", proposed to make visitors learn that "things at the nanoscale are super small", "super small nanoparticles can have very unexpected properties", and that "scientists are figuring out how to create and manipulate materials at the nanoscale through self-assembly"[4]. In order to meet these goals, the exhibit was composed of the following elements:

- *Introductory Video: An engaging video about Nanotechnology: What's the Big Deal? gives a broad overview of the nanoscale and nanosciences.*
- *At the Nanoscale: Through the activity called "A Billion Beads," visitors explore the concept of scale and can see for themselves how much a billion of something is.*

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[1] Quotes, interview with M. Glass, Washington DC, March 27th, 2009.

[2] In the institutional organization of the *National Nanotechnology Initiative*, the "implications" part of the program was supposed to be taken care of by different actors, the "Centers for Nanotechnology in Society", to which the examination of nanotechnology ELSI was delegated (cf. chapter 6)

[3] Cf. (Alpers et al., 2005) for a discussion of the importance of such collaborations elaborated by staff of the Boston Museum of Science.

[4] "Introduction to Nanotechnology", NISE exhibit. Quotes in this paragraph are excerpts from the presentation of this exhibit module.

- *Unexpected Properties: Visitors alter the size of a magnified "Quantum Dot" and watch the light that it emits shift from red to blue as it shrinks to a fraction of a nanometer.*
- *Creating Nanomaterials: Visitors watch as floating "molecules" move themselves into an orderly pattern on an air hockey table in the interactive "Self-Assembly."*

Different media were used (texts, interviews with scientists, animated films) and practical interventions were proposed. For instance, the "Billion Beads" activity proposed that...

... visitors inspect tubes that hold quantities of one thousand tiny beads, one million beads, and one billion beads. To the naked eye, the tube containing one thousand beads appears nearly empty. Visitors see that the next tube, partially filled, contains one million beads. Finally, to compare, a four-foot tall container nearly full contains approximately one billion beads.

The interactivity that the NISE exhibit proposed was thus quite different from the direct implication of visitors in the practice and making of Grenoble nanotechnology exhibit. It was a means to produce an individual citizen knowledgeable enough about nanotechnology, understanding the "basic facts", and who could then act as an enlightened voter or consumer – possibly a supporter of nanotechnology. Hinting at the ethical issues (as in *Nanodialogue*) or the "nanotechnology debate" (as in the Grenoble nanotechnology exhibit) was never an issue for the NISE partners. The Grenoble exhibit considered various definitions of nanotechnology – among which the science-fiction topic, or the local scientific and industrial development program. *Nanodialogue* was all about reflecting on nanotechnology's ELSI and considering the domain as a public issue on which the opinion of the European public was to be gathered. The American science centers considered that nanotechnology was a science before anything else, and that it was their duty to represent it as such.

From such representation of "the basics of nanoscale science", it was then possible for the visitor to act as a citizen. Accordingly, the standardized oral "introduction to nanotechnology" that the NISE proposed to the network members presented illustrations of the size of the nanometer, the main physical principles occurring at this scale (e.g. quantum effect) and the main nanotechnology industrial applications. The introduction, vetted to include the first 5 key messages of NISE, then concluded with the following (which addresses the 6th point "how will nano affect you?):

What is nanotechnology? It's the future. And like the future, it's coming, whether you are ready for it or not. So think about what kind of future you want, because we will be a part of what kind of future we share[1].

[1] Introduction to the NISE exhibit

A "future", that of nanotechnology development, was coming, independently of the wishes of the visitors to the NISE museums. Within this inescapable future, they will then have to make decisions that affect them, as consumers, voters, students or workers.

One can then understand a number of activities and collaborations in which the members of the NISE network have been involved. For instance, the Boston Museum of Science has been actively involved in the *Project on Emerging Nanotechnologies* (PEN) of a Washington-based think tank, the *Woodrow Wilson Center*. The collaboration resulted in a series of DVDs about "nanotechnology and the consumer" which were distributed in science museums across the NISE network. These DVDs presented the applications of nanotechnology in consumer goods. They described the use of nanoscale titanium dioxide in cosmetics, of carbon nanotubes in construction materials, and silver nanoparticles, used for their anti microbial properties in medical devices. In so doing, the science museums restated what was, for them, the characteristic of their positions (which they share with a think tank like the Woodrow Wilson): they were "independent of any lobby", and, as a consequence, "able to speak directly to the citizen"[1], and provide him or her with the knowledge he or she needed to act as a responsible consumer.

In so doing, the NISE network did not describe the relations between the future that is coming "whether you are ready for it or not" and the futures people might "want" and "share" – that is, between the development of nanotechnology supported by the NNI program and the individual choices of visitors. This disconnection did not go unnoticed by some of the NISE members, especially when they discussed what they considered their "new mission", namely "two-way communication" between scientists and the public.

The "new mission" of science museums

The concern for "dialogue" and "two-way communication" was persistent in the objectives of the NISE network. The European reference was permanent on these topics. Already at the 2004 NSF workshop, Rob Semper, from the San Francisco Exploratorium, had

> *asked both the researchers and the educators to think about whether informal education should be viewed as one-way or two-way communication. In Europe, where there have been many projects to stimulate dialogue, the common phrase is "public dialogue about", not "public understanding of"* [2]

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[1] Quotes from an interview with the director of the PEN (Washington, March 2009).
[2] 2004 NSF report: 5.

The idea of "dialogue" – so prominent within their European counterparts – was introduced in the American science centers as the NISE network was growing. A sign of this is the evolution of the NSF program solicitation. In 2005, the budget increased to $4,500,000 and the program description, albeit almost exactly the same as that of 2003, introduced the word "engagement", alongside "awareness" and "understanding":

*[A] Nanoscale Informal Science Education (NISE): This effort is intended to foster public awareness, **engagement**, and understanding of nanoscale science, engineering, and technology through the establishment of a Network, a national infrastructure that links science museums and other informal science education organizations with nanoscale science and engineering research organizations.*[1]

The evolution is not a detail. It reveals that the NISE network raised questions and issues about what its role was supposed to be. Larry Bell, a co-director at the Boston Museum of Science and principal investigator of the NISE network, spoke in 2008 of the "new mission" of the science museum[2]. For him, the new mission was based on a mechanism that had been designed at the Boston museum of science, where the staff organized a form of discussion called "forum", which consisted in a series of presentations provided by invited speakers in front of a self-selected audience, followed by several rounds of discussions among the participants. In Boston, a first series of forums was organized in 2006-2007 and conducted participants to discuss nanomedicine and nanotechnology for energy. The "forum" was then developed as the main innovation of the NISE network. It has been standardized, and the methodology is presented and available on the NISE website, alongside evaluation grids, tips for the organization, and examples of discussion topics.

For Bell, the forum format could answer the concern for "two-way communication" that the NISE partners had had when designing the project[3]. A NISE publication targeted at scientists stated that the "monologue style of communication" had failed "to win public trust", and that they needed to

move from a 'monologue' model of communication, with scientists lecturing the public on what it should know, to a 'dialogue' model, in which scientists meet the public in forums that are evenhanded, giving non specialists much more time to air their concerns and share them with the 'experts.[4]

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[1] Program Solicitation, NSF 05-543 - emphasis added.
[2] (Bell, 2008). See also (Reich et al., 2007).
[3] Interview with L. Bell, Boston, June 2008.
[4] Crone, Wendy, *Bringing Nano to the Public. A collaboration opportunity for Researchers and Museums*, Washington DC, NISE: 6.

The NISE network refers to a wide range of texts to argue for the importance of dialogue, among which theories of deliberation were largely present. At the Boston Museum of Science, Larry Bell was also in contact with researchers coming from science and technology studies who were, like himself, funded by the National Nanotechnology Initiatives. Commenting on the discussions he had had with them, Bell explained:

That was something new to me. The idea that the public has something to say about the technology without us having to provide them with background information. It's a little complex for us to accept, but, you know, you can't do public understanding of science any more...[1]

Whether Bell's critique of public understanding of science conflated or not with social science literature is not what matters at this point. More interesting is that the gradual importance of the critique of the "public understanding of science" model from the part of science centers expected to provide "reliable information" for a citizen-to-be. This results in contradictory objectives. But the forum offered a practical way of externalizing the "dialogue" part of the NISE project, at the price of uncertainties about the objectives and practical modalities of this device.

A deliberation objective

For museum staff, one of the major interests of the forum was its deliberative quality. The forum model developed by the National Issue Forum Institute (NIFI) served as a reference during the discussions about the preferred "format". NIFI is a network of non-profit organizations, educational and professional groups "that promote nonpartisan public deliberation in communities across the country"[2]. NIFI advocates the value of deliberation as a component of civic education, and as a contribution to better decision-making[3]. Thus, the specialists of the NIFI forums insist on the importance of small group discussions during which participants listen to each other's arguments and exchange ideas and propositions. For the NISE members[4], the example of the NIFI forum was helpful in that it provided a ready-made device independent of the issue being discussed. Yet it also raised numerous questions and uncertainties. How to connect, or separate the concern for deliberation and the discussion about

[1] Interview with L. Bell, Boston, January 2007.
[2] www.nifi.org, accessed April 11th, 2011.
[3] See (Mathews and McAfee, 2003) and National Issue Forum Institute, *For Convenors and Moderators Organizing for Public Deliberation and Moderating a Forum/Study Circle* (online publication). See (Gastil, 2004) for a discussion of the value of NIFI forums in terms of their "educational impact" on participants' "civic engagement".
[4] Quotes in this paragraph are excerpts from notes I took during conversations with staff of the Boston Museum of Science.

nanotechnology itself? “Deliberation” and “discussion” were meant in the NIFI forum to be held among citizens concerned by a local topic (e.g. urban remediation). They were directed within the NISE museums to people who had no prior knowledge or interest in nanotechnology. What information was then to be provided? A possibility was to separate the “facts” of the scientists from the “values” of the public[1]. But for the NISE participants, “the public could have something to say about nanotechnology itself”. Another concern related to nanotechnology was that many of the concerns were anticipatory. How to provide information about technologies that were not there yet? For some participants, this was an opportunity for strengthening the links between the forum deliberation and decision makers in political institutions. Larry Bell and the staff of the Boston Museum of Science wanted to develop such links. But then they needed to formalize a channel for policy-makers to listen to what participants in the forums had to say.

The uncertainty about the link between deliberation and nanotechnology itself[2] was visible as NISE members gathered to discuss the organization and standardization of the forum format. I observed one of these meetings, at the Boston Museum of Science in January 2007. This 3-day closed meeting was held as the NISE network was already up and running[3]. Forums had been organized in all the museums that were represented at the January 2007 meeting (Boston, Minnesota, Oregon, NC at Raleigh). However there had not been coordinated actions at that time. The booklet that standardized the process was not published, and the evaluations were ongoing. During this meeting, the difficulties the NISE members encountered with the forum format appeared clearly. Consider the following exchange from a transcript of this meeting (names are fictional):

Erin: I’m wondering about the ethics of us giving information to policy makers. The idea that politicians can make arguments based on us… (it) raises issues for me.

Alice: I’m way below you. Forums create opportunities for the public to have discussions about nano, to be part of a community discussion. It’s low product but still, it’s involving new people.

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[1] Another example of initiatives based on the value of “deliberation” for nanotechnology is the “citizens’ school”, developed by anthropologist Chris Toumey at the University of South Carolina, during which scientists provide presentations for a panel of lay people, who can then express their “values” and voice their “concerns”. Toumey’s critique of public understanding of science is based on the many “understandings” of the public. In Toumey’s perspective, “dialogue” is expected to leave room for participants to express their viewpoint, the overall objective being the increase in participants’ knowledge of such nanotechnology facts as “fullerene molecule is made of carbon” (Toumey et al. 2006). For Toumey, democracy “needs an informed electorate” (Toumey, 2006: 6). He also hoped to “get non experts involved in decisions about nanotechnology” through the citizens’ schools (Toumey, 2006: 7), without proposing the instruments that could construct the involvement he calls for.

[2] The ambivalence was also visible in the case of the citizens’ schools where the writing of recommendations became a topic of interest, with persistent ambivalence about the objective of the production of these recommendations.

[3] This material does certainly not cover the whole of discussions about the forums, but offers detailed insights into one of the rare occasions during which the NISE members met together and discussed the modalities of what they wanted to do together before it was solidified.

Troy: I want to do both. What is important for me is that we establish ourselves as the place where the public can make its voice heard.

Larry: What about giving our data to Arizona State University? They could frame what is said in communication with the science community.

Erin: For me, that would work. I would not want that to be THE goal but if they know how to frame and use that…

Christine: But eventually are we trying to empower new people? Or to influence policy-makers?

In this short excerpt of the 3-day discussions about the forum format, the uncertainty about the ways of "making the public speak" is visible. The need for social scientists able to work on the public discussions to transform them into transferable "public advice" was voiced, as well as uneasiness about the fragile democratic construction that would then be constructed. This ambiguous situation lasted for the whole meeting, and, according to the staff of the Boston Museum of Science, was pervasive among the organizers of the forum.

Integrating the new mission in an expertise about nanotechnology communication

Eventually, the difficulties encountered in the construction of the forum and the contradictions between the learning objective and the "new mission" were managed through the development of a specific expertise, that of the organization of the NISE forums[1]. This expertise manifested itself through the distribution of methodological guides among the network members, evaluation grids, and topic descriptions. The standardized forum format was to ensure a representation of nanotechnology which would at least comprise "basics", explaining, for instance, that "nanotechnology has to do with very small things, smaller than you can see with an ordinary microscope", and that "materials can have different characteristics at the nanoscale"[2]. As for the objectives of the forum, they were eventually presented as such in the methodological booklet distributed to the NISE members:

Forum goal

To provide experiences where adults and teenagers from a broad range of backgrounds can engage in discussion, dialogue, and deliberation by:

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[1] "Providing some kind of service", and "developing a consulting expertise independently of NISE" had been proposed during the discussion.

[2] NISE network public forum manual: 14.

- enhancing the participants' understanding of nanoscale science, technology and engineering and its potential impact on the participants' lives, society and the environment;

- Strengthening the public's and scientists' acceptance of, and familiarity with, diverse points of view related to nanoscale science, technology and engineering;

- Engaging participants in discussions and dialogues where they consider the positive and negative impacts of existing or potential nanotechnologies;

- Increasing the participants' confidence in participating in public discourse about nanotechnologies and/or the value they find in engaging in such activities;

- Attracting and engaging adult audiences in in-depth learning experiences;

- Increasing informal science educators' knowledge, skills, and interest in developing and conducting programs that engage the public in discussion, dialogue, and deliberation about societal and environmental issues raised by nanotechnology and other new and emerging technologies.[1]

As defined in the NISE document standardizing the methodology, the forum thus appeared as a device meant to ensure the public understanding of nanotechnology ("learning experience"), which could be used by the network members to convey the "main messages" defined at the launch of NISE (e.g. "how will nanotechnology affect me?"). Participants could then be good citizens, open to true and balanced information; the "positive and negative impacts", the "diverse points of view" are to be considered alongside scientific information, but are not for the participants to decide upon. The evaluation of the NISE forums could then be based on the measure of the knowledge the participants had acquired, which required, again, specific expertise. Accordingly, an evaluation report of the NISE forums provided sophisticated statistical measures of the "impacts" on the "understanding" of nanotechnology[2]. In addition, the forum could then be used as a tool through which even the "societal implications" of nanotechnology could be transmitted to the museum's visitor. This could be done through the making of "societal implications" a matter of risks and benefits, that is, of other components of a scientific field that could be more or less understood by the public[3].

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[1] NISE network public forum manual: 7.

[2] Cf. for instance the following excerpt: "As a part of the NISE Net Forums summative evaluation, evaluators asked participants questions to understand how the nanomedicine forum impacted their understandings. Findings from this evaluation indicate that the forum had statistically significant impacts on participants' understandings of nanotechnology. For example, a Wilcoxin ranked signs test indicated that participants gave a significantly higher ranking to the statement "I feel informed about nanotechnology"30 after the forum (N=30, Z=3.9769, p<.0001). Additionally, the evaluation found that the forum significantly increased participants' understanding that nanotechnology operates on a submicroscopic or smaller scale (McNemar test with continuity correction: N=32, X2=4.923, df=1, p=.0265), and that nanotechnology properties are dependent on size or scale (McNemar test with continuity correction: N=32, X2=4.900, df=1, p=.0269)". (Reich, Christine et al., 2011, *Review of NISE Network Evaluation Findings: Years 1-5*, http://informalscience.org/reports/0000/0414/Review_of_NISE_Net_Evaluation_Findings.pdf: 86)

[3] *Ibid*: 87

Hence, the many discussions about the forum's "impact on policy" did not result in a construction of an European-like, scientific understanding of the public. Neither did it provide ways for the American museums of science to envision other roles for the participant than that of an individual citizen, consumer- and voter-to-be through the "magic of dialogue"[1]. The difficulties the participating museums had to face were dealt with through the stabilization of a forum format based on "deliberation" used as an educational device, and for which the representation of nanotechnology was summarized into the "basics", delegated to experts invited to present nanotechnology to the public, or provided through the other components of the NISE project. At that point, deliberation had become a way of "engaging" with this newly acquired knowledge, and to make individual citizens reflect on how nanotechnology would affect them.

This does not mean that no other experiments could occur. The Boston Museum of Science in particular, where the staff had constantly pushed for the connection between public deliberation and decision-making processes, organized two forums in 2008 directly aimed to contribute to the decisions of the Cambridge City Council. During these forums, participants discussed the potential regulation of nanotechnology research in Cambridge, and the oversight of the risks of nanoparticles. For the local staff – I met with three of them in the spring of 2008[2] - these initiatives could make public deliberation "relevant" for policy-makers. They engaged participants to the forum in discussions about "municipal oversight of consumer products made through nanotechnology", through exchanges on a series of consumer products. Participants were then invited to vote on pre-defined options, such as "should citizens/consumers be made more aware of the lack of research on the safety of some nanoparticles in consumer goods?", or "should there be warning signs or labels?"[3]. This isolated experience was not replicated elsewhere within the NISE network[4]. Overall the forum was conceived as a way of performing deliberation on nanotechnology issues for the sake of the education of participants. Thereby, the NISE science museums considered "deliberation" a central component of their role in the American democracy, within a system where nanotechnology was separated between scientific facts (mastered by

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[1] This expression is that of Daniel Yankelovitch (2001), in the title of the book that was mentioned to me by one of the NISE partners involved in the discussions about the forum format.
[2] Quotes in this paragraph are excerpts from my fieldwork notebook.
[3] Boston Museum of Science, 2008, "Nanotechnology in Cambridge: What Do You Think? Background Information on Nanotechnology".
[4] That it happened in Cambridge is not a detail, as the city has known past experience of active public involvement in local decisions about science and technology. Cf. for instance the case of the citizen panel gathered in 1978 about recombinant DNA, which made Cambridge an exemplary case for citizen involvement in science (Krimsky, 1984).

scientists), ethical issues (an area of expertise of social scientists), and processes of deliberation (developed by museum experts)[1].

An expertise about informal science education

Once the forum format was solidified through a set of methodological rules, and the components of exhibit materials available on the web platform, the informal science education in nanotechnology could be made an expertise of the American science museums. The European science museums are entirely dependent on the calls for project, and, therefore, on the formulation of the European strategy for nanotechnology communication. The French science centers are kept apart from the construction of the national initiatives on nanotechnology, and depend on the initiatives of funders interested in the topic they seek to work on. The American case offers a different perspective, and shows that the members of the NISE network managed to constitute a recognized expertise on a specific field, that of "informal science education", which could then be called for in order to realize the communication part of nanotechnology policy. The standardization of methods for the display of and "public engagement" in nanotechnology, the centralized evaluation grids, and the construction of procedures could then confirm that the science museum held a neutral place, and could provide expertise on informal science education. This implies that NISE had to make itself heard by decision makers. For instance, the coordinator of NISE, as well as representatives of the participating museums, repeatedly talked at the Nanotechnology Caucus of the House of Representatives. During the discussions in Congress leading to the re-authorization of the nanotechnology act in 2009, she had to argue for "the expertise NISE ha(d) developed" for congress people to introduce "informal science education" in the new bill. Informal science education had then become a component of the expertise of American science museums, developed for nanotechnology in order to produce knowledgeable American citizens through deliberation and engagement.

[1] See also (Alpert, 2009) for an insider comment on the expertise of NISE science museums and the basis it provides for collaborations with scientific research centers.

Conclusion. In the democracies of science museums.

The exploration of several science centers in Europe and the United States as they confront nanotechnology has led me to describe three ways of doing representation with nanotechnology in the science museum, that is, three problematizations of nanotechnology in the science museum. The French case is that of the construction of a representational system, in which visitors actively participate in the display and practice of nanotechnology's various components (including the "public debate"). In the European case, the science museum is expected to represent nanotechnology and its social, ethical and legal aspects, while paving the way for a "scientific understanding of the public" meant to replace "public understanding of science". Eventually, the American "informal science education" enacts a model based on deliberation, for the sake of an individual citizen to be made knowledgeable about a field that will impact him or her, as a consumer, voter, or worker. The representations that are constructed by the science centers are tightly linked to nanotechnology science policy, not less because of the funding links between science policy programs, research institutions, private companies, and science centers. They are not at-a-distance representations of a passive domain: they lead to the construction of material objects in the French case, they are connected to the making of science policy programs in the European case, and they produce nanotechnology's publics and concerns in the three examples. The chapter has insisted on the importance of the representation of nanotechnology for its expected publics, as well as and that of the public for science policy officials. It also illustrated that the science center's position may vary, and needs, in any case, to be negotiated with many actors. But in all cases, nanotechnology programs involve science museums. In return, the display of nanotechnology in science museums is not a photograph of a stable scientific discipline presented for existing publics to admire. Rather, it directly participates in the making of nanotechnology as an entity gathering objects, futures, concerns and publics.

In the three cases described in this chapter, the representation devices experimented on nanotechnology produce both the public and the message. As nanotechnology's publics do not pre-exist the involvement of science museums in the representation of the field, museum staffs need to set up technologies of representation that simultaneously construct publics. Participatory exhibit staging in the French science centers, *Nanodialogue* focus groups, and American informal forums are all technologies of democracy, in that they shape nanotechnology's publics as much as they define what nanotechnology's public concerns are. Each of the three cases I considered proposes some solidification of nanotechnology, whether it is a combination of various definitions (scientific practice based on intervention on atomic matter, local science policy, industrial applications, ethical issues) requesting a variety of representational techniques (case 1), a European policy program the "implications" of which are to be taken into account (case 2), or a scientific domain the physical principles of which are to be grasped by a citizen-to-be (case 3).

These descriptions will be developed further in the next chapters. At this stage, one can already underline a few themes that will be encountered in other fieldwork. First, the French situation is that of an uncertain experiment, in which actors design more or less stabilized technologies of democracy, contested by the advocates of the inescapability of the scientific discovery (cf. the CEA totem) or by the critics of nanotechnology. What is at stake here is no less than the construction of "democracy". Exhibit designers, scientists and anti-nanotechnology activists argue over the ways of shaping public concerns, and over the modalities of the involvement of publics in the development of nanotechnology. Second, the European nanotechnology policy is characterized by an insistence on the European values that would make it necessary to examine the ELSA of nanotechnology. European nanotechnology policy officials made it a problem of democratic legitimacy by exploring the ways in which the "European public" can be heard. "Scientific understanding of the public" is an answer. Chapter 5 and 6 will show that it is not uncontroversial as a legitimacy channel. Third, the construction of the American public of nanotechnology re-mobilizes well-known figures of the American polity, among which the "informed" and the "deliberating" citizens[1]. The importance of expertise to ensure the correct representation of nanotechnology and the quality of deliberation will be encountered in the next chapters, as well as the description of nanotechnology as a scientific domain merely characterized by the nanoscale.

This chapter has also allowed me to differentiate the representation of nanotechnology in the science museum from current initiatives in science communication. Nanotechnology appears as an interesting case, since it interrogates the types of representations the science center is expected to construct, display, and transfer. In particular, it forces to complexify the current interest for the representation of "science in the making", and "controversy", in order to ensure the "public understanding of research"[2]. Just as the science exhibit used to display pictures of already-made science, so it now displays pictures of science in the making. The best example might by the "Open Laboratory"[3] at the Munich Wissenschaftsmuseum, where visitors can look behind glass walls at researchers working in a laboratory. But analyzing or designing the science exhibits in terms of the "scientific understanding of research" does not challenge the nature of representation that the museum produces: in both cases, the museum is expected to display the world "as it is" from a position at-a-distance[4]. The current concern for "public understanding of research" does not thematize the role of the science center by considering

[1] Cf. (Manin, 1997; Schudson, 1998)
[2] Cf. (Yaneva et al., 2009) on the representation of controversies, and (Durand 2004; Lewenstein and Bonnet, 2004) on the "public understanding of research". For an overview of this trend in museum studies and practices, see (Meyer, 2009).
[3] Meyer, 2011
[4] However, some of the proponents of this trend do raise questions about its implications and the difficult positions it implies, in between their funders, anti-technology activists, and visitors. See for instance the description of an exhibit on GMO controversy by X!periment (2007).

it a neutral and passive place on which "science" or "science in the making" or "issues" might be projected.

The perspective proposed here allows me not to criticize the value of "public understanding of research", but to situate it within a problematization of the role of science centers. The examples I considered in this chapter proposed more complex constructions of the representation of nanotechnology, which make explicit concerns for "two-way dialogue", and "engagement" – in short, their democratic ambitions. This should not be considered as the end point of the analysis, but as an invitation to look into the types of democracy that the museums produce, the nature of the representations on which they base it, the kind of people they produce in order to fit with it, and their connections to national or European "civic epistemologies" (to borrow Jasanoff's powerful expression). This compels us to be attentive to the work necessary to stabilize each of the ways we encountered in this chapter, which cannot prevent contestations (as in case 1) and pervasive uncertainties from taking place. It also forces to be cautious about the evaluation of the "democratic quality" of science museums. I am reluctant to adopt the language of evaluation of "public engagement" initiatives, considering, for instance, that "the translation of public engagement into policy impacts" is the unproblematic final goal of these mechanisms[1]. Rather, I have preferred to analyze the democratic constructions enacted in the science museum – a place, as it is now clear where public roles are allocated, where public concerns are defined, where political theories of representation and deliberation enact collective arrangements.

These arrangements are performed by the technologies of democracy that have been studied in this chapter. They are experimented on nanotechnology, and more or less stabilized by expert knowledge. In some cases, they are an integral part of the construction of nanotechnology's representations, while, in others, they are meant to be isolated from the specific case of nanotechnology. Whereas the French actors develop in the same movement the technologies of representation and their expertise about the representation of nanotechnology, American NISE members manage to isolate an expertise about "informal science education", which is then meant to be applied to any topic of interest of the science museum. In Europe, "scientific understanding of the public" eventually separates the representation of publics from that of nanotechnology, and, consequently, the expertise about technologies of democracy from the expertise about nanotechnology. By pursuing the analysis of devices producing nanotechnology's publics, the next chapter follows up on the analysis of the institutionalized expertise about technologies of democracy, and its (more or less successful) separation from nanotechnology.

[1] For an example that extends beyond nanotechnology, and considers some of the cases described in this chapter, see (Kurath and Giesler, 2010) – quote in this sentence p.569.

CHAPITRE 3 : STABILISER LES TECHNOLOGIES DE DEMOCRATIE AVEC LES NANOTECHNOLOGIES. REPLICATION, EXPERTISE ET STANDARDISATION

Ce chapitre poursuit le précédent en étudiant la construction de représentation des nanotechnologies et de leurs publics, par l'intermédiaire de l'analyse de la réplication de technologies de démocratie. Il se penche sur le cas de la conférence de consensus, un dispositif participatif bien connu et standardisé, qui a été mobilisé sur les nanotechnologies en France et aux Etats-Unis. Ce cas permet de mettre en évidence la mise à l'épreuve par les nanotechnologies d'un dispositif participatif voué à être mobilisé d'un sujet à l'autre grâce à la mobilisation d'une expertise stabilisée. Il apparaît ainsi que la fabrique du « citoyen neutre » censé délibérer à propos d'une question bien identifiée se heurte à des difficultés lors de l'épreuve de réplication sur les nanotechnologies. D'une part la construction du citoyen neutre doit éliminer des modes d'action (trop critiques par exemple) qui ne sont pas acceptables pour permettre la délibération et la production de recommandations modérées. D'autre part la mise à distance des nanotechnologies afin d'en faire un objet pour la délibération se heurte à l'impossibilité de saisir la nature des entités matérielles « nano » et les futurs développements du domaine. Aux Etats-Unis, la réplication du « Citizen forum » prend la forme d'une expérimentation de sciences sociales permettant d'étudier les processus de délibération. En France, la réplication de la « conférence de citoyens » dont un institut de sondage est devenu un expert assure la démonstration de la capacité des citoyens à intervenir dans la discussion publique sur le développement des nanotechnologies. Le succès de ces deux réplications passe par l'élimination d'alternatives, notamment l'utilisation du dispositif participatif pour la construction de la mobilisation sociale (dans le cas américain), d'un « citoyen de qualité » ou d'un « citoyen critique » (dans le cas français).

Le cas de la réplication de la conférence de consensus sur les nanotechnologies met au jour les investissements nécessaires à la stabilisation de la frontière entre les nanotechnologies et les technologies de démocratie censées les rendre discutables pour des publics à construire. Il invite à se pencher sur la standardisation des technologies de démocratie. La seconde section de ce chapitre se penche sur le Working Party on Nanotechnology du comité pour la politique scientifique de l'OCDE. Elle décrit en particulier, sur la base d'une enquête ethnographique, un projet relatif au « public engagement in nanotechnology ». Le suivi des différentes étapes du projet montre que l'expertise internationale sur les technologies de démocratie censées être mobilisées sur les nanotechnologies se fonde sur le maintien d'une séparation entre l'expertise

« politique » et l'expertise « technique », elle même relative à la séparation entre les technologies de démocratie et les nanotechnologies elles-mêmes. C'est à ce prix que l'expertise internationale peut tenir dans l'enceinte intergouvernementale.

CHAPTER 3. Stabilizing technologies of democracy with nanotechnology. Replications, expertise and standardization

Nanotechnology's publics are central concerns of public and private actors. Science policy officials are concerned about how to avoid a public backlash. Private actors might be reluctant to claim that they are active in nanotechnology for fear of a negative public reaction. But many others are involved in the making of public representations of nanotechnology. For them and for science policy officials, the management of potential nanotechnology controversy and the making of "good citizens" are of crucial importance.

The previous chapter has explored the construction of technologies of democracy in science museums, and demonstrated that the representation of nanotechnology enacts different democratic constructions while being associated with the representation of the social, either by the visitors themselves, as part of the exhibit, or as a long-term objective of the mobilization of science museums. In the science museum as elsewhere, representing nanotechnology implies being able to put the represented object at a distance. The problem of exteriority is dealt with in different ways in the three cases I considered in the previous chapter. In France, science museums experiment with original constructions, isolated from the making of nanotechnology programs and material objects, in which visitors produce representations of nanotechnology, and are thereby expected to represent their concerns. In Europe, the representation of nanotechnology is part of nanotechnology policy making, and it became even more so when "scientific understanding of the public" entered the objectives of nanotechnology communication policy. In the United States, the representation of nanotechnology is performed at a distance by science museum experts, who are able to add to their expertise as science communicators that of informal science education.

In this chapter, I pursue this analysis by focusing on technologies of democracy that are meant to be separated from the issues to which they are supposed to be applied. I am interested in the stabilization of participatory procedures, meant to organize the oppositions between "lay publics", experts and decision-makers and define public problems. These procedures are (more or less successfully) replicated and standardized by expert bodies. In the first section of this chapter, I consider in detail some replications of the consensus conference device on nanotechnology. These examples allow me to describe, in the second section, the production and mobilization of a "policy expertise" on technologies of democracy, which not only social science and participatory democracy scholars but also consultants and civil servants have been knowledgeable about, and have been asked to contribute to. Nanotechnology is a trial for these procedures and for expert knowledge about participatory governance.

This chapter will illustrate the investments that are needed in order to stabilize them on this additional topic, and the displacements and contestations that nanotechnology causes.

Whereas it was almost self-evident to claim that science museums produce representations of nanotechnology, the case of participatory instruments might be more problematic. "Participatory" democracy is often opposed to "representative" democracy[1], but I am not interested in reproducing this opposition. Although I recognize that participatory devices such as the consensus conference do not operate in the same political institutions as national elections, I consider here the representation processes that are at stake in participatory instruments. The consensus conference, for instance, mobilizes experts to speak for the technology that is discussed, spokespersons to present the opinion of stakeholders, and mechanisms (which I will describe below) able to transform the panel members into neutral citizens. As in the previous chapter, my main interest here is to explore the ways in which nanotechnology and its publics are represented. Eventually, this will allow me to identify problematizations of nanotechnology and its publics, some of them based on the separation between the "problem of the public" and the other components of nanotechnology, others refusing such a separation.

Numerous studies about public participation in science and technology have been developing over the past few years. Numbers of them stress the possibility for lay citizens to provide "meaningful opinions" about scientific matters, if not to contribute to the production of knowledge through specific forms of involvement, biomedical and clinical research being the classical examples[2]. Local knowledge has been shown to be valuable in the understanding of complex scientific and institutional arrangements[3]. These works have spurred a trend of studies within STS that is concerned with participatory devices and procedures. But as I made it clear in chapter 1, I want to distance my approach from studies that are concerned with the classification and evaluation of devices[4], in order to consider

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[1] Thus, I am not interested in characterizing "strong democracy" (Barber, 1984), or "empowered deliberative democracy" (Fung and Wright, 2001), and in opposing them to representative democracy. Rather, I consider various technologies that represent nanotechnology and its public, analyze how they problematize nanotechnology, and thereby stabilize political orders.

[2] Epstein, 1997; Rabeharisoa and Callon, 1999.

[3] Wynne, 1992

[4] While STS was initially critiqued by political scientists for its alleged little attention devoted to the "politics of technology policy" (Winner, 1993; Sclove, 1995), questions within the field have been gradually raised about the evaluation of participatory procedures, to the point that a series of papers have been published that proposed a framework for such an evaluation (Rowe and Frewer, 2000; Rowe and Frewer, 2004). The "public participation and science" entry of the discipline's handbook is yet another framework, dividing up participatory procedures according to their "spontaneous" or "sponsored" origin, and their "intensity of participation in knowledge construction process" (Bucchi and Nesseri, 2008). Evaluating participatory procedure has been a long-term concern of political scientists. Arnstein's ladder of citizen participation, which scales up procedures in terms of the impact they have on decision-making, is perhaps the first, and certainly the most used, of such evaluation mechanisms (Arnstein, 1969). Many other evaluation devices share its standpoint in that they consider procedures as existing and unproblematic instruments that can be assessed in order to inform future commissioners or organizers.

participatory procedures as instruments in the making, organizing democracy and mobilizing social science knowledge[1]. Thus, the analysis of participatory instruments will be done as the sociology of science has described the circulation of scientific instruments, their replication, and the issues that scientists face when they try to reproduce experiments[2].

[1] For examples of this approach, see (Irwin, 2006; Lezaun and Soneyrend, 2007)
[2] Shapin and Schaffer, 1985; Collins, 1981

Section 1: Replicating the consensus conference. Nanotechnology trials[1]

The consensus conference and nanotechnology

As seen in chapters 1 and 2, nanotechnology was defined as a problem for the participation of publics in science policy circles. During the public discussions about the "implications" of nanotechnology, the consensus conference was mentioned as a tool through which "the public" could have a say in nanotechnology policy. During hearings at the American Congress devoted to the "societal implications" of nanotechnology and meant to prepare for the 2003 Nanotechnology Act, political scientist Langdon Winner argued that Congress should "include the public in deliberations about nanotechnology early on in the process rather than after the products reach the market" [2]. He proposed that Congress

> *should seek to create ways in which small panels of ordinary, disinterested citizens (…) be assembled to examine important societal issues about nanotechnology. The panels would study relevant documents, hear expert testimony from those doing the research, listen to arguments about technical applications and consequences presented by various sides, deliberate on their findings, and write reports offering policy advice.*[3]

Developed by the Danish Board of Technology and then gradually replicated in a number of different countries[4], the consensus conference intends precisely to organize such discussions among "ordinary, disinterested citizens". This section considers two examples. The *National Citizens' Forum on Technology* (NCTF), which focused on issues related to human enhancement, was organized in 2008 as one of the projects of the *Center for Nanotechnology in Society* at Arizona State University. It was coordinated by researchers at North Carolina State University, using the *Citizens' Forum* format that the latter had developed. In 2006 the *Conférence de Citoyens sur les Nanotechnologies* was commissioned by the Ile-de-France regional council[5]. These two conferences were organized by specialists of the participatory procedure – university scholars in the former case, employees of an opinion poll company in the latter.

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[1] This section is based on (Laurent, 2009).

[2] Winner, 2003

[3] *Ibid.*

[4] See (Joss and Durant, 1995a; Klüver, 1995; Grundhal, 1995). Analysis of the use of the consensus conference in various countries comprise (Einsidel et al., 2001) in Denmark, Canada and Australia, (Guston, 1999) in the United States, (Joss and Durant, 1995b) in the United Kingdom, and (Boy et al., 2000) in France.

[5] The analysis of these two events draws on meetings minutes, interviews with actors involved (6 interviews for NCTF, 12 interviews for the *conférences de citoyens* and other French conferences), transcriptions of panel sessions and direct observation (of the early phases of the preparation of NCTF at Arizona State University in 2007, and of the final public event of the French conference).

While both groups refered to the Danish model and followed a similar process of organization (comprising the selection of a panel, training programs, interactions with experts, and the writing of recommendations), they proposed different versions of the consensus conference. Thus, they allow me to describe the challenges experts of the technologies of democracy meet with nanotechnology, and two different problematizations of nanotechnology enacted by the consensus conference. In this section, I will not attempt to account for the whole content of the exchanges among panel members[1]. Rather, I will focus on the specific difficulties the specialists of the consensus conference encountered when they replicated the procedure on nanotechnology.

Ulrike Felt and Max Föchler[2] speak of "machineries for making publics": this productive expression stresses the importance of the infrastructure needed to stabilize participatory instruments. As one can analyze the heterogeneous arrangements of materials, theories and practices necessary to produce and replicate technical objects[3], I describe here the work required for consensus conference models to be maintained. Thus, the difficult replication of the consensus conference on nanotechnology allows me to display the infrastructure of technologies of democracy. This infrastructure is based on techniques expected to produce a panel member acting in an appropriate way within the device, to represent the issue at stake to the panel members, and to produce recommendations. It is meant to stabilize the consensus conference procedure and separate it from the issues on which it is applied.

The National Citizens' Technology Forum: a laboratory in deliberation

The NCTF project was part of a program funded by the *National Science Foundation* (NSF) after the 2003 *Nanotechnology Research & Development 21st Century Act* had inscribed in the law the need for the integration of research into the "ethical, social and legal implications of nanotechnology". The *Center for Nanotechnology in Society* at Arizona State University received an NSF grant to conduct "real-time technology assessment", one of the components of which being "public engagement and

[1] I am more interested here in the investments needed to replicate technologies of democracy and produce expertise about them than in the description of the micro-evolution of lay participants' opinions and arguments and the ways in which they relate to formal expertise. These topics have been explored at length by numerous students of participation and deliberation, who highlight the contestation of technical expertise by panel members in consensus conferences (e.g. Blok, 2007), the complexity of the arguments of panel members (Kerr et al., 2007), and the tight links between their political and cognitive engagements (Joly and Marris, 2003a). This section focuses on the investments needed to perform citizens able to play such roles. Most of the publications about the NCTF already provided discussions of the arguments exchanged during the conference (Cobb and Hamlett, 2008; Delborne et al., 2009; Philbrick and Barandiaran, 2009; Powell and al., 2010; Kleinman et al., 2011). In the following, I use these publications as materials that allow me to understand the democratic constructions enacted by the NCTF, and the controversies it caused among the organizers.
[2] Felt and Fochler, 2010
[3] Cf. (Akrich, 1992). This perspective has been adopted on focus groups (Lezaun, 2007).

deliberation" with nanotechnology issues[1]. The NCTF was part of the public engagement component of the program, which was expected to focus on "deliberation".

The NCTF was coordinated by a team of researchers at *North Carolina State University* led by Patrick Hamlett, a political scientist who had developed the "Citizens' Forum" procedure and organized several of them. The Citizens' Technology Forum is meant to be a "U.S. version of the Danish consensus conference"[2]. A citizens' forum is organized as follows: a group of citizens is selected, receive background material that they read before they first meet. They then work together, with a facilitation team, in order to prepare questions to be asked to "content experts". Using the answers they receive, they write recommendations about the issue being discussed.

The NCTF took off in March 2007, at the all-hands meeting of the CNS, in which participants from all the partnering universities (including North Carolina State University) were involved[3]. Patrick Hamlett then presented the NCTF project and explained that organizers "didn't do it for the sake of it", but would "get publications out of it". A few years after the NTCF, the numbers of publications commenting on the NCTF proves he was heard[4]. In calling for "publications" to be produces out of the NCTF, Hamlett referred to examples of Citizens' Technology Fora, related especially to biotechnology, which he had previously organized. These previous experiences had been opportunities for Hamlett and his colleagues to study "pathologies of deliberation", i.e. processes through which discussions are led by more powerful actors, thus hindering deliberation. In a 2003 paper about deliberation technology issues, Hamlett had explained that the social scientist, once informed by "constructivism", should locate these pathological processes in order to be able, at a later stage, to counter them. Indeed,

Social constructivists are skilled at detailing how the use of language shapes and constructs how artifacts and individuals are understood by others and by those individuals as well.[5]

This implies that the social scientist "take steps to broaden his connections with larger, normative questions", as:

It may be time for constructivist analyses to move beyond the descriptive examination of the social dynamics of technology to a more proactive approach on the larger issues critics identify.[6]

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[1] Barben et al., 2008; Guston and Sarewitz, 2002
[2] This is the subtitle of Cobb and Hamlett's 2008 paper about the NCTF.
[3] I attended this meeting. Quotes in this paragraph are excerpts from my fieldwork notebook.
[4] Cf. in particular (Cobb, 2011; Cobb and Hamlett, 2008; Delborne and al., 2009; Kleinman and Delborne, 2008; Philbrick and Barandiaran, 2009; Powell et al., 2011)
[5] Hamlett, 2003c: 128.
[6] Hamlett, 2003c: 114

As another occurrence of the Citizens' Technology Forum format that Hamlett had developed, the NCTF was supposed to be not only an opportunity for social scientists to describe these processes but also to "take side", i.e. make sure that deliberation happened and was not captured by the most powerful actors. Indeed, Hamlett had explained that deliberation theory suffered from its blindness to "power struggles". It was necessary, for him, to render visible the power games that were at stake in deliberative settings, and might have prevented minority positions from being heard:

Constructivists are especially skilled at locating the silenced voices, at deconstructing the apparent agreements and consensus, and at pointing out how language and rhetoric are so often used as weapons in power struggles.[1]

The NCTF was located in this trend of arguments, and conceived as a device through which "pathologies of deliberation" could be measured, and, at a later stage, hopefully avoided.

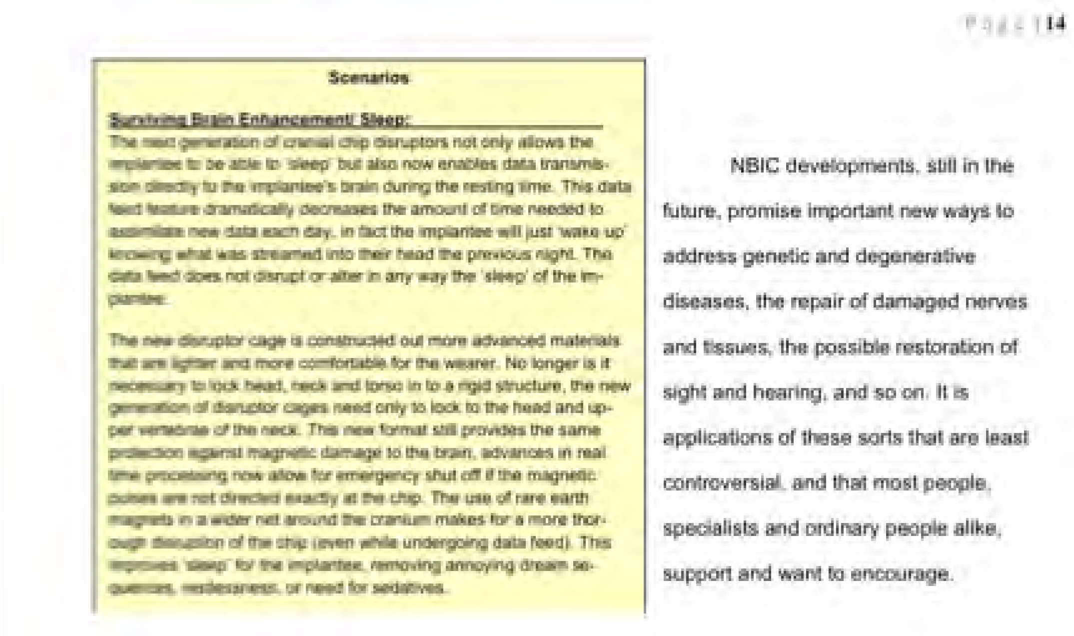
Selecting the topic and preparing the background material

The deliberation program of the Center for Nanotechnology in Society naturally focused on nanotechnology. Yet the organizers of the NCTF decided from the start to define the topic of the conference more specifically in order to allow – as they explained - for effective deliberation. Choosing "human enhancement" rather than another issue as a topic for deliberation was rapidly agreed upon by researchers at ASU. "Human enhancement" gathers all the technologies that are designed to "enhance human performances". These technologies (e.g., brain stimulation probes) are transformed by nanotechnology, especially as it converges with other technological domains. As a significant area of converging technologies, human enhancement was considered appropriate for it allowed participants to discuss existing technologies, future prospects, and the "societal implications" of nanotechnology. Thus, human enhancement was a subset of nanotechnology expected to be able to represent the whole field.

Discussions then occurred among organizers about how to write the background material, which was to be the basis for the discussion among citizens. For many of the organizers (and, above all, for the North Carolina coordinators), it was important to stabilize the representation of human enhancement in order to render the measurement of deliberation possible[2]. This was not an easy task since the field was still under development. But an innovation allowed the organizers to make human enhancement a suitable topic for the study of deliberation. As part of the *Real-time Technology Assessment* (RTTA) program[3], scenarios were developed at the Center for Nanotechnology at ASU. Written through a

[1] Hamlett, 2003c: 129
[2] I describe a measuring technique below.
[3] See Guston and Sarewitz, 2002

collaborative format involving scientists, then "vetted by experts" and proposed to public comments through a wiki-based platform, these scenarios were meant to present "plausible and collectively produced futures" and by no means "prediction"[1]. Three of these scenarios were included in the background material as an illustration of the information presented to panelists (see fig. 3.1).


Page | 14

Scenarios

Surviving Brain Enhancement/ Sleep:

The next generation of cranial chip disruptors not only allows the implantee to be able to 'sleep' but also now enables data transmission directly to the implantee's brain during the resting time. This data feed feature dramatically decreases the amount of time needed to assimilate new data each day. In fact the implantee will just 'wake up' knowing what was streamed into their head the previous night. The data feed does not disrupt or alter in any way the 'sleep' of the implantee.

The new disruptor cage is constructed out more advanced materials that are lighter and more comfortable for the wearer. No longer is it necessary to lock head, neck and torso in to a rigid structure, the new generation of disruptor cages need only to lock to the head and upper vertebrae of the neck. This new format still provides the same protection against magnetic damage to the brain, advances in real time processing now allow for emergency shut off if the magnetic pulses are not directed exactly at the chip. The use of rare earth magnets in a wider net around the cranium makes for a more thorough disruption of the chip (even while undergoing data feed). This improves 'sleep' for the implantee, removing annoying dream sequences, restlessness, or need for sedatives.

NBIC developments, still in the future, promise important new ways to address genetic and degenerative diseases, the repair of damaged nerves and tissues, the possible restoration of sight and hearing, and so on. It is applications of these sorts that are least controversial, and that most people, specialists and ordinary people alike, support and want to encourage.

Figure 3.1: Excerpt of the NCTF Background material. In this example a scenario describing a prospective technique of brain enhancement is included.

Through the use of these scenarios, the subset of nanotechnology that was chosen for its paradigmatic representation of the field could then be appropriately presented to the participants, and the future could be deliberated about. The boundary between the information to be provided and the deliberation to be studied could be effectively maintained. That did not prevent discussions among the organizers, yet these discussions could happen on how to ensure good deliberation and what to measure during the process, rather than on the nature of "human enhancement".

Managing the discussions among panel members

The NCTF was composed of six different panels, one in each of the sites where the conference was held[2]. The Citizens' Forum device is expected to give voice to the "less powerful". Accordingly, the

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[1] See (Barben et al., 2008). The methodology has been gradually refined to answer concerns from the CNS funders about the "objectivity" of the process. The project is presented here: http://cns.asu.edu/nanofutures/. I will get back to the scenario methods developed at ASU in chapter 6, as I will explore the making of "responsible futures" for nanotechnology.

[2] The six sites were the following: UC Berkeley, Arizona SU, U of Wisconsin at Madison, U of New Hampshire, U of North Carolina, U of Colorado.

representativeness of the NCTF's panels was a concern. While following the "original Danish model"[1] of voluntary participation in the panel, each NCTF site used statistical criteria (gender, age, ethnicity, political affiliation) to ensure the diversity of the panels. Ensuring the representation of the "less powerful" meant different things across the sites. In Arizona, for instance, it implied over-representing minorities in places where they were present, but not in a number significant enough to be present in a 15-member panel. Once selected, each of the panels received the background material and met to talk about it during facilitated sessions. Interactions with "content experts" were reserved for a series of Internet-based sessions.

Selection was not enough to obtain the appropriate panel member. When selected, the members of the panel were not yet citizens that could deliberate: they had to be made deliberative citizens through adequate techniques. In the NCTF, facilitation was part and parcel of the experimental settings, and was considered a variable that could contribute to explaining the types of outcomes of the process. However the coordinator of the NCTF did not propose a unified set of facilitation techniques that could be used in all of the sites. Consequently, methodological tips for facilitation were exchanged across sites, and some of them used the help of professional facilitators or people who had experience with group facilitation. Some of the local organizers explored by themselves what they could do to ensure that the link between the panel member and his or her connection to existing social characteristics did not hinder the deliberation process. One of them, who had had previous experience in group facilitation, explained during an interview that "each of the panel members (of deliberative exercises) comes with his or her hidden agenda". The first thing she did was then to ensure that such "hidden agenda" did not perturb the deliberative process. In doing so, she used a set of techniques she knew from previous experiences:

"I don't want them to introduce themselves right away. Because if they do, they present their own agenda right away. Rather… I start by asking to tell a sentence or two about a random topic… like the weather (…) Once I'm sure that they all have listened to each other, then we do the introductions."[2]

As the discussions went on, she then made sure that "deliberation was going on" by breaking down the panel in small groups, and re-arranging them if subgroups did not conduct adequately, that is, had some of their members more silent than others[3].

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[1] The expression is that of one of the organizers. It is also described as such in the final report of the NCTF.
[2] Phone interview, NCTF facilitator at ASU, May 14, 2009.
[3] Overall, she was satisfied with the techniques she used. Yet she also mentioned in an interview the case of one of the participants whom she could not involve in the discussions ("there was this one guy (…) I think he was just there for the money. He was high half of the time (…) talking about aliens then getting back to sleep." (Interview, facilitator)). In this case, it proved impossible to involve the panel member who was too reluctant to become part of the intended discussion.

Maintaining the format through technical devices

Facilitation techniques require specific material tools: flip charts, tables, screens and projectors are commonly used. More sophisticated devices can be used to help the facilitation process, thereby ensuring that the consensus conference plays the role it is expected to play. The NCTF introduced a novelty in the Citizens' Forum format with the use of "keyboard-to-keyboard" exchanges among the six different sites. During the first and third weekends of the NCTF, panel members physically met in each of the six sites. During the second, local groups could exchange with each other through an online process. Groups comprising members from each of the sites were constituted. These groups were supposed to dialogue online each at a time, while the others watched the ongoing conversations. It was through the Internet part of the discussion that the NCTF could become a "truly national" event, and an innovation in the practice of the Citizen Forum.

The Internet has another virtue. It could be used in order to ensure that the deliberative citizen was not captured by special interests. Indeed, as one of Hamlett's colleagues explains:

Online communication can mask the identity of participants with regard to appearance, age, and ethnicity. This can benefit the policy debate because individuals are less likely to respond to others based on their preconceptions and stereotypes.[1]

Thus, the Internet dialogues allow the organizers to produce a citizen who is oblivious to the social characteristics' of the other members of the group. One can then compare "keyboard-to-keyboard" interactions and "person-to-person" interactions and explore the influence on deliberation of the knowledge of "social characteristics".

The Internet is also a powerful tool for control of the issue being discussed. The software used for the NCTF allowed the organizers to disconnect some people, thus controlling who could speak and exchange with the content experts that were supposed to answer the questions raised by the participants. The "truly national" dialogue could not happen without fine technical arrangements about who could speak with whom. While one group gathering participants from each of the sites was active, the others were expected to watch the screen and read the exchanges. That way, the organizers expected "real deliberation at the national level"[2] to happen. "Real deliberation" would involve a limited number of people each time, so that the moderator of the Internet session could make sure that every member of

[1] (Prosseda, 2002: 220). This quote is an excerpt from a paper that describes a previous Citizens' Technology Forum organized by Hamlett and his colleagues.
[2] Cobb and Hamlett, 2008

the active group had a chance to intervene, and that the issue being discussed remained within the topic of "human enhancement". As the moderators had priority in the posting of messages, they could intervene quickly when they felt that questions were "too vague" or that they "did not really fall into the topic of human enhancement"[1]. For instance, as some people were trying to raise questions about nanotechnology-related health issues, they were quickly reminded that the topic was human enhancement, and that toxicological risk issues did not fall into that category. As many factors could destabilize the procedure (participants switching discussion topics, or intervening when they are not supposed to), the Internet could overcome potential destabilizations and thereby to re-stabilize the procedure.

Yet what the facilitators could not make sure of was the attention of the "inactive" participants. As reported by some of the local site organizers, many of them simply did not bother to read on a screen while they knew they had a long time to wait before they were allowed to get into the discussions. Hence, the exchanges appeared as a series of unrelated, and often repetitive dialogues: the investments put in technology to ensure that it maintained the citizen forum as an experimental setting in deliberation were thus constantly challenged.

Producing recommendations and measuring deliberation

Producing the appropriate citizen was not enough: once there, the citizen had to produce the recommendations that would be the end product of the event. At this point again, important work was needed to ensure that the citizens came up with the final recommendations[2]. The recommendations were to be those of the citizens and mediation was necessary to produce the citizen's words. Therefore, consensus conference organizers were careful not to merge "influence" and "facilitation". As one of the organizers of the NCTF said in a working paper written after the NCTF: "facilitation is no influence"[3]. No methodology was proposed by the coordinator so each site had to define where "influence" began. An organizer at one of the NCTF sites thus recalled that, as she was sitting in the room where the panel met, "the citizens were asking questions (she) knew perfectly the answers of" and that she "felt she should not answer those questions", for fear that her intervention might bias the deliberation processes that were going on[4].

Measuring deliberation required the evaluation of the quality of the exchanges. In doing so, the

[1] These were expressions used during the online discussions. The transcripts of the online sessions have been made publicly available by the organizers of the NCTF.
[2] Each panel produced one set of recommendations. All of them are publicly available online.
[3] Cobb, 2009
[4] In this example, the questions dealt with existing regulations of nanotechnology. Such reluctance to intervene was based on a "feeling" not necessarily shared by other NCTF actors. In other sites, organizers were clearly involved as "content experts" and intervened to answer questions from the citizens during deliberative sessions.

North Carolina organizers were drawing on past experiences with the Citizens' Technology Forum. In a paper related to the GM citizens' forum, "citizen deliberation" had been described as "quite successful" since

> *During the deliberations, the (members of the panel) willingly expressed their opinions and listened carefully to the opinions of others. As they worked toward consensus on specific recommendations, they treated each other with respect even when they strongly disagreed.*[1]

Thus, the "commitment" of panel members in discussions about "very complex issues" was an evaluation criterion. For the NCTF specialists, such a commitment (and, as a consequence, deliberation in general) had value if it could be defined as "non-hysterical"[2].

Demonstrating the "non-hysterical" character of deliberation during the NCTF was done through specific instruments. The organizers of the NCTF conducted pre- and post- interviews with the panel members in order to measure deliberative processes. Additional instruments were used, for instance, the measure of the "internal political efficacy" (IPE), which evaluates the acquired knowledge of the participants as well as their confidence in it, and in their ability to use it publicly[3]: participants are asked to answer a series of questions about the topic of the forum, and grade their confidence in their answers (they also have the possibility to tell that they have guessed). The measure of IPE was used by the organizers from North Carolina in order to prove that "effective deliberation" had happened during the NCTF[4], thereby defining the value of deliberation in terms of learning, awareness of the knowledge gain, and ability to use it to act as a knowledgeable citizen. Indeed, IPE draws a boundary between what is known and un-problematic (the issue itself) and what is being done in the procedure (the transformation of participants into knowledgeable citizens). As the measure of IPE implies that there are right/wrong answers to technical questions related to the issue being discussed, such an instrument produces a distance between a factual reality (which had been otherwise already described in the background material) and the actions of the citizen (learning facts about this factual reality). The use of IPE in the NCTF was the formalization of something already articulated in previous Citizens' Technology Fora: that learning "factual information" about the issue being discussed was one of the values of deliberation. In turn, this rendered the work to produce the background information all the

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[1] Hamlett, 2003b.

[2] For example, Hamlett commented on a previous Citizens' forum (on biotechnology) in the following words:
Our two panels studied the issues very carefully, and their opinions and recommendations represent what the average informed citizen thinks about genetically modified foods. The concerns these groups expressed cannot be dismissed as uninformed or hysterical; they reflect the careful weighing of evidence, competing claims, and public values. (Hamlett, 2003a)

[3] See (Cobb and Hamlett, 2008). The Citizens' Forum's specialists borrowed the concept of IPE from deliberation theorists.

[4] Cobb and Hamlett, 2008

more important.

<u>*Demonstration of the value of deliberation*</u>

The NCTF made two important dimensions of the Citizens' Technology Forum visible. First, the Forum is a means through which the consensus conference can be used as a tool to demonstrate that citizens *can* deliberate and that deliberation has value. Talking about the NCTF, Cobb and Hamlett explain that it is a matter of "testing (a) skeptical perspective" on deliberation that contends that "deliberation is at best useless, at worse dangerous"[1]. Here is the political value of the social scientist to be found: by demonstrating that citizens can deliberate and that deliberation has value, the Citizens' Forum is expected to convince policy-makers that they should rely more on deliberative processes. Indeed:

Why should we promote deliberation? One reason is that decision-makers are eager to find ways to elicit and integrate public concerns and values in the technology development process.[2]

So decision-makers are to be exposed to the value of deliberation, and shown that the mechanism works, i.e. that citizens can "listen to each other", "reach an agreement" and "have articulated opinions" within a process that does not oppose group-based positions. Through such a demonstration policy-makers can recognize that deliberation is a "way to elicit and integrate public concerns and values". The NCTF had another demonstrative interest, as it replicated the consensus conference model at a "truly national level". As the organizers explained, the NCTF was an opportunity to show that the model that proved robust in "a small country like Denmark" could be extended to the U.S.

Once deliberation and its value have been demonstrated, it is then possible to experiment what makes the best format for deliberation – and here is the second dimension. This may be undertaken in a comparative fashion. The researcher may compare direct interactions with "keyboard-to- keyboard" interactions within the same mechanism (as it happened in the case of the NCTF). He/she may compare two consensus conferences in order to learn about the rules that govern civic engagement, using selection modalities as causal variables. Further research may be envisioned, for instance, identifying "pathologies of deliberation" and exploring ways to counter them[3].

Thus, the citizens' forum appears as a social scientific research instrument, which considers social order as divided in social groups that articulate "group-based positions". On this premise the citizens'

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[1] (Cobb and Hamlett, 2008). Unless otherwise specified, quotes in this paragraph are excerpts from this paper.
[2] Cobb and Hamlett, 2008: 4
[3] Cobb and Hamlett, 2008: 15

forum may demonstrate that one can get out of “group-based discussions”: the civic engagement that it modeled is expected to be free from interest-group politics. Thus, the citizens’ forum parallels other works by the same group of social scientists. For instance, M. Cobb describes in his publications the need to “frame” public issues according to the characteristic of different social groups that act as (political, religious, ideological…) “filters” between these issues and their perceptions[1]. Whereas the final objective is not the same in this trend of work (which advocates the fine tailoring of issue “framing”) and in the Citizens’ Forum (which heralds the value of deliberation in countering such filters), both approaches share the same vision of the nature of the American political system allegedly captured by interest-group politics.

Hence, the experiment in deliberation that the citizens’ forum proposes is a two-fold process. On the one hand, it is a matter of using a device to create conditions for deliberation, and demonstrate that deliberation produces interesting outcomes – “interesting” meaning above all that learning about a “factual reality” and the self-perception of this learning process occur. The fact that the device produces deliberation is known; the objective is then to investigate whether deliberation produces interesting results. On the other hand, the device is tested at the same time in order to know if it provides good conditions for deliberation – again, “good conditions” being those that foster learning. In so doing, the Citizens’ Forum produces deliberative and experimental citizens through the mobilization of a body of social science knowledge that seeks to describe deliberation processes. As such, it is conceived as a laboratory of deliberation, which provides the model of future political action fostering deliberation.

Evaluation and use of the outcomes

Once the recommendations are written, additional work is required to ensure that the public demonstration - of the value and rules of deliberation on the one hand, of the value of informed citizen opinion on the other- is effective. The evaluation of the procedure is a key part, since the whole point is to make the value of deliberation, and the social laws that determine it visible. While some measuring tools are well-defined and constantly mobilized by the original promoters of the Citizens’ Forum formats, the replication of the model at the scale of the whole country raised other problems. Although the North Carolina organizers proposed research questions at the beginning of the process[2], other organizers considered that what was being tested was not clear. They were unsure of the evaluation criteria to apply in order to evaluate the value of deliberation, even when provided with those used by the initiators of the citizens’ forum format.

[1] Cobb, 2007
[2] According to one of the interviewees, research questions comprised the study of “acceleration processes”, and “pathologies of deliberation”.

Serving both as a demonstration to policy-makers of the value of deliberation and as a research tool intended for an academic audience, the NCTF's end products had to be shaped to fit the two goals. Eventually, the report was intended for policy-makers – and researchers from ASU convened a workshop in which the NCTF was presented to policy-makers. The academic side of the demonstration was made through publications[1]. It implied convincing an academic audience that the experiment was an acceptable demonstration, a task that is still ongoing at the time of writing.

The Citizen Forum on trial

As a social scientific experiment, the NCTF was a replication of the Citizen's Forum device, which had been gradually stabilized by Patrick Hamlett and his colleagues. Nanotechnology was a trial for the device: it implied that future developments be represented for the panel members, and that a national public be constituted – for an issue that was indeed thought of as nation-wide. The Internet, and the use of scenarios were adaptations meant to stabilize the technology of democracy. But the incomplete stabilization of the device was also a reason why organizers felt uncertain about the extent of their intervention, and participants were managed in non-uniform manners.

The Ile-de-France Conférence de citoyens

Preparing for the conference

In 2007, the Ile-de-France regional council decided to hold a consensus conference on nanotechnology. A regional councilor from the Green party, Marc Lipinsky, who was (and still is at the time of writing) vice-president for research, initiated the process. A *comité de pilotage* (organizing committee) was then composed. Its president was a physicist known for his intervention in the domain of the ethics of science. Some of the members of the committee (including the president) did not know much about the consensus conference procedure. Others were familiar with it. Daniel Boy and Dominique Donnet-Kamel were two of them. They had been involved in the organization of the first consensus conference held in France, which had been planned by the parliamentary office of the evaluation of scientific and technical choices (OPECST) in 1998 about GMOs. The 1998 conference explicitly referred to the Danish model but was named *conférence de citoyens* to avoid the stress on

[1] Among these publications were Cobb' and Hamlett's papers, as well as papers that were more skeptical about the value of the device. I will get back to this latter group below.

"consensus"[1]. The GMO *conférence de citoyens* then became a reference for people like Boy and Donnet-Kamel, who were subsequently involved in the organization of other conferences. The 1998 conference was used as a main example in a book Boy co-authored with philosopher Dominique Bourg about how to do *conférence de citoyens*[2]. The first thing the president of the *comité de pilotage* did when he was appointed was to read the book. The organization then followed closely the process laid out in Bourg and Boy's book: the *comité de pilotage*, independent of the commissioner, chose the experts, and supervised the whole process.

While both the Citizens' Forum and the *conférence de citoyens* referred to the Danish model of the consensus conference, the training program was not organized in the same way in the two cases. The US model had the panel members write questions after having read some background material, and submit these questions to experts. In the *conférence de citoyens*, the panel members were first trained by specialists of the field before reflecting on the questions they would ask to invited experts during the final public conference.

The role of Ifop and how the poll institute had been intervening in past conferences de citoyens

The regional council chose a poll company, Ifop, to organize the selection of the panel, the facilitation of the training sessions, and the logistics of the conference. Ifop had already participated in the organization of the 1998 GMO conference, and since then had organized a number of *conferences de citoyens* for public actors and private pharmaceutical companies. It had developed a methodology that followed the scheme described by Bourg and Boy[3]. From there Ifop had developed skills in applying this model to various issues. As one of the Ifop employees in charge of *conférence de citoyens* explained to me, the private companies that commission Ifop to organize these conferences have been gradually convinced of the value of the instrument:

> *It works very well every time. At the beginning, they* [the commissioners] *were a little worried. They didn't really talk about it, since they were wondering what would come out of it. Now everything's fine, they know it's going to be interesting, they know they will get good sense results on health governance.*[4]

Thus Ifop was able to propose to its customers a procedure that would display their civic commitment, and would demonstrate that citizens, once properly informed, could have sensible

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[1] This conference was described and commented upon in (Boy et al., 2000).
[2] Bourg and Boy, 2000
[3] The Ifop people I met also explained that the first thing they had done when starting working on *conférence de citoyens* was to read Bourg and Boy's works.
[4] Interview, Ifop, Paris, February 2009. The interviews used in this section were conducted in French. I translated all the quotes used in this section.

opinions. And "sensible" meant that they would be acceptable to the commissioner. The pharmaceutical companies commissioning the conferences would not have agreed to sponsor a device that would recommend a transformation of the intellectual property system, e.g. "to make drugs publicly available right after their developments" (an example used by an Ifop employee during an interview). The *conference de citoyens* could ensure that the recommendations would not be that revolutionary.

By ensuring that the procedure was reliable enough, Ifop had thus been able to make it a stabilized market object. When selected to work on the 2006 nanotechnology conference, Ifop people were confident they would be able to make use of the experience they had and applied a process that they "mastered well enough" as one of the Ifop people explained in an interview.

The impact of the conférence de citoyens

Marc Lipinsky explained at the beginning of the process that it was "an experiment". The exercise was supposed to experiment the consensus conference procedure on nanotechnology , and, beyond that, to demonstrate the possibility of non-expert thinking on technological issues. The shooting of a movie during the conference was a request from his part, and, despite strong opposition within the regional council because of budgetary issues, he insisted that making a documentary on consensus conferences should be part and parcel of the overall process[1]. The movie ensured the visibility of the experiment, and to display the value of the consensus conference procedure. Lipinsky also insisted from the start that the exercise was "a serious one", and that he wanted to take the outcomes of the process into account for the future political decisions of the regional council. As they mobilized tools and instruments they had already used, the organizers were also keen to stress the importance of the "impact" of the process.

One of the questions raised in Bourg and Boy's book is indeed the "impact" of the *conférence de citoyens*. The authors divide the "impact" of the consensus conference into its "role on the policy debate" and "direct impacts". While the latter is acknowledged to be low, the former is defined as the main result of the conference. Thus, the procedure is expected to contribute to the decision-making process, as part of the overall debate on technical issues. As Boy himself underlined about the 1998 *conférence*:

If one is to adopt this perspective, citizens' opinion is not situated in the realm of political decision-making, but in that of public debate. (…) Its ultimate goal is not to reach a « better solution » but to ensure that the main elements of the controversy be noticed.[2]

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[1] *Les Nanos et Nous*, directed by David Hover.
[2] Boy et al., 2000: 807; my translation

Ifop people for their part are anxious to draw attention to the impact of the conferences they have been involved in. Even when private companies are commissioners, the connection with the "political decision" is a central point. When asked about how they determined the success of the *conférence de citoyens* that they had been involved in, the person in charge of the procedure explained:

The first thing is obviously: 'what does all this leads to?'. And I have to say that all our conferences led to results. When we work with ZGM [a pharmaceutical company which is Ifop's main commissioner], *officials and politicians are there each time (...). And the thoughts of citizens about health policies really get to them. Well, it's never a direct impact (...) but it contributes to the richness of the debate.*[1]

Thus, when participating in the 2006 nanotechnology conference, Ifop as well as the members of the *comité* who had been involved in other conferences considered that part of the value of the exercise was to be found in its contribution to public debate.

The conférence de citoyens and nanotechnology

The regional council had determined the topic of the conference ("nanotechnology" without more specificities) when Ifop was chosen and the *comité de pilotage* selected. The early meetings of the *comité de pilotage* were opportunities for the organizers to think about how they wanted to present nanotechnology to the panel members. Two of them, a philosopher of science and the administrator of a civil society organization called *Vivagora*, which advocates for the "democratization of technical choices" [2], proposed to include a text they had written in the introductory package to be distributed to panel members. This text was entitled *La Vague des Nanos* ("The Nanotechnology Wave") and defined nanotechnology as a program that went hand in hand with "science-fiction" and "a futuristic vision"[3]. The proposition was supported by the president of the organizing committee but encountered strong opposition from other members of the committee, as well as from the Ifop people. Ifop and the members of the *comité* who had been involved in past *conférences de citoyens* contended that the document was not appropriate. For them, it did not present nanotechnology "in a factual way"[4], whereas the *conférence de citoyens* was supposed to separate factual information from panel deliberation – as previous conferences had managed to do. As one of the members of the organizing committee who had been directly involved in the 1998 *conférence de citoyens* and indirectly in several others explained:

[1] Interview, Ifop, Paris, February 2009.
[2] I will get back to the example of the organization in the next chapters.
[3] The previous two quotes are exerpts from *La Vague des Nanos*.
[4] The same expression ("*de façon factuelle*") was used in interviews by Ifop people as well as members of the *comité de pilotage*.

A presentation to the panel should be something factual. It needs to present what the technologies are, what the applications are, what they do.[1]

She pointed to an excerpt from *La Vague des Nanos* during an interview, and asked me if I "thought it was factual information":

"For about twenty years, futuristic visions and scenarios close to science-fiction go hand in hand with nanotechnology developments. For the process of fabrication at the molecular scale leads scientists to « foresee the unforeseen », i.e. renders plausible, if not likely, the apparition of radically new applications and still today impossible to even imagine."[2]

For the critics of *La Vague des Nanos*, such perspective was at best "an analysis and not the needed factual presentation", and at worst a "biased vision of nanotechnology"[3]. On the contrary, they called for a "factual presentation" of nanotechnology, which could be made of "lists of applications, of the people who develop them, of the scientific principles on which these applications are based"[4]. The Ifop people were also very critical of this document. For them it was not "relevant and objective information" to be distributed to the panel members, but "a sure way to stir up fears and emotions"[5]. Instead, they considered that the boundary between factual elements and panel deliberation had to be worked upon once again, this time about the future developments of nanotechnology. Drawing the factual/political boundary implied keeping the future at bay in order to focus merely on "concrete, existing applications based on solid scientific elements"[6].

In the 1998 conference, the organizers had chosen not to include "stakeholders" in the *comité*. The methodology developed subsequently by Bourg and Boy contended that the *comité de pilotage* should not be composed of "stakeholders" but specialists of the issue on the one hand, of the methodology on the other hand[7]. Yet the members of the 2007 organizing committee who had been involved in past conferences considered that some of their colleagues in the committee (including the authors of *La Vague des Nanos*) were "clearly involved in the nanotechnology debate" and thus "biased against nanotechnology"[8]. The authors and supporters of the text were members or close relations of *Vivagora*.

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[1] Interview, D. Donnet-Kamel, Paris, May 2009.
[2] Excerpt from "La Vague des Nanos", my translation.
[3] Interview, D. Donnet-Kamel, Paris, May 2009.
[4] *Ibid.*
[5] Interview, Ifop, Paris, February 2009.
[6] *Ibid.*
[7] Bourg and Boy, 2000: 77
[8] Some members of the organizing committee and Ifop used these expressions during interviews.

They did not claim that they opposed nanotechnology developments. But it was clear that, for them, nanotechnology could not be reduced to a set of technological advances and material objects. Instead, they considered that nanotechnology was a science and a technology policy program tied to a definition of the future, that it comprises technological practices, science policy instruments such as roadmaps, and visions inspired by science fiction that defined what the future should be. When defined as such, nanotechnology encompassed visions of social order as well as technology development, and, consequently, could not be separated from the politics of the future that it was built on. Having defined nanotechnology as a political and a philosophical issue, it made little sense for the authors of *La Vague* to define a "factual reality" about it, which could be deliberated on by citizens. On the contrary, they argued that any discussion about any aspect of nanotechnology should locate possible spaces for the intervention of civil society actors in decision-making processes.

So while the NCTF organizers managed to deal with the future by using scenarios to objectify it, the replication of the *conférence de citoyens* on nanotechnology faced difficulties in inscribing the future developments of the field in the training addressed to the panel. As no agreement could be made about a common introductory text, the presentation package to be distributed to panel members was eventually made of a collection of press articles chosen to represent different viewpoints and opinions about nanotechnology. But the discussions about nanotechnology were not limited to the composition of the background information material. They were numerous during the exchanges about the training program. While Ifop tried to apply the methodology they had developed, some members of the organizing committee (and particularly those close to Vivagora) kept referring to the specificities of nanotechnology. Through an insistence on the "ethics of technology", they sought to reflect on nanotechnology as a science policy program first articulated in the U.S. The insistence on nanotechnology as a science policy program led to request the participation of social scientists in the training program, as well as representatives of civil society organizations, who could then explain why civil society mobilization was needed on such an issue. This led to considerable changes in the procedure as Ifop and some members of the organizing committee knew it. For this latter group, the careful selection of scientific trainers should have ensured the separation between what should be made available to panel members ("factual information" as one of the Ifop members insisted on) and the discussion among them, where "opinions" can be raised[1]. Because of the oppositions raised in the *comité*

[1] During an interview, a long-term participant of several *conférences de citoyens* told me – somewhat critically- about the "academic concern" of the *conférence de citoyens*, in which the participation of "the best specialists in the field" is a requirement for the "neutrality of the process". The 1998 *conférence* was set up as such, as well as most of the *conférences* organized afterwards. Bourg and Boy raise the question of the identity of the trainers in their book. They do not exclude the possibility of having non-academic interventions during the training part. Yet for them, such choice would imply the submission by the trainer of a "declaration of interest" and maybe even a "declaration of convictions". Bourg and Boy are reluctant to have people intervene if they prove to be "acknowledged activists" (Bourg and Boy, 2000: 85).

de pilotage, nearly half of the trainers eventually came from other domains than physical sciences, some of them from NGOs active about the "ethical implications" of nanotechnology.

<u>*Selecting the panel*</u>

Ifop was in charge of the selection of the panel members. The company used a process similar to the one used in previous conferences. In a first step, Ifop employees were sent across the Paris regional area[1] and identified a set of potential panel members. This group was supposed to fall into statistical criteria. Yet the criteria used by Ifop are far from being determined once and for all. As it is important to have a balanced opinion, part of the job of the recruiting person is to ensure that factors that may affect the outcomes of the conference are taken into account. For instance, Ifop observed that the number of children had a significant influence on risk perceptions during panel discussions. Consequently, the number of children was used as a criterion in the nanotechnology Ile-de- France conference. For all the sophistication of the criteria being used, the selection required last-minute adjustments and ad hoc strategy. One of the members of the panel thus explained how she was recruited:

I have a friend who participates in panels, focus groups, things like that… She was called to participate in this, and wasn't free. So she asked me and that's how I ended up being there.[2]

The second step of the selection process was then to interview the people who had been selected and make sure that they would be appropriate panel members. "One has to check if they will be playing the game" explained one of the organizers from Ifop. In the nanotechnology case, the methodology was far from being perfectly determined. Although the second-step interview had become a standardized procedure in the selection, refinements were made each time about how to assess the participants-to-be, which, according to organizers, did not prevent "mistakes" from happening. The nanotechnology Ile-de-France conference was such a case:

No, it doesn't work each time. And for the nano conference, we got it wrong on a case… Well I should have noticed. This guy told during the interview that he didn't really believe that 9/11… Well, he said something like that, like Americans didn't really make it to the moon. We did another interview to confirm but eventually, I put him in the group. Eventually it didn't turn very well with him. He saw conspiracies everywhere.[3]

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[1] In some of the other conferences where Ifop had been involved, panels were selected across the whole country.
[2] Interview, panel member, Paris, February 2009.
[3] Interview, Ifop, Paris, February 2009.

I will come back to the case of this person – whom I will call Louis for the remainder of the text – in the following of this paper. The "mistake" that was made resulted in the presence in the panel of a citizen who did not behave as he should have.

Managing the discussions among panel members

Ifop was in charge of the facilitation of the training and working sessions of the citizen panel. The facilitator who was hired by Ifop to do this had become a long-term partner of the *conférence de citoyens* team of the poll institute. He was originally a consultant in strategic management, and had shifted his professional activities to group facilitation in companies, and, thanks to Ifop, in *conférences de citoyens*. His methods were based on a set of techniques inspired by social psychology: breaking down the panel in small groups, making sure that the less vocal people were given a chance to talk, the key point being, according to his own terms, to "make sure that a group identity was created"[1] thanks to a permanent attention to who spoke and who did not. These techniques are well known by professional facilitators, but they do not constitute a stable methodology that could be easily put into practice. Thus, the Ifop facilitator explained that:

It's more or less the feeling that matters... With the experience, I know roughly what we have to do, but it depends a lot on the group and the debated topic.

That the effectiveness of the facilitation techniques "depends on the group and the topic being discussed" is visible when considering that for all the efforts put in the facilitation techniques, it may happen that they fail to make panel members engage in the discussion the way they should. Indeed, Louis proved to be a difficult case for the facilitator:

There was this man... It's just not possible to work with people like that... Civil servant and member of a union, you see what he could be like... Well, always complaining, always questioning what I would propose.

Louis contradicted the facilitator a number of times, and insisted on a critique of nanotechnology programs, that several members of the organizing committee called "radical" since it contested nanotechnology as a science policy program, rather than accepting to consider nanotechnology a set of technical applications that could be discussed one by one. Louis wanted to have the most radical

[1] The quotes in this paragraph are taken from an interview with the conference facilitator (Paris, April 2009).

activists[1] talk to the panel members as part of the training program and suspected the organizing committee to hide elements of the debate. So in addition to the disagreement among members of the *comité de pilotage* about what nanotechnology was, oppositions appeared between Louis and the facilitator on the same topic: while the facilitator kept referring to the "facts of nanotechnology", Louis insisted on questioning what he believed was a global program with questionable objectives. Not only did Louis cause additional work for the facilitator ("I always had to keep an eye on him" said the facilitator in an interview), but through his interventions nanotechnology proved to be an issue difficult to stabilize in the format of the Ifop *conférence de citoyens*.

As some members of the *comité de pilotage* stressed the need to take ethics into account, "ethics" gradually became for the Ifop people the symbol of a refusal to look at the issue in a "neutral" fashion. As such, it prevented the mobilization of the methods already tested in other cases. The Ifop organizers complained that the members of the panel "felt that something was going on". Contrary to what happened in the other conferences they had organized, the panel members "were lost, they were extremely negative". Faced with this situation they feared to lose control of, Ifop people thus proposed to have a scientific journalist come and talk in order to "clarify things":

> *Everything was about risks, there was a need to provide a cold explanation of what this technology was*.[2]

The presentation done by the scientific journalist did not raise questions about nanotechnology, but presented, "in a simple language", the applications that nanotechnology could lead to. It also illustrated the opposition among the organizers: it was "a factual description" for Ifop, but "pure demagogy to please people" for the president of the *comité de pilotage*.

Closed rooms

Following Bourg and Boy's advice, Ifop uses closed rooms in the conferences it organizes. Closing the rooms in which the citizens worked physically ensures that deliberation does not suffer from perturbation, and that the training program is not deviated in ways that would hinder the knowledge transmission. As such, closed rooms are important material resources for Ifop to ensure that the training program brought "factual information" to the panel, and also to reproduce its facilitation methodology. During the nanotechnology conference, the rooms proved extremely difficult to close As the documentary movie about *conférence de citoyens* was being shot, the movie director and technicians were constantly present, and according to the Ifop people, they sometimes intervened in the discussions

[1] I will get back to the forms of mobilization of the most radical activist groups in chapter 7.
[2] Interview, Ifop, Paris, February 2009

among the panel members to ask questions or call for clarification. In addition, the *comité de pilotage* required all the sessions to be recorded for members of the *comité* to watch and follow how the training program went. Recordings were ways for the *comité* to comment on the methods followed by Ifop: the president of the *comité* used them to contest some of the intervention of the facilitator[1] and other members advised him to be "less directive" after having watched the recording of the session[2]. In addition, the regional council had requested that an evaluation of the conference should be done. Consequently, a political scientist attended all the sessions as an external evaluator. This was at first opposed by Ifop. Negotiations again happened when the panel wrote the final recommendations. The agreement that was settled between Ifop and the *comité* allowed the evaluator to attend the session without recording it. Hence, maintaining these closed rooms always on the verge of opening up proved extremely difficult for the Ifop people.

Producing recommendations

During a final public conference, the panel members invited experts to answer their questions[3]. Some of them had been involved in the training program. Others were representatives of private companies, scientists involved in nanotechnology projects, social scientists and representatives of NGOs. The discussions addressed the potential health risks of nanotechnology, its applications in the military sectors, the questions of privacy its application in electronics raised, and its perspective for economic development. They were organized around the solicitations of the panel members, who did not hesitate to question the affirmation of the invited experts. Consider for instance the following exchanges, between two of the panel members and a representative of a French cosmetic company:

- **Paolo**: *It then follows that your products are not toxic.*
- **F. QUINN**: *About nanoemulsions, we measure water and oil toxicity. We add C, E or A vitamins in some of them, dissolved in oil, and they are not hazardous.*
- **Paolo**: *Then, why did you eliminate the label « nanotechnology » from your products ?*
- **F. QUINN**: *I am not aware of that. We registered two trademarks using the term nanoemulsion.*
- **Nicolas**: *You used to use the expression « nanosome ». You then replaced it by « liposomes ».*
- **F. QUINN**: *They are two slightly different particles.*[4]

[1] More details on this point will be provided in the next session.
[2] Such monitoring was hardly bearable for the facilitator, who harshly told me in an interview "*It was incredible. They would record everything! They really had nothing better to do… How can one do good work when you're spied on by a bunch of idle civil servants!*"
[3] I attended this final conference.
[4] Excerpts from the transcripts of the public conference (my translation).

That the panel members contested the affirmation of the invited experts explicitly displayed that the *conference* had managed to produce citizens able to intervene in nanotechnology. This excerpt has another interest. It points to the fact that even if it was agreed to represent nanotechnology as a collection of separate applications, the identification of these applications was controversial. Caught between communication strategies that are sensitive to the negative evolution of the image of the "nano label" and the technical characterization of substances, the representation of the "nano ness" of industrial products seems difficult. The next chapters will explore this important point further, by analyzing the construction of the boundaries between "nano" and "non-nano" substances and products. At this stage, one can notice that the *conférences de citoyens* managed to produce citizens able to question the affirmation of experts, and made a problem of identification of "nano-ness" visible.

The panel members then convened in a one-day session, during which they wrote their report. As in other Ifop *conferences de citoyens*, the panel members of the nanotechnology conference were expected to produce recommendations. The writing of the recommendations was done through the mobilization of specific tools: displaying propositions from the panel on a screen, then confronting them with earlier propositions made in subgroups was a technique used by the facilitator. The objective was then to "make sure that words are really those of the citizen" as one of the Ifop organizers put it. The same person explained in an interview that the facilitator and himself had "rewritten sentences just for grammar issues".

Recommendation writing was an exercise Ifop had been thinking about when it had become involved in the organization of the *conferences de citoyens*. As the facilitator explained, this required constant care. Together with the person in charge of *conferences de citoyens* at Ifop, he had to be constantly with the panel members and help them work together. Yet no visible "influence" is acceptable: "the challenge is to gradually disappear, while having been at the origin of the group constitution", as the facilitator of the nanotechnology conference told me. Ensuring that the recommendations were indeed those of the citizens proved difficult to ensure in the 2007 conference. Consider the following story, which a member of the organizing committee (M) told me. This person is talking about one of the experts who intervened in the panel's training program:

M: *"It was a little annoying... She was a young researcher, very enthusiastic. She told them directly : 'if I were you, here is what I would put in the recommendations'. And that's what they did !.*

B.L.: *What was the recommendation?*

M: *that the CNIL*[1] *budget be raised*

B.L.: *And that proposal was problematic?*

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[1] "Commission Nationale Informatique et Liberté", a French public agency responsible for the defense of privacy rights. CNIL regulates the use of personal data.

-M: *No, not at all… But still, I know we hadn't provided explicit guidelines, but it was more or less agreed that experts wouldn't take side, that they would let the citizens deliberate. So, we ended up having a little too much emphasis on issues of individual privacy.*[1]

In this case, the link between the training program and the recommendations was too easily visible and the training became an "influence". An external observer could too easily track back one of the recommendations to its origin. The result was, for the person who recalled the episode, a perturbation in the definition of nanotechnology as a careful and balanced set of various technological sectors. Whereas "individual privacy issues" were but one of the many issues related to nanotechnology, they received, according to him, an "exaggerated treatment" as regards the other components of nanotechnology.

<u>*Outcomes of the process*</u>

The recommendations of the citizen panel, while being overall supportive of nanotechnology research, eventually asked for more research in toxicology, increased institutional oversight of nanotechnology developments (for instance through the creation of a pluralist commission of control), and greater control over private companies. During a public event in 2007, the Ile-de-France regional councilor who commissioned the conference presented it, and explained that he was pleased with the "sense" of the recommendations, which were consistent with the expert reports that had been released at the time. For him, the conference had a demonstrative value: that of the capability for "ordinary citizens" to articulate sensible opinions on technological issues. As explained above, he was also keen to prove that he was taking the exercise seriously. A few months after the conference, he sent a letter to all panel members in which he explained that, although most of the recommendations were addressed to national regulatory actors and thus impossible for the regional council to meet, he had managed to take some of them into account by fostering toxicology research projects. Having worked hard to make sure that the panels were made of the "ordinary citizens" they expected, the Ifop people for their part were overall satisfied with the end product. They explained in interviews that "eventually they manage to get through despite all the problems"[2]. "Getting through" meant here "producing sensible opinions", as Ifop had managed to do so in previous conferences.

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[1] Interview with the president of the comité de pilotage, Paris, January 2009. The researcher in question told me during an interview: "I do have doubts about the process… When you look at how you can influence the process (…) What I told them on CNIL, I found the almost exact same expression in the recommendations."

[2] The "problems" in this quote refer to the discussions about the framing of nanotechnology and the making of the training program.

The Conférence de citoyens *as a specific form of public participation*

The 2007 nanotechnology conference was an opportunity for Ifop to enact methods and instruments they had been using in previous conferences. For some of the committee members, the event was based on the mobilization of tools they were familiar with. Through the nanotechnology conference emerged a way of doing public participation that is based on a separation between "factual information" provided to panel members, and the "discussions" among them. Such separation allows the procedure to travel and be replicated. It can make Ifop be comfortable about the procedure they sell to their successive customers, but it also requires constant work in order to ensure that the panel is made up of appropriate citizens, and that the issue being discussed is properly framed. For that matter nanotechnology proved to be a difficult case, which did not fit well in the procedure as some of the actors involved referred to the specificities of nanotechnology in order to argue for modifications in the procedure Ifop sought to replicate. A second characteristic of the *conférence de citoyens* as it emerges through this example is its demonstrative role. There were indeed repeated concerns for the "impacts" of the experiment, but the commissioner was equally concerned with the demonstration it produced that lay people could articulate "sensible opinions"[1]. Demonstration was ensured by the movie about the *conférence*, and by the public conference itself. That citizens could question experts during the final public conference, and eventually wrote recommendations that did not contradict the main conclusions of existing expert reports was another demonstration of the possibility for lay publics to be involved in deliberations about nanotechnology.

Shifting the problematization of nanotechnology

I described above two definitions of the problems the consensus conference is expected to address and the ways to stabilize the procedure in order to propose solutions. The Citizens' Technology Forum sees the consensus conference as an experiment through which deliberation can be explored and worked upon, in order for less powerful social groups to be heard. The Forum is meant to be a small-scale experiment that proves the value of deliberation in general. The *conférence de citoyens* shares the

[1] The importance of the demonstrative dimension is clear in other instances of *conférences de citoyens* organized about nanotechnology. One of the organizers of a 2006 conference sponsored by an association of private companies thus explained: "my predecessor had told me he wanted to organize a *conférence de citoyens*. He had insisted on the interest of this device in order to demonstrate (*faire la démonstration*) that science/society relationships may happen other than in a crisis mode. I was convinced. The whole thing was then to choose a subject." The interest of the conference is here to demonstrate that it is possible to "hold sensible discussions on complex issues", no matter what the specificities of the issue are. In this example, nanotechnology was chosen because, as an emerging issue, "it had not been shaped by the media yet" (Interview, 2006 conference organizer, Paris, September 2009).

demonstrative feature, but integrates it in a concern for the "impact" of lay citizen reflection on technological issues. Contrary to the Citizens' Technology Forum, the *conférence de citoyens* is expected to bear on decision-making or at least contribute to a general debate.

The two forms of consensus conferences are two technologies of democracy. They define problems to be dealt with and ways of doing so. Their particularity is that they are expected to be mobilized on nanotechnology as on any other issues. Accordingly, they define the problem of nanotechnology in the same way as for other technological areas: one should demonstrate that deliberation has value and can be improved or that citizens can formulate sensible advice, on nanotechnology as well as on other domains. Thus, they do not intend to question the existence of the field itself, but to represent it for deliberating panel members. But the particularities of nanotechnology made this task particularly difficult. Was it necessary to display a series of applications in medicine, construction or energy? How was a global science policy program of development to be presented to panel members? While the NCTF answered these questions by focusing on a single area ("human enhancement") and using scenarios to display potential evolutions, the French *conférence de citoyens* was caught in pervasive oppositions between Ifop and members of the *comité de pilotage* about whether nanotechnology could be pictured as a set of separate objects or needed to be described as a "wave" with uncertain future developments and in which civil society needed to actively intervene. Similarly, Louis (the misbehaving panel member in this latter case) contended that anti-nanotechnology activists should have talked, and that nanotechnology should have been pictured as a global program to be actively contested. These criticisms of the stabilized Ifop *conférence* consisted in bringing nanotechnology back in the very mechanism of the procedure.

The difficulties in maintaining the separation between nanotechnology and the technologies of democracy required additional investments in order to overcome destabilization effects (e.g. citizens not behaving correctly, or organizers calling for a definition of nanotechnology considered inappropriate). In such situations, where tensions were always present between stabilization and destabilization processes, room appeared for alternative problematizations of nanotechnology that re-attached the consensus conference to the actual making of one or several of nanotechnology's components, whether objects, futures, concerns or publics. I discuss below three of these alternative constructions, which, in some cases, were ad hoc adjustments, and, in others, continuation of previous experiences.

The conflicting status of the experimental setting: how to use the consensus conference as an empowerment device.

I presented the model of the Citizens' Forum as a laboratory of deliberation to one of the organizers of the NCTF during an interview. She immediately replied:

Well... that might be a fair description of Hamlett's view of the consensus conference... but I do think it's about democracy after all. It's about giving people the possibility of making their voice heard, to give them the ability to act in the policy world.[1]

She then referred to a public presentation of the NCTF made to policy-makers in Washington in March 2009, during a one-day meeting organized by the Center for Nanotechnology in Society at Arizona State University, in order to illustrate the "democratic impact" of the Forum. Thus, my own attempt to define the Citizens' Forum as an experiment in deliberation revealed a tension about the nature of the NCTF, and, thereby, about its democratization objective. The Citizens' Forum had been developed by researchers at North Carolina State University, and the other partners of the NCTF were not necessarily familiar with this device when they started participating in the organization of the forum. That the methodological material provided by the organizers was minimal made it possible for some of the organizers to propose another problematization of nanotechnology and its publics.

Consider for instance the use of scenarios. Ensuring the possibility for the panel members to grasp nanotechnology was a concern of some of the proponents of the scenario method. In the NCTF case, scenarios allowed to maintain the future within the set of topics panelists could deliberate upon. As seen above, they were tools for the conduct of the experiment in deliberation that the NCTF performed. Yet the researchers involved in scenarios making projects[2] saw the scenario mainly as tools for citizens to get confidence in their own capability to influence the future. They considered that scenarios could "build reflexivity through foresight"[3]. As such, scenarios were not supposed to produce a boundary between the deliberative process and the material provided as a background of it. Rather, they were meant to "cope with uncertainty" in order for those who produced, commented on or used them to eventually "take some sort of action"[4].

Looking more closely at the NCTF process reveals that other definitions of the role of the consensus conferences were proposed, in particular through references to another citizen conference on nanotechnology organized two years before the NCTF at Madison, Wisconsin. The Madison conference had been organized by researchers at the University of Wisconsin with the support of the *Center for Democracy in Action*, a local organization that promoted civic engagement in public decision-making. The University of Wisconsin researchers then participated in the Madison part of the NCTF, and one of the researchers at Wisconsin subsequently moved to Arizona, where he then worked on the organization of

[1] Phone interview, NCTF organization at ASU, March 2009.
[2] That is, researchers at CNS-ASU who contributed to NCTF by providing the scenarios.
[3] Barben et al., 2007
[4] Selin, 2005

the Arizona part of the NCTF. The 2005 Madison consensus conference led to the presentation of the final recommendations to state-level politicians. After the Madison conference, the panel members created a "citizens' coalition on nanotechnology", which launched a science cafés program and mobilized on nanotechnology. The coalition set up a website, on which they have been publishing essays on issues related to the governance of nanotechnology. When the National Nanotechnology Coordination Office[1] convened its first meeting on Environmental, Health and Safety Issues related to nanoparticles, one of the members of the coalition flew to Washington for this meeting and the coalition submitted written comments. These comments reasserted the call for government oversight of potential health risks, increased toxicology research and development of risk management methodologies, which were considered necessary in order to take into account the potential release of engineered nanoparticles in the environment. They also insisted on the need for public dialogue with civil society organizations – theirs being one of them. The Citizens' Coalition – later renamed Nanotechnology Citizen Engagement Organization a.k.a nanoCEO – then participated in an initiative launched by the International Center for Technology Assessment (ICTA) that led to the submission to the Environmental Protection Agency (EPA) of a petition that called EPA to regulate nano silver as a pesticide[2].

The researchers at the university of Wisconsin involved in the organization of the 2005 Madison conference were a key part of the process of mobilization in which the panel members were engaged. They helped set up a press conference after the exercise. They helped the group of citizens organize science cafés. They actively participated in the mobilization of the Coalition by providing information and suggesting interventions in local and national events. Two years later, as they were involved in the organization of the NCTF, they were keen to refer to their previous experience of the consensus conference. By contrast, they considered that helping the panel members to engage on nanotechnology after the conference itself was "clearly not the main concern of the NCTF", which, in comparison with the Madison event, was "a little bit disappointing"[3].

All the efforts made by the NCTF organizers to maintain the format of the citizen conferences as a laboratory in deliberation implied ensuring that citizens behaved adequately during the Internet sessions. Yet, as I explained above, these sessions failed to convince participants to engage in them. Here is an example of cracks in the attempts of the NCTF organizers to enact the laboratory in deliberation the Citizens' Forum is supposed to be. This crack left room for the Madison researchers to propose another problematization of nanotechnology and its publics. Indeed, a reason for the lack of interest for the online sessions was put forward by a researcher at the University of Wisconsin who participated in

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[1] NNCO is a federal body in charge of the coordination of nanotechnology federal activities.
[2] I will get back to this event in chapter 4.
[3] Phone interview D. Kleinman, May 2009.

the 2005 conference and the NCTF. She explained that in the latter case "citizens knew that they were part of a research project"[1], and, consequently, tended to "not even bother" to fight for ideas or opinion. She contrasted the NCTF with the 2005 Madison conference in which "the framing was different", in that the organizers insisted from the start that the conference was expected to impact public decision-making. As a result, the recruited people were "concerned about the topic" and, as such, would "probably not have made it into the NCTF" (because of their involvement with the issue being too high)[2].

Referring to the Madison experience allowed the researchers at the University of Wisconsin to stress the importance of the idea of empowerment. Insisting on empowerment defined consensus conferences as a method through which less powerful social groups could exercise control over technology by participating in its assessment. This perspective is linked to the view of prominent advocates of public participation in science and technology. Thus, the organizers of the Madison citizen conference who took part in the organization of the NCTF directly referred in interviews to Richard Sclove's work in order to describe their vision of the citizen conference. As a proponent of "technological pluralism", Sclove advocates the involvement in knowledge production of

... social groups comprising non-experts – that is, ordinary women and men. Sometimes they are organized according to their occupations (a little bit like our trade unions), sometimes according to their social concerns (like our environmental or women's groups), and sometimes according to where they live (like our community and grassroots organizations).[3]

In this view, consensus conferences grant power to lay citizens, to those who would otherwise be left out of decision-making processes. For that matter, nanotechnology is a special domain, for which there might be additional possibilities for citizens to exercise social control over technological choice. This is the sense of Langdon Winner's testimony in Congress during the hearings on the "social implications of nanotechnology" before the House committee for science and technology, during which Winner specifically advocated the use of consensus conferences[4].

The 2005 Madison example could therefore be interpreted as a way of ensuring the control of technology by less powerful actors. As two organizers of the 2005 Madison conference explained in an academic paper in which they reflected on the value of this exercise,

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[1] Phone interview, M. Powell, June 2009.
[2] The researchers at Madison involved in the two conferences have drawn a comparison of the two events in terms of the identities of the participants and the outcomes of the processes (Kleinman and Delborne, 2009).
[3] Sclove, 2000: 112
[4] Winner, 2003

consensus conferences could be critical mechanisms for building perceived capacity to participate among ordinary citizens. This increased citizen capacity could in turn contribute to longer-term policy outcomes, particularly if broader and more diverse groups of citizens participated[1].

The experimental deliberative setting of the NCTF and the empowerment vision of the Madison conference share the same understanding of the social order. In both models, they are "group-based positions", i.e. those advocated by particular interest groups with identifiable social identities. Yet while the Citizen Technology Forum is used as a device to show how power relations in deliberative settings can be identified and possibly set aside, conferences in the empowerment perspective are conceived as tools for the social control of technology, as they are meant to empower groups that are less powerful than others[2].

A "quality citizen" discussing nanotechnology as a science policy program

While members of the organizing committee of the 2007 *conférence de citoyens* argued about how to represent nanotechnology, oppositions also appeared about the role of panel members. The president of the organizing committee, speaking about the members of the panel, thus explained:

Fortunately, there was Françoise, it's her who kept the discussion going. Because Ifop wants 'neutral' citizens, but then they refuse to have those who know things ! I think she managed to get through their selection process by mistake.[3]

Indeed, Ifop is looking for people who, according to a member of Ifop's consensus conference team, "do not know anything about the issue at stake". This separates the procedure and the issue to which it is expected to be applied. But this goes to the point that, for the president of the *comité*, Ifop refuses to accept potentially valuable contributors. Contrary to this vision, the president described a "quality citizen" who would be able to make decisions precisely because of his or her particular interest in the issues being discussed. According to the president of the organizing committee, Françoise was the one who fostered the discussions during the nanotechnology conference by introducing reflections on

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[1] Kleinman and Powell, 2006

[2] The organizers of the 2005 Madison conference discussed the empowerment of the less powerful social groups through the consensus conference (Kleinman and Powell, 2006). Winner explicitly uses this objective within his critique of the lack of political ambition of constructivism (Winner, 1993). Hamlett shares the same critique of constructivism but does not draw the same conclusion about the role of social science (cf. section 1)).

[3] Interview, president of the organizing committee, Paris, January 2009. Unless otherwise specified, quotes in this paragraph are excerpts from this interview. The president is referring here to one of the panel members. The name has been changed.

financial incentives for toxicology research. Once the conference was over, Françoise was sent by the president of the organizing committee to other public events to talk about the citizen conference. For him, not everyone was able to fulfill the role of the quality citizen he called for. He compared her with other members of the panel:

Yes, as compared with the others… There were grandmothers, very nice, they did what they could but well… it never really went very far.

These latter persons were precisely those the facilitator were happy about:

One really saw that people like them [the "grandmothers" in the previous quote] *could make good sense remarks. When they said, for instance, that industrialists couldn't do whatever they wanted.*[1]

As panel members who accepted the fact that they did not understand, and nevertheless provided remarks *de bon sens*, they were considered as good members of the panel by the Ifop employees. But the "quality citizen" as proposed by the president of the organizing committee did not fit in the facilitation process as proposed by Ifop. As the president explained during an interview:

We clearly had two different visions of neutrality with Ifop. For the facilitator, neutrality was gained through ignorance (he would always say, "don't worry I don't know anything about this")… They have a horizontal conception of neutrality, They want to have a group as diverse as possible… I do think that quality matters.

So the opposition on the identity of the "good citizen" was not only a matter of defining the appropriate format of citizenship to be enacted in the citizen conference process. It was also linked to the nature of the device and its connection to the issue being discussed. As the facilitator claimed that he did not know anything about the issue, he made the issue independent of what he was paid for, that is, the organization of the procedure. The panel, and himself, had to be trained, but this was not problematic: the methodology allowed for adequate exchanges among panel members and himself, on any technical issue that was presented in the way Ifop was used to. The difficulties that Ifop encountered to keep the rooms closed were ways for the president of the *comité de pilotage* to contest their choices, and insist on the importance of the quality citizen to discuss nanotechnology. As he watched the training sessions, he complained several times to the facilitator that "no efforts were made to ensure that citizens raised questions about nanotechnology development programs". For the president of the

[1] Interview, facilitator, Paris, April 2009.

organizing committee, the quality citizen had to reflect on scientific issues, which needed to be questioned according to the specificities of the case being discussed. Thus, nanotechnology implied, for him, a stress on questions of "ethics and policy". As a global science policy issue, it implied a lot more than the evaluation of risks and benefits, namely a careful examination of the crafting of research programs and regulatory devices. As nanotechnology proved difficult to keep still in the procedure, Ifop was inclined to think that it was "too broad a subject for a *conférence de citoyens*"[1]. For the president of the organizing committee, on the contrary, nanotechnology was a perfect case to incite the citizen to question policy institutions. Consequently, the 2006 Ile-de-France *conférence de citoyens* left room for the articulation of an ad hoc problematization of nanotechnology, which identified a democratic problem to be dealt with by the production of a quality citizen able to reflect on the specificities of nanotechnology as a global science policy program.

A critical citizen able to question nanotechnology

As discussed above, producing a citizen that will be able to be trained and who will produce an articulate opinion is not a straightforward task. It does not always work, as members of the panel sometimes do not behave as planned. While this may have re-stabilization effects (e.g. though the constitution of a group identity against the person acting badly, and thus becoming excluded), it also produces cracks in the procedure. These cracks can then be the basis for a critique of the consensus conference. Thus, one of the evaluators of the Ile-de-France nanotechnology conference explained:

I thought there would be more critical perspectives within the panel. The guy that criticized the most gave up after a while, that's a real shame[2]

She was talking about Louis, the very same person that the facilitator blamed for "not being able to do anything", and who at the end of the process gave up trying to include his critical perspective in the final recommendations. For her, Louis played an important role, albeit confined and eventually limited in what it produced. Through him, a critique of the facilitation process could happen. She herself thought that the facilitation role of Ifop ended up producing middle-of-the-road positions that were not particularly relevant (if not harmful if used in a legitimizing manner)[3]. Ifop, for her, eliminated the most radical positions - "radical" in that they called for a critique of nanotechnology, not as a risk issue, but as an issue of science policy. Their positions could have questioned how decisions were

[1] The Ifop employee in charge of *conférence de citoyens* suggested during an interview that this could have been a reason for the difficulties Ifop faced with this conference.
[2] Interview with the evaluator of the Ile-de-France conference, Paris, February 2009.
[3] *Ibid.*

supposed to be taken, why a nanotechnology program had to be undertaken, and, ultimately, why participatory mechanisms had to be organized at all as a part of this program. She interpreted the fact that Louis eventually gave up his fight to see some of his radical views included in the final recommendations as a sign that Ifop was trying to ensure that the opinions expressed were "moderate".

Thus, the work needed to ensure that the citizens behaved adequately and that the issue was "factual information" (temporarily) left room to articulate a critique of public participation as proposed by the *conférence de citoyens* model. These positions paralleled those of the "external" critics, i.e. those that refused to participate in these events allegedly already part of a technology program that should have been critiqued[1].

Cracks, gaps and room for alternatives

The tensions that occurred in the framing of the issue being discussed, in the selection of the panel, in the moderation processes, in the production of the recommendations and in the management of their use were opportunities to introduce other ways for the citizen to behave, and, more generally, other definitions of the problem that the consensus conference was supposed to deal with. While some actors were at pain to draw a boundary between a participatory methodology that they sought to replicate in different settings, others questioned it and proposed to reconsider both the role of the citizen in the conference's panel, and the ways of discussing nanotechnology. Using the bits and pieces of the procedure that they found at their disposal, they explored other ways of representing nanotechnology and defining the problem of its relationships with various publics. Thus, I described how the nanotechnology *conférence de citoyens* led to the articulation of an approach that specifically tailored the consensus conference to nanotechnology. In this approach, a quality citizen develops his/her initial abilities substantially enough to question nanotechnology as a science policy program. Another alternative approach integrated public participation into nanotechnology considered as a science policy program. The American examples offer an empirical case in which the difficulties in stabilizing the experimental deliberative version of the consensus conference left room for the call for the empowerment of nanotechnology's publics. In this case, it was mostly through references to the Madison conference - as the NCTF proved less concerned with following up with the recommendations written by the panels than in the Madison previous experience – that the empowerment version of the

[1] Cf. the anti-nanotechnology activists encountered in the previous chapter. I will get back to this group in chapter 7. All French consensus conferences on nanotechnology were criticized by civil society organizations. Reacting on another conference organized in 2006 by an association of private companies, *Les Amis de la Terre* released an article called "'*Conférence' ou manipulation de citoyens*" in which they criticized not only the limited framing of the conference in terms of risk issues, but also the necessity to have consensus conferences at all. The article contended that consensus conferences were mere communication campaigns, which could never hope to have a say in any concrete decisions.

consensus conference could emerge.

Replicating technologies of democracy

Considering participatory procedures as technologies of democracy that define the nature of the issue being discussed, the behavior of the citizen, and the nature of the outcomes, this section has described two definitions of the problem of the relationships between nanotechnology and its publics through the consensus conference. The Citizens' Forum is characteristic of an "experimental deliberative way", in which the consensus conference is expected to play the role of a laboratory for the study of deliberation on nanotechnology. As such, it goes hand in hand with standardized social science knowledge about what it means to do public participation in science policy. In France, the model of the *conférence de citoyens* proposes a public demonstration of the validity of informed lay thinking on nanotechnology. The U.S example echoes tension between deliberative and interest-group democracy – a long-term concern of American political science[1]: the two American consensus conferences are equally built on the basis that the social world is composed of different social groups with identifiable (albeit potentially subjected to evolutions) interests. The French example offered opportunities to explore different paths to public participation, in which the citizen could take part in the national debate on technology. The standardization of the procedure allows social scientists and private companies to make the procedure travel and to replicate it across various technological issues. In the cases analyzed here, it becomes a social scientific research device, or a product expected to be sold on the market of public opinion. Through this analysis, consensus conferences appear as devices which can be mobilized for different aims, and the machinery of which is called for to produce certain citizens – a work that supposes selection, judgment over which behaviors are acceptable or not, and fine grain adaptation to ensure that deliberation occurs. The other part of the construction of citizen conferences is the representation of the issue at stake. Nanotechnology could be represented through scenarios in the American case, but caused vivid discussions in the French one.

The case of nanotechnology renders visible the work needed to enact models of participation based on the consensus conference. As previously used instruments were replicated on nanotechnology, such a complex issue has to be made fit for the procedure, and it required work to do so. The boundaries on which the existing devices were based (between materials provided to panelists and deliberation processes to be studied on the one hand, between factual information and political discussions on the other) proved difficult to maintain. I described some of the cracks and gaps that were visible in the NCTF and the Ile-de-France *conférence de citoyens*. They were opportunities for alternative

[1] Mansbridge, 1980

versions of the conferences to be proposed, and more or less integrated through the process of replication. Thus, the critical look at the *conférence de citoyens* could eventually be ignored in the final outcomes of the nanotechnology *conference*. But the president of the organizing committee granted an active role to the "quality citizen", and advocates of empowerment from the University of Wisconsin made their approach explicit in critical comments on the NCTF.

The perspective laid out so far contends that the analyst of participatory procedures cannot easily separate *ex ante* nanotechnology from the participatory procedure that is expected to deal with it, possibly in order to explore which procedure is adapted to it. The separation of the procedure from nanotechnology results from the work of the actors themselves, as they try to isolate a participatory methodology that can be replicated independently of the technical issues to which it is supposed to be applied. As I have described, such separation may be contested by actors who argue for the specificity of nanotechnology and the need to adapt the procedure to it – whether to allow for a discussion on global science policy, or leave room for a collective empowerment that could eventually allow an emerging social movement to intervene in science policy.

Looking at participatory procedures as contested arrangements leads us to re-think the problem of their evaluation. A model of consensus conferences defines its own relevant evaluation criteria – and these criteria might differ substantially. Consequently, the "impact on decision-making" criteria do not account for the multiplicity of potential evaluations. The NCTF's demonstrative value may have nothing to do with a direct "impact" on decision-making: that does not make it a politically meaningless device. Similarly, the institutionalization of participatory devices appears as a more complex process than the inscription of it in a linear line of decision-making. Institutionalization is better understood in terms of stabilization, which, as I have shown, requires investments, so that the procedure is able to solve the tensions that occur as it gets replicated without leaving room to competing problematizations. Institutionalization appears less as a matter of ensuring legislative existence to participatory procedures than as a matter of stabilizing ways of dealing with technology.

Consequently, rather than calling for the professionalization and institutionalization of public participation in nanotechnology, and in S&T in general[1], I am much more willing to insist on the ambivalence of participatory instruments. One the one hand, taking the ambivalence of participatory procedures seriously allows the analyst to explore the machinery of the production of the "participating citizen", the investments required to do so, and the diversity of potential definitions of public participation in science through the same participatory device. On the other hand, acknowledging the ambivalence of participatory procedures is a way of performing a realist critique of public participation. For some critics, participatory procedures are built on questionable power relationships hidden behind

[1] Blondiaux, 2008

the stress put on consensus and deliberation[1]. As such they would prevent oppositions much needed in any healthy democracy. The analysis laid out in this section has shown that there are indeed social organizations enacted by the participatory procedures, and that these organizations construct included and excluded participants. It refuses the romanticized vision of the consensus conference as an unproblematic instrument that reveals that lay citizens have articulate opinion on complex and technical matters. Yet far from invalidating consensus conferences in particular (and public participation and deliberation in general), the analysis shows that the permanently challenged stabilization of the procedure allows both the analyst and the actors themselves to reintroduce conflicts and oppositions within the very making of technologies of democracy.

The case of the consensus conference is paradigmatic to illustrate the replication of technologies of democracy on nanotechnology. It renders the mobilization of expertise on technologies of democracy visible, and the experiments and demonstration in which it is engaged. Other examples could be envisioned. Consider for instance the case of the French Commission Nationale du Débat Public (CNDP), which conducted a nation-wide debate from October 2009 to February 2010 on nanotechnology. The CNDP organizes public meetings based on the contribution of all interested actors, who are invited to write *cahiers d'acteurs* (stakeholders' brochures). Debates result in a report written by CNDP, which does not provide recommendations but describe the diversity of the arguments about the topic at stake[2]. Founded in 1995, the CNDP is mostly mobilized on local infrastructure projects. In 2009, 7 ministries commissioned the CNDP to organize a "national public debate" on nanotechnology in order to "enlighten" public decision-making on nanotechnology[3]. As the replication of the consensus conference, that of the CNDP debate procedure on nanotechnology required

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[1] This is Chantal Mouffe's critical reading of the call for consensus in liberal democracy (Mouffe, 1999; 2005). In the area of development studies, scholars have spoken about the "tyranny of participation" as they attempt to display the power relationships at the heart of the mobilization of participatory devices (Cooke and Kothari, 2001; cf. also Goldman, 2001, and, for an example in planning, Turnhout et al., 2010). The main difference between the perspective I am outlying here and these critical works lies in the treatement of power and social relations. I am not attempting to display the power games that determine the mobilization of an ideal for consensus and/or participation, but I am looking at the practical construction of democratic order through the experiments of technologies of democracy that can be studied with the tools developed by STS.

[2] Above a certain amount of investments for the project, the industrialist is legally required to commission the CNDP to organize a public debate, early enough in the project in order to allow for modifications. Since 2002, it has the possibility to organize debates on "general options" (see Revel et al., 2007 for a presentation). Some of CNDP debates take the form of a negotiation among stakeholders, others are more on the exploratory side, allowing for redefinitions of technical questions and social identity (cf. a classification proposed by Michel Callon in Callon, 1998). Sébastien Crombez and I argued that the CNDP is doing "informal technology assessment" through the exploration of controversies, thus operationalizing in an institutionalized device what Arie Rip described (Rip, 1986; Crombez and Laurent, 2009).

[3] After a consultation process about environmental policy in France that was organized after the election of Nicolas Sarkozy (the "Grenelle de l'Environnement"), a set of environmental laws was passed in October 2008. These laws comprised an amendment about nanotechnology, which required a "public debate" to be organized "on a national scale".

adaptations and investments. That the debate was to be "national" made the organizers plan meetings all over the country. Each meeting focused on topics linked to the industrial and research activities of the city where the debate was held, and, in some cases, developed a more general theme. For instance, the Orléans public meeting focused on the local nanotechnology industry (particularly cosmetics) and on consumer safety.

As for the consensus conference, nanotechnology proved to be complex to be represented within the CNDP debate[1]. The topics chosen were regularly displaced during the public meetings (which the organizers had accepted from the start), as participants raised questions not related to the foreseen topics. For instance, participants at the Orléans meeting discussed workers' safety or privacy issues related to the use of nanoelectronics, and others questioned the value of the overall French nanotechnology program. The identity of nanotechnology substances and products remained unclear, as participants did not agree, for instance, on the presence or absence of nano substances in food products. Consequently, the final report written by the Commission could mainly call for the "identification of substances" and for "information" about the uses of nanotechnology in consumer products[2]. This is, as we will see in the second part of this dissertation, the core of the problem of the public management of nanotechnology. But the Commission could mainly state it without being able to make the characterization of nano products the topic of public discussions.

How the public debate on nanotechnology could "enlighten" public decision-making remains unclear, as, at the time of writing, the French government has not released any official response to the conclusions of the Commission[3]. But the most striking feature of the CNDP debate was that contestation was extremely vocal. The meetings were repeatedly interrupted by opponents claiming that the debate was merely a trick meant to make the public accept an unquestioned program of development of nanotechnology. Consequently, the organizers tried to separate meetings into two rooms, a closed one in which invited experts were present, and a second one open to the general public. Two organizers were present in the open room to facilitate the discussions, and exchanges were then supposed to be possible by phone or on the Internet. As this did not diminish the contestation, the organizers eventually set up closed meetings in which the participants had to be identified (cf. the opening scene of the dissertation). But the elimination of this unwanted public was not enough to overcome the problem of the representation of the field of nanotechnology and of the identification of its products.

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[1] I discussed this in (Laurent, 2010a: 179-189).

[2] Commission Nationale du Débat Public, 2010, *Bilan du Débat Public sur la régulation et le développement des nanotechnologies*, Paris, CNDP: 6 (my translation).

[3] The government was not legally bound to do so, as the nanotechnology debate was a so-called "débat d'option", that is, related to general policy-making options, and not to a local infrastructure project.

The case of the CNDP could be described in the very same way as that of the citizen conference. The device relies on expert knowledge and practices. It is expected to perform demonstrations, and face trials when replicated on a new issue. It faced difficulties linked to the representation of nanotechnology, and to the critique of anti-nanotechnology activists. It is expected to foster the exploration of controversies, but as this is not easy to enact in the case of nanotechnology, there is room for alternatives – in this case the mobilization of a radical critique of nanotechnology.

At this stage, I do not want to discuss further the details of the CNDP debate. I will get back to this example later, as an opportunity to explore the possibilities for anti-nanotechnology activists to perform a radical critique of technologies of democracy[1], and as a component of an experimental problematization of nanotechnology in France[2]. But without further description, the CNDP debate already appeared as another example of the difficult replication of technologies of democracy on nanotechnology.

Having insisted on the stabilization of expertise on technologies of democracy throughout the circulation and replication of participatory instruments, I explore in the second section of this chapter another dimension of the stabilization of technologies of democracy meant to be separated from nanotechnology. After the descriptions of American and French problematizations of nanotechnology and its publics, the second section of this chapter focuses on the production of international standardized expertise about technologies of democracy meant to be applied to nanotechnology. The example I use to do so is that of the Working Party on Nanotechnology at OECD, more specifically of its "public engagement" project.

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[1] This will be done in chapter 7.
[2] This will be done in chapter 8.

Section 2: Producing international expertise about technologies of democracy

After having described the mobilization of expertise on technologies of democracy in different countries, and the differences in the replication of the same device, one can then wonder about the connections among national problematizations of nanotechnology and its publics. This second section explores the making of international expertise about technologies of democracy in nanotechnology. It considers the work done at the Working Party on Nanotechnology (WPN) of the Organization for Economic Cooperation and Development (OECD), and focuses on a project devoted to "public engagement in nanotechnology". The case of the expertise about technologies of democracy at OECD provides elements to understand how an international organization produces "policy expertise" about nanotechnology, and offers an illustration of the construction of an international space, which shapes/is shaped by institutional and technical constraints[1].

As nanotechnology's publics received permanent attention from policy-makers, international cooperation was expected to extend to the making of expertise about ways of engaging the public. Therefore, the example of OECD WPN illustrates a case of stabilization of technologies of democracy through expert knowledge. Against a passive vision of the expertise about politics, it analyzes the realities that the production of international expertise performs, that is, the democratic constructions it stabilizes, and the allocation of public roles it enacts. Within the reflection on the stabilization of technologies of democracy, this analysis will shed light on the standardization of "public engagement" as a solidified set of techniques meant to act on publics. At a time where "public engagement" is heralded as a key concern for science policy-making[2], it will offer, by the same token, an illustration of the active roles of experts in policy in the shaping of democratic orders[3].

The production of expertise relies on mechanisms aiming to ensure objectivity. Quantification processes are ways of doing so[4], as are organizational arrangements meant to construct boundaries between public decision-making and expertise production[5]. Some recent examples of the mobilization of international expertise are characterized by original constructions that re-define the science/policy boundaries[6]. In the case of nanotechnology at OECD, we will see that the science/policy boundary is extremely important to maintain, at two levels. First, the "expertise on policy" that OECD WPN is

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[1] Other examples will be analyzed in chapters 3, 4 and 5.
[2] See chapter 1. For an example about "upstream public engagement" see (Wilsdon and Willis, 2004). The prevalence of the public engagement theme does not prevent ambivalences, as this section will make it clear.
[3] There is an emerging literature on the experts of participatory democracy. Jason Chilvers has conducted an analysis of the U.K. "epistemic community" of deliberation and participation (Chilvers, 2008). Magali Nonjon has proposed a sociological analysis of the French experts of participation (Nonjon, 2005; 2006).
[4] Porter, 1996
[5] Jasanoff, 1987
[6] Climate policy is a telling example (Miller, 2001).

expected to provide in order to ensure international cooperation on nanotechnology is distinguished from the "expertise on risk" that another OECD body, the Working Party on Manufactured Nanomaterials (WPMN) focuses on. Second, OECD international expertise is not expected to interfere with national policy choices. In the case of OECD policy expertise, neutrality is the result of working processes involving negotiations among countries and the mobilization of technical skills, which this section will illustrate. It does not have to be taken at face value though. For the production of expertise problematizes nanotechnology and its relationships with "publics" in particular ways, which allocate roles and responsibility among publics and national or international expert bodies. It does so not in the abstract, but through the instruments, like questionnaires and guidelines, on which it is based[1].

Another boundary at OECD WPN separates technologies of democracy from the issues to which they are supposed to be applied. The cases of replication of participation devices on nanotechnology analyzed in the first section of this chapter show that nanotechnology is a trial for these instruments, which then have to be adapted to the specificity of this domain. Therefore, the separation of expertise on technologies of democracy and expertise on nanotechnology should not be considered self-evident, but as the outcome of processes that need to be described. In the case of the OECD WPN, it is the very dynamics of the production of international expertise that ends up separating devices meant to engage the public from the content of the public issues they are expected to address.

In the following, I describe the process of expertise production at OECD WPN. After a short presentation of WPN, I describe the method used to gather information about public engagement in nanotechnology in member countries. I then turn to the production of guidelines expected to describe how to engage the public in nanotechnology. Eventually, I illustrate how boundaries are maintained, between "public engagement" and "nanotechnology" on the one hand, and between "international expertise" and "national policy-making" on the other. The whole process will thus appear to make it easier for approaches that separate expertise on technologies of democracy from the making of nanotechnology to make their way in international arenas.

Producing international expertise about technologies of democracy at OECD WPN

After about a year of discussions of a U.S. proposal to the OECD Committee for Science and Technology Policy (CSTP), in which the most active promoters of nanotechnology in the federal

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[1] Cf. (Lascoumes and Le Galès, 2001) on the instrumentation of public policy, and (Bruno et al, 2006) for an example about the use of benchmark in Europe and the political construction it enacts. One can argue that the mechanisms through which international policy expertise on nanotechnology is produced is itself a technology of democracy, well standardized and replicated on nanotechnology after having been deployed on other topics. This will be discussed at further length in chapters 4 and 5.

administration had been involved[1], a Working Party on Nanotechnology (WPN) was created in March 2007. The WPN "vision"[2] stated that

unlocking the potential (of nanotechnology) will require a responsible and coordinated approach to ensure that potential challenges are being addressed in parallel with the development and use of technology.[3]

WPN supports the "responsible development and use" of nanotechnology. It launched projects devoted to producing expertise on "public engagement in nanotechnology", and thereby became a production site for the expertise about technologies of democracy.

WPN organization follows that of all OECD working parties. The working party is run by a bureau composed of delegates of the most involved countries. Plenary meetings occur at regular intervals. They gather members of the OECD Secretariat, and delegates from member countries active in the working party. Countries may send one or several people to participate in the working party. In November 2008, the email list of the WPN delegates comprised about a hundred names (mostly science policy administrative officials). WPN plenary meetings usually gather about 40 people from about 15 member countries. Each project is run by a steering group composed of a subset of the delegates involved in the working party, as well as members of the Secretariat, and who regularly meet, physically or by teleconferences. Projects may mobilize external experts, especially through workshops hosted by steering group member countries. They are presented and discussed during plenary meetings.

The Secretariat of the WPN was originally composed of Nathalie L.[4] -who was sent by France as a contribution to the WPN, a senior staff member of WPN parent body, and, in later stages, two additional full time OECD policy analysts. Nathalie left the WPN in December 2008. As a French civil servant, I was then offered Nathalie's position. I started to work part-time for the WPN Secretariat in January 2009 and left in October of the same year. The position interested me both as fieldwork and as an opportunity to explore with practitioners the potential articulations of public engagement in nanotechnology. The fact that I was closely involved with OECD WPN was a way for me to access the details of its work. My position indeed allowed a direct access to the work of the WPN and rendered ethnographical work possible. I will show that it also contributed to rendering visible some constraints of the processes of expertise production at OECD that might have otherwise been left un-noticed.

In November 2008, the WPN projects were the following:

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[1] The head of the *National Nanotechnology Initiative* attended the meeting of the OECD Committee for Science and Technology Policy (CSTP) in Seoul in 2006 in which the proposal for OECD work on nanotechnology policy was discussed.

[2] I use quotation marks to indicate excerpts from OECD documents and from notes I took during fieldwork at WPN.

[3] WPN vision statement.

[4] I anonymized the characters of this paper who work at OECD. Nathalie is a fictional name.

Project A	*"Nanotechnology at a glance"*
Project B	*"Business Environment"*
Project C	*"International Cooperation"*
Project D	*"Outreach and Public Engagement"*
Project E	*"Policy Dialogue"*

I will refer to Project D and its followers as the "public engagement project". As a regular OECD project, the Public Engagement Project first gathered information from member countries through questionnaires, then identified "best practices" and produced a set of guidelines, called "Points for Consideration when Planning Public Engagement in Nanotechnology", which were then tested in different countries. Looking at the evolution of the project and the production of expertise it implied will illustrate the ways through which a consensual international form of collective action is produced, at what costs, for what kind of "international publics", and for what type of nanotechnology.

Producing questionnaires – leaving room for multiple public engagements

An initial ladder model of "public engagement"

After the first WPN plenary meeting in May 2007, a steering group for the newly created Public Engagement Project was formed, in which Australia, Belgium, Canada, Denmark, France, Portugal, the Netherlands, the United Kingdom, the United States and the European Commission agreed to participate. The first step of the new Project D was to gather information: sending questionnaires to country delegates was rapidly agreed upon (this is an usual procedure at OECD). At that time, Nathalie had joined the WPN and was put in charge of Project D. The writing of the questionnaire started in November 2007, and circulations of successive versions among members of the steering group and the Secretariat took more than five months. Far from a neutral tool, the questionnaire was crucial to define public engagement. As I detail below, it was an international negotiation issue.

The questionnaire drew a line between "communication", and "public engagement". The first part of the questionnaire addressed "communication campaign", "audience", "teacher training", while the second proposed a definition of "public engagement", which, albeit not explicit, appeared through questions such as the following, quoted from the first version of the questionnaire[1]:

[1] This first version was submitted to the members of the steering group in September 2007.

> *c- Can you describe the main outcomes of public engagement in nanotechnology in your country ? Have the outcomes been used in the planning of science and technology policies in the field? In which ways have they been useful?*

In this initial formulation, public engagement was thus understood as a process that provided "outcomes" expected to be used in the crafting of "science and technology policies". Subsequent versions of the questionnaires added a scale on which the "effectiveness" was measured according to the level of "influence" on policy-making.

> 5.2 On a scale of 1-10 rate how effectively these public engagement activities have influenced policies related to nanotechnology ?
>
> New Legislation, policies and/or guidelines developed — Not Effective
>
> 10 9 8 7 6 5 4 3 2 1

The original questionnaire thus proposed a model of public engagement, in which each mechanism could be assessed according to its position on a scale going from one-way communication of known information to public participation in regulation making. It was written by Nathalie, who, as a law scholar, was "concerned about the integration of the outcomes of these processes into the making of regulation"[1]. As it mirrors Arnstein's "ladder of citizen engagement"[2], I will refer to it as the "ladder model of public engagement". This model is directional: going "up the ladder" means increasing citizens' influence on policy-making, and is thus understood as a better way of organizing democratic life.

The original question about the use of the outcomes was then refined by the U.K. delegation (which by that time, had become the leader of the steering group). It asked, in the last version of the questionnaire, more direct questions about the "implementation" of the "results from your public engagement". Question 5 was originally a yes/no question ("have the results from public engagement initiatives been implemented in policies related to nanotechnology?"), and became, in the final questionnaire, an open one that implied that there should have been some sort of implementation in any case (see illustration below).

> 5- Describe how the results from public engagement initiatives in your country have been implemented in policies related to nanotechnology?
>
> 5.1- Please cite examples of the implementation of these initiatives:

[1] Interview with Nathalie, Paris, October 2008.
[2] Arnstein, 1969

Beyond the ladder model

The exchanges among the members of the steering group made it necessary to reconsider the ladder model. The original question about the use of the outcomes of public engagement was gradually made more complex. It was divided into two, in the final questionnaire:

3. -Describe the main goals of these nanotechnology public engagement initiatives in your country?
4. -Describe the major outcomes and/or key recommendations that emerged from these nanotechnology public engagement initiatives in your country?

At that point the "goals" of the public engagement initiatives were considered uncertain enough to be topics for questions: the influence on policy-making was not the sole and unique goal any more. Consequently, the "results" mentioned in question 5 were not that clear any more. If they were meant, in the original questionnaire written by Nathalie, to refer to recommendations possibly written by panel members after a consensus conferences or a citizens' jury, the "results" as considered in the final question 5, could encompass a much wider meaning – concerning, for instance, lessons learnt about the engagement process itself- after questions 3 and 4 had introduced possibilities for important variety among goals.

The initial questionnaire asked for a description of the public engagement activities undertaken by each country. Members of the steering group felt a need to provide more guidance for delegates to fill out the questionnaire. A table was added to help them answer the questionnaire. The initial table was the following:

Name of the initiative	Hosting institution	Form of the initiative	Main stakeholders involved

It was subsequently refined (final version below)

Scope of the initiative (national, regional, local, in a school, etc…)	Name of the initiative	Hosting institution	Form of the initiative (including the number of people involved)	Main stakeholders involved (as experts or directly involved in the delivery)	Target audience(s) (students, general public, women/men, children (indicate age range), etc…)

The original table asked for the list of the "main stakeholders involved", which was intended to cover all the actors participating in the engagement process. The addition of a column about "audience", and the examples "children, students, general public…", considered that the "public" who, in the ladder model, was expected to contribute to policy-making, was but one among many possible "publics". For instance, "children", sorted out according to their "age range", constituted another public, whose engagement would certainly be different from that of the participating citizen of the ladder model. Hence, the greater attention directed to details allowed the WPN not to limit the questionnaire to the framing of the ladder model.

Questionnaire results: Not too strict a framework for "public engagement"

18 countries replied to the questionnaire[1]. Examples of answers to question 3 (main goals), 4 (outcomes, recommendations) and 5 (implementation of results) of the questionnaire help illustrate how the wording allowed for a variety of interpretations.

	Germany	Korea	U.K.
Question 3 (main goals)	Not answered	to help general public enhance their understanding of nanotechnology and support for national activities initiated by government	To explore and develop various modes of upstream engagement in order to find out how these might assist in the beneficial development of nanotechnologies policy.
Question 4 (key recommendations)	If informed and if interested, citizens are well aware of the chances of nanotechnological approaches (...). But they also do want to be informed about the possible risk (...).	There is positive attitudes on nanotechnology R&D and business activities, however awareness on EHS[2] issues started to appear	(...) There are concerns about the lack of knowledge about the human health and environmental risks (...). (...) There is strong support for fundamental science to arrive at answers to these questions
Question 5 (scale)	7	5	Not answered
Question 5 (implementation)	(...) The BMBF launched the nanoTruck - a mobile information campaign on nanotechnology.	continued increase in public investment on nanotechnology	This remains a challenge for UK policymakers, since processes to date have yielded little in the way of new incisive results which might affect or alter policy.

Korea reported 10 engagement activities, among which "science ambassadors", "science fair", "exhibits", that sought to "enhance the support" of "different audiences", including "kids" and "students". The U.K reported the activities done under the "upstream public engagement"[3] banner (including a citizen jury – like mechanism called *NanoJury*), the objectives of which being that they eventually had "impact on policy" – for still disappointing results according to the U.K. delegate who

[1] The questionnaire was sent to "policy-makers" who were mostly WPN delegates. Consequently, some of those who answered had participated in the crafting of the questionnaire, as members of the Public Engagement Project steering group.
[2] Environmental, Health and Safety.
[3] Upstream public engagement had been advanced in the U.K. as a central concern for the public management of emerging technologies (Wisdon and Willis, 2004).

filled the questionnaire (and could not answer the quantitative question on the impact on policy-making). Germany reported "very effective activities" in so far as "people were interested". As a consequence, the main "implementation of public engagement results" consisted in yet another information diffusion device ("Nanotruck"). Retrospectively, one can see that these three examples defined the problem of public engagement in nanotechnology in different ways. While the UK delegate, in pushing for "upstream public engagement" was close to Nathalie's ladder model, the Korean delegate saw "public engagement" as a set of activities aiming to make sure there was "continuous increase in public investment" by fostering the enthusiasm of the national population. The German delegate framed "public engagement" as a problem of access to information, thereby facing difficulties when people "do not care".

It is clear from the example of the questionnaire that the information gathering process is not just a simple task of collecting information about an unproblematic reality: the questionnaire had to leave enough room in the definition of "public engagement" for all the members of the steering groups, and, more generally, of the WPN to participate in the questionnaire study, and thus be recognized as active players in the field of public engagement in nanotechnology. This implied re-opening framing that defined public engagement in too strict a manner: the initial definition provided by the ladder model had thus to be expanded beyond the requirement of this very model. This expansion manifested itself in the various questions of the final questionnaire. They were crafted in such a way that they could be applied to different understandings of what public engagement in nanotechnology could be, be it a public perception study, a science fair or a process of consultation with NGOs.

Solidifying guidelines

Gathering information was only the first step of the project. In a later process, "best practices" were supposed to be identified in order to produce guidelines about how best to engage the public in nanotechnology. During the April 2008 WPN plenary meeting, a definition of public engagement based on four characteristics was chosen, inspired by the work of British social scientists working on "public engagement in nanotechnology"[1]:

- *Deliberative - emphasising mutual learning and dialogue*;
- *Inclusive - involving a wide range of citizens and groups whose views would not otherwise have a direct bearing on policy deliberation*;
- *Substantive – with topics selected that are appropriate to exchange*; *and*

[1] Rob Doubleday, a British social scientist, provided the definition.

- *Consequential - making a material difference to the governance of nanotechnologies.*

The definition was then used as an overall framework for the whole Public Engagement Project. The original definition was meant to apply to "public engagement, including communication and outreach" in the subsequent documents and reports. Indeed, the distinction between "communication" and "public engagement" that the questionnaire had introduced was not re-stated after its results had been collected, and the guidelines to be written were supposed to deal only with "public engagement". The definition was expected to cover all the mechanisms that the Public Engagement Project dealt with.

Delft Workshop

The crafting of the guidelines occurred during a project workshop that was organized in October 2008 in Delft, in the Netherlands. My first participation to the work of the WPN took place there, since I was invited to speak as an expert sent by the French delegation. Indeed, the workshop was expected to provide expert input to be added to the analysis of the experiences in each country based on the results of the questionnaire. The workshop was organized as follows. The first day was a public event during which speakers (including myself) sent by different member countries gave talks about the status of public engagement in nanotechnology in their countries. It was followed by a one-day closed OECD workshop, in which people sent by their respective national delegations participated[1]. The objective of the second day was to reflect on the initial results from the questionnaire study, and the outcomes of the previous day, in order to start working on the report of the public engagement project and elaborate preliminary guidelines ("broad principles for public engagement processes"), that would then be refined by the Secretariat and the steering group members to become the Points for Consideration.

Presentations made during the first day reflected the diversity of the national experiences as reported through the questionnaire[2]. Two examples will illustrate this diversity. Arie Rip proposed to consider "reflexive governance"[3] as a suitable framework for public engagement, and the possibility for civil society to act as a watchdog, through, for instance, its implication in the making of codes of conduct. The American speaker, a member of the federal office coordinating the activities of the U.S. National Nanotechnology Initiative, of the U.S. delegation to the WPN and of the steering group for the Public Engagement Project, explained that "people are not rational" and behave according to the particular "frames" and "filters" through which they see the world – an unproblematic reality in her

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[1] Some of them were the country delegates to the WPN, others (such as myself) were not. Quotes in this paragraph are excerpts from my fieldwork notebook.

[2] I presented some examples of public dialogue undertaken in France, and spoke of the Ile-de-France *conférence de citoyens*.

[3] A topic Rip, as a STS scholar, has studied in his scholarly work (e.g. Rip, 2006a).

account. For her it was necessary to "train the trainers" in order to study public perceptions, identify the "frames" of particular "audiences", and tailor the discourse accordingly[1].

For all their differences, the various perspectives could be said to fit in the project. In particular, it was possible to apply the definition of public engagement as "deliberative", "inclusive", "substantial" and "consequential" for all of them. For instance, public perception studies were to be made through "dialogues" involving "a wide range of participants" in discussions about "appropriate topics". This work was expected to inform "communication and dialogue strategies". Hence, the public perception understanding of public engagement in nanotechnology could be said to be "deliberative, inclusive, substantive and consequential" as the WPN definition contended. This is of course a different understanding of public engagement than that of Rip, or that of the ladder model described below. Yet WPN definition could be used to encompass this variety.[2]

Nathalie and Jocelyn, the two Secretariat members who participated in the meeting, synthesized the presentations of the first day at the beginning of the second. Nathalie proposed to differentiate between objectives related to "information", "exploration" (of a public issue), and "involvement" (in decision-making). The discussion that followed immediately led to "enlarging the list of objectives". This was "a real need" according to one delegate, and he mentioned "building networks" as an objective to be added. The list could not end there: "we need to add capacity" was restated several times, and remained a mysterious statement until the capacity-fan delegate explained that "public engagement often helps people develop scientific capacity". At that point Nathalie felt compelled to ask whether everyone still agreed with the definition of public engagement as deliberative, inclusive, substantive, and consequential. Being reassured by all the delegates' strong support for this definition, she then showed the new list of objectives on the screen:

information exchanges

policy-making

exploring specific issues

developing scientific capacity

networking

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[1] This is the position of communication scholars like Dietram Scheufele and David Berube, both personally known to the American delegate and cited throughout her presentation. It echoes the perspectives of the NCTF organizers from North Carolina.

[2] Whether the use of this definition is consistent with Doubleday's own "upstream engagement" propositions (Gavelin et al., 2007) is another issue. Remember also that small adjustments to the definition were made (e.g. adding "including communication and outreach") in order to ensure that it could be used by the project.

Then what about "evaluating and monitoring"? Wasn't it necessary to add something on this, which, over the course of the discussion, referred alternatively to "getting feedbacks from the public" and "knowing what public attitudes are"? It was indeed, and Nathalie added a line on her list. The discussion then followed with examinations of potential "points to consider" suggested by Nathalie. They comprised "audience", "type of process", and "outcomes". "Context" was then added to the list, and the different items were discussed. For instance, questions about "audience" were expected to include considerations about "age, sex, receptive or not receptive character".

A description like this cannot pretend to be exhaustive. Yet it does give a sense of how OECD expertise on public engagement in nanotechnology was produced, that is, through a process of informal collection of bits of expert advice from the first day workshop, information gathered from questionnaires, the personal experience of country delegates, and interventions from the Secretariat.

Points for Consideration

The workshop report restated the elements exchanged during the discussion among delegates, and thereby stabilized a set of guidelines, named "points for consideration", which were supposed to be used "when planning public engagement in nanotechnology". The December 2008 report of the project provided a first version of these guidelines, divided into 7 points for consideration. They were the following: "identify the context", "be clear about your objective(s)", "plan the process", "select the activity", "identify the organizers", "know your goals / recognize success" and "learn and adapt". Below is an example (point n°2 "Be clear about your objective") taken from the Points for consideration document proposed at the November 2008 plenary meeting, in which the content of the discussion at Delft can be identified:

Objective	Examples of questions
Communication about nanotechnology, its application and impacts	**Is your aim:** Information exchange, exchange of experiences / good practices around nanotechnology and current developments, understanding opinions, exploring a specific aspect of nanotechnology, other?
Monitoring or evaluation	**Are you engaging in:** Monitoring of public attitudes to nanotechnology; evaluation of an awareness-raising campaign; counting audience figures (e.g. TV), other?
Exploration of a specific issue	**Is your need for:** Debate on a scientific issue or application of nanotechnology to a sector or issue (e.g. nanomedicine, nano and energy, nano and food), other?
Developing capacities	**Are you seeking to develop:** Capacities in science and innovation, networking capacity? Other?
Achieving a specific goal	**Is your target:** Achieving a specific level of knowledge amongst the target group, benefiting from local knowledge exchange, developing or implementing a new practice, gathering views on a proposal or initiative e.g. gathering public input for policy-making)?
Others	

At this point the Points for Consideration were mostly solidified. It was by this time that I replaced Nathalie at the Secretariat. I experienced directly the solidification of the *Points*. As I wanted to change some of them, or add new ones, I was quickly reminded by my colleagues that the *Points* had been agreed upon by all members of the steering group after the Delft meeting, and then approved by all delegates during the November 2008 plenary meeting: the *Points* could not be modified. Yet discussions still occurred among members of the steering groups to make sure that public engagement as it emerged from the Points for Consideration could indeed encompass the variety of national experiences. For instance, a teleconference in March 2009 concluded that

the definition of public engagement emphasizes two-way processes, but the beginning of the point for consideration document is more focused on informational, one-way processes. The document should be used for different types of public engagement activity.[1]

To restore the balance, examples were added at the end of the Points for Consideration document to show how the guidelines could work. To an example provided by Australia about a process called *"Forum"* made of a series of public meetings on nanotechnology issues was added a case study about science shops. The Irish delegate added it as

[1] Quotes from my personal notes.

This methodology has more of a 'bottom up' approach, where publics actively ask questions (...), (and) want to be more involved in the processes of knowledge production.[1].

Both cases were used as examples at the end of the Points for Consideration to show how the boxes could be filled in[2]. The Points were thus proved to "work" since they could accommodate various experiences and still apply the common definition of public engagement to them.

Constructing international expertise on public engagement

As the Public Engagement Project evolved, the WPN needed to accommodate the perspectives of its different member countries. So the simple models that were proposed to make sense of public engagement - the ladder model (in the questionnaire), or the separation between information, exploration, and involvement (during the Delft workshop) - needed to be made more complex. Thus, the process of knowledge generation about public engagement in nanotechnology needed to make sure all activities potentially connecting "nanotechnology" and "the public" would be taken into account. This was done through a complex process during which the Secretariat members framed the possibilities for the intervention of national delegates (by, for instance, providing a quantitative description of the "impacts on policy making", or initial "points to consider" to be used as a starting point for the discussion among delegates), national experiences that might have appeared contradictory were brought together through a questionnaire or in the process of guidelines writings, and details and refinements were proposed for all potential definitions of public engagement in nanotechnology to fit in. The process required careful crafting and active involvement of all steering group members, in order to encompass multiple technologies of "public engagement". The definition of public engagement as "deliberative, inclusive, substantive and consequential" was interesting for that matter since it allowed both to maintain a common identity for the project and the variations of the understanding of it across member countries. Yet there were also demarcations that needed to be maintained in order to produce an expertise that would hold value as that of the international organization.

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[1] Email sent by the Irish delegate.

[2] Empty tables were provided at the end of the *Points for consideration* document, which were supposed to be completed by policy makers according to the questions proposed for each of the *Points.*

Stabilizing demarcations – Producing objective international expertise

<u>*Demarcating between technical and political expertise*</u>

The Points for Consideration were meant to be addressed to policy-makers involved in the planning of public engagement in nanotechnology rather than any other random public issue. The specificity of nanotechnology had been a concern at the early stage of WPN: that "public perceptions have been lagging behind"[1] in nanotechnology was one of the reasons for which the work on "public engagement" was so important. The questionnaire was sent to national actors involved in public engagement in nanotechnology, and asked many questions about the technologies of participation they used, but did not request information about nanotechnology issues. The Points for Considerations mentioned nanotechnology twice, in the "context" point, when it asked:

"how is nanotechnology impacting on your society (if at all)? Is nanotechnology being widely discussed in your country?"

These questions did not interrogate the content of nanotechnology public issues.

The little consideration for nanotechnology technical issues was not incidental. At OECD, there is another Working Party specialized in nanotechnology, the Working Party on Manufactured Nanomaterials (WPMN)[2]. The separation of work between the two was to be carefully maintained, and this transpired in the everyday work practice of WPN. As I was involved in the activities of WPN, I experienced this directly. As I will describe, my lack of experience about the work at OECD forced the WPN secretariat members to make the principles grounding their work explicit.

At the November 2008 WPN plenary meeting, Austria proposed to host a round-table that would aim to identify "governance frameworks" for nanotechnology. The link with the Public Engagement Project was clear for Clement G., the member of the Austrian delegation who proposed to organize the round-table. A member of the Technology Assessment Institute in Vienna, he had been participating in a project called "NanoTrust" that seeks to establish consistent "risk governance" of nanotechnology through a variety of devices, including "a platform of dialogues with NGOs", and "dossiers" that provided information on topics such as "nano in food" or "nano in health".

For some members of the national delegations, such an initiative appeared as an opportunity to reflect on "new governance models". The French delegation, for instance, repeatedly insisted on the need to push for the integration of publics' perspectives in nanotechnology policy-making. Nathalie's

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[1] Excerpt from the preparatory document of a meeting held in Amsterdam in February 2007.
[2] I will get back to the WPMN in the next chapter.

ladder model, for that matter, had been very well received by the head of the French delegation, for whom the "actual integration of public engagement into nanotechnology policy-making" mattered the most. She had been a member of the organizing committee of the Ile-de-France *conference de citoyens*, and considered that the CNDP national debate was a step in the direction of the "integration" of public engagement in nanotechnology policy-making. Other initiatives taken in France for the "collective governance of nanotechnology's risks" also followed the direction of the "new governance". Chapters 5 and 7 will provide some details about these mechanisms. At this point, suffice it to notice that the French delegation was very much in favor of initiatives that connected the expertise about public engagement and the expertise about risks, and backed the Austrian proposition.

The organization of the roundtable was to be done by the Technology Assessment Institute and the WPN. As I was interested in the topic, I was involved in the organization of the roundtable for the WPN, and thus worked with Clement to refine the agenda. Following a suggestion from my part, the focus of the roundtable was defined as "policy-making in uncertainty"[1]. The draft agenda proposed "parallel sessions" on "policy instruments for dealing with nanotechnology risks", namely "codes of conduct", "voluntary measures for the industry" and "participatory models and inclusion of lay people in regulatory processes". The example of a specific nanoparticle ("possibly nano-silver") was to be considered to provide illustrations of "risk governance in context of uncertainty".

The agenda was not satisfactory for the WPN, because of the repartition of work between WPN and the Working Party on Manufactured Nanomaterials (WPMN). Hence, a distinction that my colleague Jocelyn was concerned about, and that the risk governance round-table was on the verge of ignoring: "WPMN does risks, and we do policy". Indeed, a senior staff member commented on the draft agenda quoted above and criticized it: it considered "risks and not benefits" and mixed up "science and policy". Jocelyn and I were then summoned to a meeting with him, during which he explained:

"The mandate is clear: WPN does policy. We develop policy and benchmarks that ensure the responsible development of nanotechnology. WPMN does technical work. It asks whether the regulatory system is functioning for nanotechnology."

Therefore, any hint that nanotechnology risks would be looked at during the risk governance round-table would be suspicious. It would threaten to shake the institutional repartition of work, and bring the Secretariat on the verge of going beyond its mandate. What was to be done then?

"You can't do a meeting with nanotech risks. What you can do is governance. What are we trying to do ? What are the governance tools ?"

[1] The quotes in this paragraph are excerpts from a draft version of the round-table agenda.

Hence, the solution: as "policy instruments in uncertainty" threatened to cross the line between technical examinations of risks and work on policy options, "governance" would be an appropriate framework. Consequently, the WPN round-table was eventually organized as a workshop on "communicating knowledge – communicating uncertainty"[1], which examined "the path from risk assessment to risk management" in the first parallel session. "Participatory processes" and "voluntary measures" were still topics for discussion in two other sessions, yet on condition that "it (was) not nanotech risks that were talked about". As a consequence, neither the "participatory processes" nor the "voluntary measures" to be examined would potentially intervene in the definition of nanotechnology risks.

This episode can be considered as a breaching experiment, rendering visible what was otherwise so much inscribed in everyday work practice that it did not have to be made explicit. This is a case where my active involvement with the actors I was studying provoked a re-stabilization of central principles of collective action. Here, my contribution to the work of WPN could not be accepted, and I had eventually to get back to a "descriptive" position, from which I could analyze OECD initiatives without transforming them. This is not the only type of interactions with the actors being studied: the following chapters will provide examples of different forms of research engagement.

The risk governance roundtable made explicit the boundary between WPN and WPMN, between expertise on risks and expertise on policy. There were other situations where similar "breaching processes" forced OECD staff to re-stabilize this boundary. Thus, a member of the French delegation proposed during a WPMN plenary meeting to inquire into "the possibility of a governance framework for nanomaterials risk prevention" and consider the "integration of stakeholders". The proposal did not receive any approval. Indeed, it appeared to be "policy expertise", and, as such, fell "within the area of expertise of the WPN" as it was later said by the Secretariat. French actors multiplied the propositions within WPN and WPMN that threatened to displace the science/policy boundary on which the work of the international organization was based: they were constantly rejected by the secretariat. For maintaining the demarcation between technical and political expertise is necessary for nanotechnology to be dealt with by the OECD: "risks" are dealt with by the WPMN, "policy" by the WPN. Eventually, nanotechnology expertise at OECD needs to be demarcated as "technical" and "policy" to ensure that the organization can indeed produce it. Attempts to blur this demarcation by delegates (such as the WPN Austrian delegate, or the French WPMN ones) or misbehaving members of the Secretariat (like myself) thus imply additional work to make sure that it is maintained, and that delegates and staff members behave properly.

[1] Quotes in this paragraph are excerpts from the final version of the roundtable agenda.

Linking "public engagement" with the examination of nanotechnology's potential risks prevents from separating policy expertise from technical examination. Thus, attempts to do so at WPN were eliminated in favor of approaches that did ensure the separation of expertise on technologies of democracy from expertise on nanotechnology. This, however, was a contingent choice and the result of the purification work of the international organization.

<u>Demarcating between policy expertise and normative judgment</u>

The science/policy demarcation is not the only boundary WPN needs to enforce, for the OECD expertise also needs to demarcate its international expertise from the national initiatives and choices. The risk governance round-table incident had another dimension for that matter, since the original focus proved to imply that regulation was necessary. And that was problematic since

It's not our job to regulate EHS (Environment, Health and Safety) *or to stop bad guys getting access to the technology or don't do EHS issues.*[1]

Hence, distinguishing between "policy expertise" and "normative statement" was a key concern. While the former was indeed the core of the WPN activity, the latter was clearly beyond the scope of its mandate.

In the Public Engagement Project, it was important "not to be judgmental" about what the country delegates might propose – even if their contributions might have contradicted the overall definitions agreed upon by members of the steering group (e.g. in the questionnaires, or, later, the definition of public engagement as "inclusive, deliberative, substantial and consequential"). Stabilizing the boundary between WPN "policy expertise" and "normative statements" made it difficult to deal with the issue of the evaluation of public engagement activities. The evaluation to be done was that of the Points for Consideration, i.e. the methodology, and not that of the engagement mechanisms themselves. Keeping the evaluation of public engagement at bay allowed the WPN to consider, as it was repeatedly said in meetings and written in reports, that "there is no right answer", that "a lot depends on national context", that "cultural contexts do matter". Thus, the expertise of the WPN could not pretend to propose definite statements about how to do public engagement in nanotechnology. The WPN was to be "objective" in that it could not favor one (national) definition of public engagement over another

[1] Excerpts from the notes I took during the discussion with the head of OECD Committee for Science and Technology Policy.

one[1]. The objectivity at stake here is that of the international organization: it is not supposed to adopt one national viewpoint rather than others, and, as a consequence, should abstain from judging national situations – which could be considered as attempts to interfere with countries' sovereignty.

This did not prevent the evaluation issue of regularly popping up at WPN in discussions among delegates, in emails and written reports[2]. Yet each time it surfaced, the Secretariat was attentive to making it clear that it was "not the main point of WPN work". In providing these precisions, the Secretariat made use of a "template" (see example below) meant to evaluate the "usefulness of the Points for Consideration", and not, "the engagement methodologies themselves". In fact, as Jocelyn explained to me, "we don't care if particular mechanisms work or not, we want to check if the methodology (i.e. the Points for Consideration) is useful", in order to refine them if needed.

E. Select the activity **The examples of questions helped me…**		Ranking				
		1	2	3	4	5
Identify possible activities						
Select between activities						
Decide on the activity						
Other (please state)						

The "template" was constructed as a device aimed to ensure that the demarcation between policy expertise and "normative statements" was maintained. It shifted the objective of the Public Engagement Project from an initial "how best to engage the public?" to a more complex "what are the questions to ask in order to plan a mechanism that aims to engage the public, whatever that mechanism might be?". The last expression is the product of my own effort to render explicit the position of the Public Engagement Project at its testing stage. This was not a position that delegates understood clearly, yet whereas the Secretariat never attempted to discriminate among forms of "public engagement", it did react to perturbations introduced by delegates to make sure the demarcations of WPN expertise were maintained. Therefore, the Secretariat could ensure that WPN expertise would not interfere with national policy-making – which it would have, had it chosen to use the ladder model as an evaluation device of national public engagement initiatives.

[1] One could make the same argument for the WPMN, in which country delegates were keen "not to say that particular legislations are better than others" (quotes from a WPMN plenary meeting).

[2] E.g. the following email, sent by a member of the steering group: "Should the third dot point below include evaluation along with monitoring and benchmarking?(...) I like the fact you've clarified that you're seeking to evaluate the method, not the activity, but at the back of my mind there are also all the examples of things that were great policy outcomes at the time - but not so great when finally put into practice (deregulating banks and the loans industry, GMOs, food irradiation...)"

Constructing international expertise, problematizing nanotechnology

The Points for Consideration were sent to all delegations for them to apply them to local exercises. They had to report on existing experience using the tables present for each of the Points. The person in charge of a website called *Nano & Me* (addressed to consumers) filled in the tables for the U.K. delegation. The Irish delegates used a previously held series of public meetings at a university. Some of those who used the Points in the early stages of the process remarked that "they really made (them) think about the process", and others said that they "were useful in raising relevant issues": that the Points for Consideration were useful could be then written in the minutes of one of the teleconferences, and later restated during the WPN plenary meeting.

At a later stage, the Points were to be tested in a number of voluntary countries. The final list of engagement activities to which the Points were to be applied comprised the French CNDP national public debate, the UK Nano & Me website, a series of Australian "public engagement activities" (e.g. "booths at public shows, discussions with scientists at community club meetings, online forums and engaging scientists with the public in scenario planning"), and six South African activities (such as "career profiling", "nanotechnology exhibits" and "science cafés", all aimed to "cultivate and stimulate interest in nanotechnology").

Thus, the construction of "international public engagement" was to be made separate from the work about risks and technical issues. The mobilization of the "international public" was to be that of a collection of various national publics separated from one another. The necessary ambiguity about it had as a counterpart: the impossibility to talk about nano substances and their risks, the construction of a "problem of the public" separated from other problems related to nanotechnology objects, futures and concerns. Thus, international public engagement in nanotechnology was more than the mere addition of national initiatives gathered together by virtue of ambiguous enough definitions: certain problematizations of nanotechnology and the public could be more or less easily heard. Indeed, conceiving the role of "public engagement" as based on the study of public perception according to different "frames" of interpretation – which was the position the U.S. delegation proposed within WPN – could fit in easily with the boundaries the work of WPN was based upon: it separated "nanotechnology" from the perception by various "publics", and thus a technical expertise from a political expertise. It could be presented as an at-a-distance expertise, which would not evaluate national political choices but would do nothing but "describe" what the opinions were in the various countries, according to various criteria. By contrast, the French insistence on "reflexive governance", of the inclusion of publics in the very making of risk regulation fitted less easily. The first reduced nanotechnology to a problem of representation at a distance. The second could not be heard and was not articulated in other ways than Nathalie's ladder model, and, later, through isolated propositions made by members of the French delegation. The constraints of the international organization and the boundaries it needed to enact made some technologies of democracy easier to be considered as legitimate objects of international policy expertise - those based on the representation of unproblematic nanotechnology and stable social groups – while also eliminating others.

Consequently, it is less the "influence" of the expert body that is worth examining than the very process of expertise production[1]. For the internal organization and the constraints of international negotiation determine the type of expertise that can be produced, and, consequently, the problematization of nanotechnology and its publics that are enacted. Thus, the constraints of the production of international expertise favored the technologies of democracy that were based on the separation between the devices and the topics to which they were expected to be applied. This means that problematizing nanotechnology in terms of the evaluation and management of public perceptions of uncontested technical realities was the most stable outcome of the process of expertise production at the OECD WPN. The international expertise on technologies of democracy was not the addition of national expertise but problematized nanotechnology in specific and "international" ways, which prevented from connecting public engagement with the actual making of nanotechnology objects, futures and concerns.

[1] Vincent Gayon made this point in a recent study about the production of expertise at OECD in labor policy (Gayon, 2009).

Conclusion: Stabilizing technologies of democracy, representing nanotechnology at a distance

This chapter has described several attempts at stabilizing technologies of democracy, through the circulation and replication of a single model (the consensus conference), or through the production of international expertise about public engagement in nanotechnology (which produces another international space, different from the one made of the circulation of the consensus conference model). In all these examples, we encountered processes that are meant to separate technologies of democracy from the issue to which they are supposed to be applied. They are all related to the production and stabilization of expertise, and, consequently, to the separation between the expertise on technologies of democracy and the expertise on nanotechnology. In the cases of the replication of technologies of democracy that I described in the first section, the organizers of consensus conferences and public debate mechanisms attempt to re-mobilize their expertise on nanotechnology. The standardization of policy expertise on nanotechnology described in section 2 could have redefined the type of expertise on technologies of democracy. The example of WPN, however, can be read as a failure to produce a specific expertise on "public engagement in nanotechnology": what was produced was an expertise on "public engagement" which happened to be mobilized on nanotechnology.

This chapter has also described different constructions of democratic orders, some of them based on an expertise about technologies of democracy meant to be independent of the issues to which they are applied, others specifically tailored to nanotechnology. Following the discussion introduced in chapter 1, "democratic order" has referred to outcome of the organization of oppositions about nanotechnology and/or its publics. In the American consensus conferences, deliberation is a way of countering oppositions among social groups, or (within the empowerment argument) a basis for social mobilization. In France, the oppositions among panel members on the one hand, between the panel and the experts on the other, are mediated by specialists of a procedure producing uncertain outcomes. At OECD, the oppositions among national perspectives are dealt with through the constitution of an international expertise based on boundaries between "science" and "policy", and between "international expertise" and "sovereign decisions"[1].

Then, the question is about the normative charge of the analysis. Is it necessary to "choose" among these versions of democratic organization? Many of the actors encountered in this chapter contrast an "ideal" of democracy with its practical realization. For example, the proponents of the ladder model at OECD WPN evaluate the proximity to the ideal of actual integration of publics in decision-making processes. The critical co-organizers of the NCTF explored the ways in which web-based tools,

[1] The boundary work between "science" and "policy" is also important in risk management, particularly in the U.S. (Jasanoff, 1987). Other examples in chapter 4 and 5 will show that it is indeed central in the work of the international bodies working on nanotechnology.

the selection of and the financial incentives for panel members could be tuned in order to ensure a deliberation that could "empower" participants[1]. Accordingly, both groups question the ways and means through which the gap between the ideal and the realization can be reduced.

My perspective has been different. I have not considered "ideals" separated from the actual construction of democratic orders, but described the problematizations of nanotechnology and its publics as enacted in the practical conduct of consensus conferences and in the production of international expertise about public engagement. This also means that it is not possible anymore to mobilize an external criterion to "choose" what versions of democratic organization would be the most relevant. But this does not mean that the analysis has no political value. Indeed, it renders visible the alternatives that the stabilization of the separation between technologies of democracy and nanotechnology eliminates, such as (in the case of the replication of the consensus conference) the "quality citizen" advocated by one of the members of the organizing committee of the Ile-de-France *conférence de citoyens*, the mobilized stakeholders of the Wisconsin conference, or (in the case of the expertise production at OECD) the French reflexive governance model. In the examples considered in this chapter, these alternatives are eventually excluded: consensus conferences are replicated, and the international expertise reproduces the science/policy boundaries on which the work at OECD is based. But the investments needed to stabilize the separation provide room for critique. The alternate constructions are articulated in the cracks and gaps that this stabilization work needs to overcome. This is the result of the intervention of both the actors and the analyst. My involvement in OECD, for that matter, is a sign of such an intervention, but the descriptive position in the other examples is not different, in that it also renders visible the alternate constructions[2].

We saw that the uncertainty about the very existence of products and programs of nanotechnology rendered the replication of technologies of democracy and the construction of expertise about them more complex. Organizers of consensus conferences and public debates were uncertain about what was to be represented. The identification of consumer products containing nanotechnology objects proved extremely complex, as did that of the future evolutions of the field. Delegates at OECD WPN were tempted to consider the uncertainties inherent to the evaluation of the risks of nano substances, but had to limit their investigation to a "policy" expertise that could not explore the making of nanotechnology objects, futures and concerns. In the case analyzed here, the arrangements that emerge from technologies of democracy do not connect the making of objects and futures with that of concerns and publics. This is not automatically linked to the focus on representation. Indeed, the previous chapter showed that science museums organize connections between the making of publics and

[1] Cf. (Delborne et al., 2009) for a discussion of and recommendations about online deliberation, and (Kleinman et al., 2008) for a similar approach about participation incentives. (Kleinman et al., 2011) is a discussion of the gaps between the "imagined" and the "actual" participants in consensus conferences, using the example of the NCTF.
[2] I will get back to this point in chapter 8.

that of objects (in the French case), or programs (in the European one). But it compels us to empirically explore technologies of democracy that are not meant to produce a separation between "nanotechnology" and "publics", but construct other types of boundaries, specific to the case of nanotechnology. These technologies will be studied in part II of the dissertation. They comprise devices meant to distinguish "nano" from "non nano" substances, "nano" from "non nano" products, and to define the future evolutions of nanotechnology in "responsible" manners.

PART II. ADMINISTRATING NANOTECHNOLOGY.

Defining existences with technologies of democracy.

The first part of the dissertation has analyzed processes of representation undertaken in science museums and participatory mechanisms. Nanotechnology challenges the exercise of representation. Science museum staff and experts in participatory procedures need additional investments in order to stabilize the representation of nanotechnology, and of the visitors and citizens they attempt to engage. In all cases, the separation between nanotechnology and technologies of democracy is not a given. Rather, it is negotiated according to the particularities of the situations. Whether in some cases, the two conflate in a single representational system (as in French science museums), they are carefully separated by European science policy officials advocating the "scientific understanding of the public", American experts of "informal science education", specialists of consensus conferences, and international experts of "public engagement". Accordingly, the relationships with the construction of nanotechnology's objects and futures vary. To take examples from chapter 2, French science museums make visitors construct their own material representation of nanotechnology. The opinion of science museums' visitors is supposed to be taken into account for the making of European science policy. In the U.S., the individual responsible citizen is expected to be educated, through specific expertise in informal science education, about the necessary developments of nanotechnology.

The circulation of technologies of democracy and their stabilization in European and American sites produce consistent spaces defined by public problems and allocations of roles for citizens and experts. The international space that the OECD "policy expertise" produces is based on the separation between "science" and "expertise", deemed necessary to reach international consensus. Accordingly, it is a space in which the public can do nothing but perceive more or less exactly the unquestioned development of nanotechnology. The European science policy offices concerned with the communication of nanotechnology consider that a "European public" is to be constructed, who, once properly represented, could have a say in the making of nanotechnology policy.

The two previous chapters have linked the making of representations with that of nanotechnology itself. In the second part of this dissertation, I pursue this exploration further by analyzing technologies of democracy that are meant to construct nanotechnology objects, concerns and futures, while managing the public problems they cause. In the case of nanotechnology, the management of public problems goes with the construction of the domain itself. Thus, I will consider some sites where the existence of nanotechnology is specifically dealt with, while the domain is considered an issue for the collective administration of science. I focus on the construction of chemicals defined as "nano" – which I label "nano substances" (chapter 4), consumer goods defined as "nano" – which I label "nano products" (chapter 5), and "responsible futures" of nanotechnology (chapter 6).

The material production of substances and products occurs in private and public laboratories. Chapter 4 will begin with the case of a French producer of carbon nanotubes, and will display the multiple links between industrial strategies, national policy-making, and the management of public concerns. But the existence of the objects of nanotechnology is also problematized elsewhere: in US legal initiatives, in international organizations, and in national regulatory and standardization bodies. These discussions mobilize technical knowledge and international negotiations. They enact modes of collective organization at the same time as they define the problems of nanotechnology, the ways of collectively dealing with them, the material existence of its objects, and its future evolutions. Accordingly, I will explore the ways in which the definitions of nano objects and futures are inscribed in science policy programs, and integrate strategies for the management of public concerns.

My interest in this second part is for a large part about the making of a public policy about nanotechnology. This pursues the concern of political science for public administration, the evolution of public problems, and administrative action. It considers the mobilization of expertise and its uses in administrative circles. Considering the scope of the democratic activities I chose (defining problematizations, managing their diversity), I consider that democracy is at stake in standardization organizations or regulatory bodies. But an important point lies in the "public" character of the initiatives I will consider. Some of them, like public policy research programs, are initiated by public bodies, whether national or European. Others are undertaken by private companies wishing to demonstrate their ability to contain the objects they produce, or by civil society organizations challenging public administrations in legal arenas. The picture gets even more complex as many of the initiatives that attempt to collectively deal with nanotechnology substances, products and futures are of a hybrid nature. Consider for instance the case of standardization organizations, which will interest me in chapters 4 and 5. The International Organization for Standardization (ISO), as well as the Comité Européen de Normalisation (CEN), are private bodies, gathering national standardization organizations. Yet policy-makers actively participate in their work, intervene in the formulation of their main objectives and in the details of the conduct of their projects. Therefore, the nature of the "public initiatives" that this second part will consider cannot be strictly defined beforehand. Describing the making of nano substances, chapter 4 will consider the example of a private company, legal discussions in the U.S., and definition attempts at ISO. These three cases will display tight links between national policy-making, industrial strategies, and the management of public concerns. Chapter 5, focusing on the definition of nano products, will pursue the examination of the construction of nanotechnology at ISO, and contrast it with European and French experiments in which public and private actors are involved. Chapter 6 will examine the making of responsible futures for nanotechnology in American and European science policy offices and social science research centers. In these three chapters, I will explore problematizations of nanotechnology undertaken in sites where public and private, national and international actors gather.

The problematizations of nanotechnology I will describe are enacted through technologies of democracy that define public concerns, "nano" objects and future evolutions of nanotechnology, while allocating roles for public and private actors. From a discussion about the objects and futures of nanotechnology, they draw regulatory and market spaces for nanotechnology. I examined in the previous part the investments necessary to ensure the separation between "technologies of democracy" and a "nanotechnology" they are supposed to represent. The challenge, here, is not the same. The experts in charge are much willing to consider nanotechnology a specific case, and do not consider that the main task is to replicate a device that would be valuable because of its ability to circulate from other technical domains to nanotechnology. Rather, they undertake an explicit ontological role that consists in making safe and marketable nanotechnology objects, and responsible nanotechnology programs for future evolutions. The question of nanotechnology's novelty can then be examined according to its negotiations. How to construct differences between what is "nano" and what is not? How to define programs that will ensure that nanotechnology is "responsible"? Analyzing the answers to these questions will shed light on technologies of democracy that reproduce previous ones and/or integrate "nano-specific" displacements.

CHAPITRE 4 : NANO OU NON NANO ? TRACER DES FRONTIERES PARMI DES SUBSTANCES CHIMIQUES

La première partie de la thèse s'est penchée sur des opérations de mise à distance des nanotechnologies visant à assurer leur représentation. Ont ainsi été décrites des technologies de démocratie dont la particularité est d'être distinctes des nanotechnologies, et dont les productions distinguent la production des publics de celle des objets et des futurs des nanotechnologies. La seconde partie de la thèse se penche sur la construction de l'identité « nano » des substances chimiques et des produits de consommation, puis sur la fabrication de futurs « responsables » pour le développement du domaine. Le chapitre 4 s'intéresse aux façons d'assurer la gestion des risques potentiels des substances « nano » et, par là même, de définir le caractère « nano » lui-même. La première section décrit un processus de production de nanotubes de carbone. Elle utilise cette exemple pour montrer que les nanotubes sont potentiellement tous différents, et que leur spécificité « nano » est loin d'être évidente. Dans ce cas, une solution de confinement matériel et discursif permet à l'industriel de contrôler les substances. D'autres cas apparaissent plus complexe. Ainsi, les nanoparticules d'argent sont des objets pour lesquels le confinement n'est pas possible. Une controverse américaine relative à l'existence ou à la non existence du « nano argent » (est-il ou non réductible aux ions argent, qui sont eux bien connus ?) met en évidence un mode de traitement du problème du caractère « nano » des substances fondé sur les oppositions entre « parties prenantes » et traité par le recours à la « bonne science » censée répondre, dans un futur hypothétique, aux incertitudes.

La question de l'existence « nano » des substances chimiques peut parfois être évitée (si le confinement est possible) ; elle est parfois traitée par le biais des confrontations juridiques entre parties prenantes. La seconde section du chapitre se penche sur les arènes de normalisation des substances « nano » et met au jour des opérations produisant à la fois un ordre international pour la décision technique, et des définitions du caractère « nano » des substances. Le terrain principal est celui du comité technique de l'International Standardization Organization (ISO) consacré aux nanotechnologies. Au sein de ce comité (le TC229), la définition de « l'échelle nano », puis des « nano-objets » a donné lieu à des échanges nombreux entre les délégués. Il apparaît ainsi que les définitions fondées sur un critère de taille permettent de faire tenir un ordre international fondé sur la séparation entre l'expertise technique et la décision politique nationale. Ce n'est pas le cas des définitions fondées sur les propriétés (notamment toxicologiques) des substances, qui échouent à mobiliser une instrumentation technique suffisante et menacent de faire vaciller les frontières nécessaires à la production du standard international. Le cas de l'ISO permet également de mettre au jour des tentatives de définition relationnelle des substances nano (fondées, par exemple, sur les substances « nano » avec leurs équivalents « non nano »). Enfin, il est contrasté avec celui du Working Party on Manufactured Nanomaterials (WPMN) de l'OCDE, où le même impératif de production d'une expertise internationale distincte des choix politiques nationaux s'appuie sur le choix de matériaux de référence produit par des entreprises. La négociation internationale prend alors pour objet le choix de ces références, et articulent décisions stratégiques des entreprises et programmes nationaux de politique publique.

Chapter 4: Nano or not nano? Drawing boundaries among substances

Dealing with nano substances

The development and commercialization of new materials are important components of nanotechnology programs. Many substances are mentioned in nanotechnology policy documents: the American National Nanotechnology Initiative (NNI) insisted from its inception on fullerenes (carbon atoms, football-shaped compounds), carbon nanotubes (carbon fibers with nanoscale diameter), metallic nanoparticles (gold, silver, manganese,…), nano titanium dioxide and iron dioxide. Throughout the explorations that eventually led to the construction of national programs supporting nanotechnologies, such substances – "nano substances" - were promised to be used to develop multiple applications. As a first step in Roco's roadmap of nanotechnology federal programs (see chapter 1), the development of nanomaterials comprises processes and products that industrialists have known for years, as well as new processes experimented in the laboratory, and new uses based on properties linked to the size of the materials components. Science policy reports thus insist on the "enhanced properties" of nano-size materials. For instance, the "nano" properties of carbon nanotubes would make them interesting for the production of lighter, and more resistant materials, self-cleaning paints, and tracking devices for medical imaging. In turn, the potential health and safety effects of these substances raised public concerns: nano substances having "enhanced" reactivity could well have "enhanced" toxicity as well.

Having in common their reduced sizes, nano substances have nonetheless uncertain identities. They are as much objects of science policy (the "first step" of nanotechnology programs' roadmaps) as a set of material substances with properties linked, in one way or another, to size. A report of the American Environmental Protection Agency lists some examples of "size-dependent, novel or enhanced properties" of nano substances:

- *Surface area that is dramatically increased in comparison to the bulk material.*
- *Reactivity that dramatically differs from the molecular or bulk material*
- *Solubility or suspend-ability that differs dramatically in comparison to molecular or bulk material*
- *Absorption, transmission, emission, and/or fluorescence spectra that differ substantially in wavelengths and/or intensity from the molecular or bulk material*
- *Paramagnetism*
- *Ability to cross typical physiological barriers, such as skin, blood-brain barrier, placenta, and cell membranes*
- *Toxicity that differs from the bulk material*

- *Characteristics (e.g., strength, absorption of light) of a macroscale material (e.g., composite) that differ markedly when it is made from the nanoscale material.*[1]

So if the "nano-ness" of nano substances is, at first sight, related to size, many other chemical and physical properties are potentially different from their non nano counterpart. For instance, the "nano" version of a given material has a higher specific surface area, that is, a higher reactivity[2], which could imply enhanced toxicological properties. Specific surface area could then be used as a criterion to define "nano-ness", if "nano-ness" is to be related to reactivity and toxicological effects. But what about the other properties? And how to standardize the measurement methods? This "ontological uncertainty"[3] of nano substances (which the chapter will characterize at further length) implies that no *a priori* chemical identity can be assumed. This is the reason why I use the expression "nano substances" to denote the substances I am interested in, rather than "nanomaterials" or "nano objects", which are themselves controversial terms as this chapter will make it clear.

The chapter argues that dealing with nano substances implies defining material existences. This requires working on metrology, characterization and classification in order to differentiate nano from "non nano" substances. The first section of the chapter[4] describes cases where the ontological uncertainty about nano substances is explored and dealt with, in ways that either manage to move away from the need to define existences for nano substances, or are structured by a binary opposition (the substance exists / does not exist). In some cases, it is possible to ignore the uncertainties about the existence of nano substances by maintaining a tight (material, legal, rhetorical) control over them. The first case presented in section 1 of the chapter illustrates how a private company encounters the uncertainty about the existence of carbon nanotubes, and managed to control them. But control is not always possible. The controversy about silver nano in the U.S., analyzed at a later time in section 1, shows that legal confrontations and calls to expert science compete in order to define the substances. A common point of these cases is that all the actors involved call for standards and norms. The second section of the chapter shows that the existence of nano substances is discussed in international arenas, such as ISO and OECD, through the making of international standards. ISO and OECD attempt to draw boundaries between "nano" and "non nano": in doing so, the principles of international negotiations and technological constraints make it easier to adopt some definitions of nano-ness than others. In particular, the size criteria used to define the "nano-ness" of substances could be more easily adopted than more complex property-based definitions, which had direct consequences for risk

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[1] EPA, Concept Paper for the Nanoscale Material Stewardship Program: 12.
[2] Chemical reactions occur at the surface of a given material. If the surface area is higher, then the number of possible reactions is higher.
[3] The expression was used by Sheila Jasanoff about biotechnology (Jasanoff, 2005a).
[4] The first section of this chapter uses materials presented in (Laurent, 2010d).

management. Thus, defining the nano-ness of substances is an opportunity for public administration, private companies and hybrid organizations like standardization bodies to rethink the way they problematize the risks of chemicals.

The previous chapters illustrated the fact that the development of material objects is the component of nanotechnology programs with which actors involved in the construction of representations of nanotechnology felt the most at-ease. For them, the area was reassuring. There might have been public concerns to deal with, but they apparently related to "traditional" risk issues, which could be managed by assessing risks through scientific methods, in order to implement consistent public decisions. No futuristic or science-fiction inspired discourses were to be found in the production of more efficient materials. As seen in the previous chapters, representing nanotechnology as an operation in the development of industrial applications was indeed at stake in the early construction of nanotechnology federal programs, while associations of private companies successfully managed to push Drexler's visions out. In nanotechnology programs, the rational examination of the risks of nano chemicals was conceived as a necessary condition for the "responsible development" of nanomaterials, and nanotechnology in general. Thus, the director of NNI co-authored a report on the "risk governance of nanomaterials" with Ortwin Renn, a well-known specialist of risk perception studies, in which "responsible development" heralded as a necessity, was based on the evaluation of risks, that of the "expectations and concerns" of civil society, and public actions in accordance with these evaluations[1].

This chapter demonstrates that Renn' and Roco's approach is one way among others to problematize nano substances. Considering situations where actors attempt to deal with nano substances, it illustrates various ways in which their potential risks become objects for public actions. As many scholarly works have shown, risk evaluation and management methods simultaneously define ways of constructing reliable knowledge for administrative actions, and produce citizens expected to inform themselves, accept the delegation of work to experts, or, on the contrary, participate in the collective management of risks[2]. In doing so, these methods solidify certain definitions of public problems. Understanding how nano substances are problematized implies that one describes the instruments through which potential chemical risks are dealt with: controversies among the actors involved[3] and differences across countries may then illustrate the range of democratic constructions that the

[1] (Renn and Roco, 2006b). The approach has been that of classical analysis and management of risks since the well-known U.S. National Academy of Science report (Jasanoff, 1987), to which evaluations of risk perceptions are added at all stages of the process.

[2] See (Jasanoff, 1987; Jasanoff, 1992) about the science/policy boundary; (Jasanoff, 1998) about risk perceptions; (Barthe, 2009) for an example about nuclear waste; (Fisher, 1990) for a critique of risk/benefit evaluation.

[3] A canonical example of controversy about risk evaluation and management is Brian Wynne's study of Cambria sheep farmers, which describes the opposition between the scientific methodology of British administrative experts, and the local knowledge of farmers (Wynne, 1992)

problematizations of nano substances enact. Accordingly, we will see that the devices mobilized for the management of nano substances are meant to characterize nano substances and their risks at the same time as they define roles for public and private actors and ways of dealing with public concerns. As such, they are technologies of democracy. Whether they are new experiments or replications of existing ones is to be explored in this chapter. But in any case, they connect the making of nanotechnology objects with the construction of science policy programs, the definition of public concerns, and the mobilization of publics. Thus, they problematize nanotechnology and shape democratic orders.

This engages various actors: industrialists putting new materials on the markets and worried about potential future legal constraints, NGOs active on the topic as they have been working on environmental health issues, regulators concerned with the inclusion of nano substances in chemical law, and advocates of nanotechnology programs wanting to avoid a "GM-like crisis" which would allegedly lead to a massive rejection of nanotechnology[1]. These actors make the ways of dealing with nano substances explicit in various sites. Some of them deal with a unique substance coming from a single production process (e.g. a private company producing carbon nanotubes, and reflecting on their potential risks), others with a cluster of substances (e.g. when American NGOs use legal petitions in order to force federal agencies to regulate nano silver compounds). In other cases, the whole range of nano substances is discussed (e.g. when the *International Standardization Organization* attempts to define the term "nanomaterial"). This chapter considers successively three empirical sites where the problem of nano substances is formulated and dealt with: private companies, U.S. regulatory agencies, and international standardization bodies. It thereby sheds light on the relationships between public nanotechnology development programs, industrial strategy plans, and the production of international standards.

[1] The argument also constructs a particular citizen, who would be unable to rationally balance risks and benefits. Studies about GM have shown that risk perception is far more complicated, and based on institutional understandings of risks (Marris et al., 2001). At any case, nanotechnologists' "folk theories" about the public have been shown to lie on little empirical grounding (Rip, 2006b).

Section 1: Do nano substances exist?

This first section explores situations where the question of the existence of nano substances is raised, and which connect the making of substances with that of nanotechnology programs, concerns, and publics. It contrasts two situations, which allows me to characterize the problem of existence related to nano substances. The first one considers the case of an industrial company producing carbon nanotubes and materially and discursively containing them. In this case, the problem of the existence of nano substances can be ignored because of the possibility of containment. In the second example of this section, the existence of nano substances (in this case nano-silver) is discussed in a binary manner: U.S. civil society organizations and industrial companies argue over the possibility of reducing nano-silver to silver in the legal arena. The opposition over the existence of the non-existence of nano silver is eventually resolved by the recourse to "sound science".

Multiple and contained carbon nanotubes

Industrial companies are major players in the development of nano substances. They produce nano substances, use them and put them on the market. Carbon nanotubes are a good example in order to analyze how science policy, private companies' strategic decisions, and regulation-making for nano substances are articulated. Let us consider the case of the French company A***, one of the main chemical companies in the country, and an early player on the carbon nanotubes market. The trajectory of David Bertrand[1], one of A***'s R&D managers in charge of the development of the carbon nanotubes related activities will guide us through this exploration. It will illustrate how industrial actors deal with the ontological uncertainty of nano substances. As the production of A***'s carbon nanotubes is directly connected with the making of the French nanotechnology policy, this case offers an entry point in the description of the constitution of nanotechnology as an assemblage of objects, futures, concerns and publics.

Nanotubes in the evolution of private and public nanotechnology research

The development of nanotubes production at A*** was linked to the construction of public research policies, in France and the U.S. In 1999, David Bertrand was sent by A*** to the U.S. He was

[1] The name has been changed. This section is based on an extensive interview with David Bertrand (Paris, March 2010). Unless otherwise specified, quotes in this section are excerpts from this interview.

then in charge of a long-term project, which attempted to identify the strategic domains of activity in which his companies should invest. Bertrand started working on nanotechnology within this project, as he "felt that the topic was growing". Yet nanotechnology was not an unknown domain for David Bertrand then. The R&D direction of A*** had considered producing fullerenes in 1998 for applications in pharmaceuticals which would have used these nano substances as drug vectors inside the human body. This experience had familiarized David Bertrand with both nanotechnology as an innovative domain, and a potential source of health and safety risks. Hence, while in the U.S., he got particularly interested in the federal initiatives for nanotechnology support. Bertrand then met the main actors of federal nanotechnology programs, including Mihail Roco, director of the NNI, and Richard Smalley, Nobel Prize in chemistry, discoverer of fullerenes, and instigator of the very first federal initiatives for nanotechnology support (cf. chapter 1). The report Bertrand wrote at the end of his American project identified "strategic sectors" for A***'s development, all related to nanotechnology. Among those, nanotubes caught Bertrand's attention, then that of A***'s direction, for their proximity to the carbon-based chemical activities of the company. The time was that of robust growth for the company, which was seeking to invest in innovative sectors. The potential applications of nanotubes seemed to offer interesting – albeit non quantified at the time - perspectives of market development, at the same time as they were of interest for their technological properties:

Nanotubes were the most interesting choices. There was no market analysis. The CEO wanted innovative research project. So I presented this, I insisted on electric properties, and mechanical resistance – nanotubes are more resistant than steel -, thermal properties…

After he returned to France, David Bertrand thus received funding to develop a production unit.

<u>*Industrialization of the process*</u>

As Bertrand started working on carbon nanotubes, the objective was to use processes developed in academic laboratories and extend the production scale[1]. A first pilot production unit was installed in order to start the production of nanotubes. An important difference with the production processes existing at the time was then the choice of the catalyst. As the existing processes were all small-scale, laboratory-based experiments, researchers could afford to use a catalyst easily found, but costly and potentially hazardous. Matters of cost, safety and efficiency intervened in the choice of the new catalyst. They were also at stake when Bertrand and his team tried to fit the parameters (temperatures, pressure, duration, etc.) of the process. They had a hard time, since the process remained mysterious. Bertrand

[1] Bertrand established a partnership with a Toulouse-based laboratory.

knew that high temperatures were needed, and that, in contact with transition metals such as iron, nickel or cobalt, carbon atoms arranged themselves in nanotube forms. But the details of the mechanism were not known. At best, Bertrand's team could propose hypothesis on the process[1].

The choice of the process A*** made did not allow Bertrand's team to control precisely the growth of nanotubes. Consequently, the process was gradually defined by successive trials and errors. For instance, Bertrand describes the choice of the catalyst as follows:

We have been studying catalysts for the reactions that produce carbon nanotubes. We put everything in the oven and we add catalysts. But we can't look at what happens during the process. We see at the end whether it has worked or not.

The direct observation of the final product might allow the industrialist to tell "whether it works". The identification of a "good nanotube" is then the issue. At first, Bertrand's team used a simple, color-based criterion: "if the solution is black enough, then we have nanotubes". But this crude observation did not provide much in the characterization of the physical and chemical properties of the products. Defining the "good nanotubes" required a more sophisticated approach.

Nanotubes for specific properties

Bertrand's team slowly and iteratively refined the process according to the properties of nanotubes (such as mechanical resistance, elasticity, thermal properties, etc.). Defining the "good properties" was done according to the need of a company with which A*** started collaborating at the beginning of its nanotube project. A Texas-based company, Z***, which then produced "carbon fiber matrix, doped with carbon nanotubes, for applications in high-tech equipment for sports", became A***'s customer in 2005. The connection was made by a French researcher who used to work for the Toulouse laboratory A*** was partnering with, and who then moved to Z***:

He went back to the lab in Toulouse. We provided them with samples of nanotubes. And we adapted the process so that our nanotubes could fit into their process. And when they told us that they did, we knew we had our final process.

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[1] The process that A*** developed was not the sole possibility for the production of nanotubes. The "historical" carbon nanotubes, those that had been identified by the Japanese physicist Ijima in the early 1990s were produced differently. Whereas Ijima used electricity and very high temperatures (3000 to 4000°C), Bertrand's team used a process known as "chemical vapor deposition", through which, at lower temperatures (600-750°C), nanotubes could grow on a metallic basis. For Bertrand, the electric process had drawbacks: its costs, and the fact that it was more difficult to control in terms of occupational safety. In a context where the health risks of nano substances had begun to be discussed in public arenas (see below), the electric process was not an option for Bertrand.

Hence, while collaborating with Z***, A*** "made its process evolve according to their needs":

*We would send them samples. Then it wouldn't work (…). Well, then we would add a little more hydrogen, raise or lower the temperature. This was completely empirical, without any characterization… So now we have a production process for particular nanotubes. Why these ones? Because they fit in Z***'s products!*

Hence, the final product was obtained according to Z***'s constraints: Z*** needed particular properties of mechanical resistance, heat transfer, density, etc., and the process was tailored by trial and error till A*** managed to produce a material that met these needs. That this material was made of unknown nanotubes, possibly different from each other, did not matter as long as A***'s customer could use it for the applications he developed. This is the meaning of the term "empirical" in the previous quote. The "empirical" work is opposed to "characterization", that is, the possibility of precisely describing the physico-chemical characteristics of the components of the product (length of the nanotubes, diameter, specific surface area, etc.) and defining the process according to these. The empirical refinement of the process caused A***'s nanotubes to be different from those of its competitors. Apart from spin offs and laboratories producing small quantities of nanotubes through electric-based processes, large chemical companies, most of them from Germany, are A***'s main competitors. The differences between their nanotubes and A***'s can be only described through the properties of the overall materials, and not from the precise characterization of its components.

The gradual construction of the production process occurred in connection with various public policy initiatives, which were undertaken in France in order to support public and private nanotechnology research, and increase the collaborations between university and industry laboratories. After the electronics sector, materials caught the interest of the French ministry of industry, which developed support programs in the early 2000s[1]. A*** was involved in their elaboration, and benefited from them at an early stage, as David Bertrand himself participated in numerous meetings and projects with national (ministries of industry and research) and local (regional economic development services) administrative bodies. Thus, A*** received funding from the Aquitaine region in order to experiment with new units for the production of nanotubes. The company coordinated a program of the French public agency for industrial innovation (*Agence de l'Innovation Industrielle*)[2], which gathered companies and public laboratories in order to develop applications of carbon nanotubes, and shared knowledge on potential risks. For the potential risks of nano substances, and especially carbon nanotubes, had begun to emerge as a public issue.

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[1] Interview, direction de la compétitivité, Ministry of Economy, Paris, Septembre 2006.
[2] AII was then absorbed within another public body, OSEO.

Nanotubes and their risks

The process through which A*** develops nanotubes in order to produce particular properties is familiar in the domain of materials science, where the development of industrial products is done according to expected functions[1]. Yet the case of nanotubes raised additional difficulties. Many physical and chemical characteristics (length and diameter of the tube, rigidity, specific surface area, number of walls…) might have an impact on the properties of the final product, through a process that remains unknown to the industrialist. The early interrogations about the potential risks of nanotubes made this a problem for the company. As soon as the production started, Bertrand and his team raised the issue of the potential toxicity of the nanotubes. They were working with fine carbon powder and Bertrand was soon concerned about their potential hazards. He was not the only one who worried about the potential concerns related to nano substances. As the pilot production line was installed, in 2004, nanomaterials health risks indeed became a public concern. An advisory council to the Ministry of Economics released a report on nanotechnology in 2004, and insisted on the need for the French administration to deal with the health and safety risks of nanomaterials[2]. A working group gathering representatives from several ministries (environment, work, health, research, and industry) was created in 2005 within the national administration in order to work on nanotechnology risks, above all those related to the industrial production processes – among which A***'s were explicitly mentioned as an object of concern for the public administration[3]. The ministry of labor then commissioned the French Agency of Occupational and Environmental Safety (*Agence Française de Sécurité Sanitaire de l'Environnement et du Travail*, AFSSET) to deliver an expert report on nanomaterials and work safety. At that time academic publications had begun to appear, which commented on the potential toxicity of carbon nanotubes[4] and which both the public administration and private companies became aware of. In particular, articles of Ken Donaldson[5], an Edinburgh-based researcher, described peritoneal injections of nanotubes on mice, resulting in inflammatory responses.

Thus, the potential health risks of carbon nanotubes became an integral component of the company's strategy as soon as industrial production began. The stakes were high for A***: as the risks of

[1] Bernadette Bensaude-Vincent illustrated this point in her works. She thus described complex ontologies, which cannot be considered purely materialistic (Bensaude-Vincent, 1998). For a historical overview of the construction of materials science as a discipline, see (Bensaude-Vincent, 2001).

[2] Dupuy and Roure, 2004

[3] Interview with the then secretary of the group, Directorate of Health, Health Ministry (Paris, May 2008). According to her, the creation of the group was an initiative of the ministry of health, where "everybody has in mind the crisis of asbestos".

[4] Wahreit et al., 2004 ; Donaldson et al., 2004

[5] For instance (Donaldson et al., 2006).

nanomaterials – and those of nanotubes in particular, became a public issue, the hazards of the products developed, and their control, could not be ignored by the company:

As soon as the pilot was there, then the director of communication, the direction of the environment, the technical direction, the direction of the plant, the préfet, the sous-préfet, the president of the region (...). Everyone was rushing there... there were so many people coming to see the reactor that we couldn't work anymore. It had become so present in the media... At the same time, nanomaterials were becoming a priority for the whole company. And there was pressure to control what we were doing.

<u>An infinite number of nanotubes. The impossibility of predictive toxicology</u>

A possible approach in order to deal with the risks of nanotubes – which Bertrand considered at the time – is that of predictive toxicology. It consists in the demonstration of a causal link between some physical and/or chemical characteristics of the nanotube (length, diameter, elasticity, specific surface area, ...) and hazards. Yet it quickly appeared that the determination of these parameters was difficult. Let us consider for instance the measurement of the length of the nanotube. At the end of A***'s production process, nanotubes are woven together:

How to measure the length of a nanotube caught in a ball of thread? We tried to catch a thread and pull with an atomic force microscope. But it doesn't work, the nanotubes break (...) People have done it but they managed only to do it with one or two nanotubes... Once you need productivity, that is, a high carbon yield, you have lots of nanotubes in the ball, and it's impossible to pull them apart.

Instead of "pulling the nanotubes apart" in order to isolate them from one another, Bertrand's team attempted to disperse them:

We said to ourselves: "let's disperse the nanotubes". When you disperse the nanotubes with ultrasounds, or with surfactants, they break down... They're not the same anymore!

Thus, David Bertrand was bound to claim that "nobody knows how to measure the length of nanotubes". What about the other parameters then? Diameter could not be measured by diffraction methods (which works for spherical particles with flawless surfaces), and "varied along the length of the nanotube". Measuring diameter was then made through microscopic observation and the calculation of an average number from a sample. This was not the most satisfactory approach for Bertrand:

Well, we disperse in spite of all that, and we hope it does not impact diameter. (…) We look at a sample, and we calculate the average diameter. It's a complete bricolage.

In the situation of A***'s process, which was elaborated according to the properties of the final product and not for the production of precisely tailored individual nanotubes, and as "one does not have the nanoscale glasses and the nanoscale tools which could help manipulate the nanotube", the characterization of the nanotubes remained uncertain. It could only be grounded on the direct observation of individual nanotubes, which are hoped to be representative. This was far from certain:

We have no process able to produce "pure" nanotubes. There is always a more or less broad statistical dispersion.

After numerous microscopic observations of its products, A*** managed to learn that its nanotubes were "flexible" (as opposed to the rigid nanotubes that can be obtained by electric process), and "multi-walls" (as opposed to "single-wall" nanotubes), meaning that they are made of several coaxial tubes. Yet here again, the link between the process and the product is determined by nothing but direct microscopic observation – a situation that Bertrand describes as such: "roughly speaking, we have no idea how to predict what this or that process will produce". Consequently, predictive toxicology is an exercise that is bound to fail. This is what a member of the French association for normalization (AFNOR) and the French delegation to international standardization bodies, explained in an interview:

Today there are studies claiming that nanotubes are hazardous and others that they are not. This is really not surprising, it all depends on the nanotubes you use (…) There is no way to have predictive toxicology on nano objects. There could be 60 million toxicologists in France and it would not be enough. (…) You can have 50,000 different nanotubes.[1]

What existence for nanotubes?

That nanotubes all differ from each other is not necessarily an issue[2]. But in the case of nanotubes – and, more generally, nano substances, risks are suspected and industries are asked to manage them carefully while, as in the case of A***, ignoring the detailed composition of their product.

[1] Interview, AFNOR, Saint-Denis, Octobre 2008.

[2] Thus, composite materials are all different from each other. Each company produces materials with specific properties through processes that are tailored according to the properties that are sought (Bensaude-Vincent, 1998). Characterization might be as difficult in this case as it is in that of nano substances. Yet no risk concerns require differentiating among composite materials through other means than the comparison of their expected properties.

The difficulty in characterization only becomes a problem when producers are asked to evaluate the toxicological effects of the substances and regulators attempt to introduce risk management instruments. Introducing labeling, registration requirements, or production restriction indeed implies differentiating between nano and "non nano" substances and identifying the criteria that are used to discriminate what is to be controlled.

Distinguishing between substances relies on the classifications of chemicals (e.g. Mendeleev's table for chemical elements), and instrumented identification technologies (e.g. mass measurement and chemical composition evaluation devices). Once the industry is involved, it is also a matter of regulators and jurists, who need to identify substances in order to manage them (e.g. through the control of industrial products, the limitation of populations' exposure, or the labeling of consumer goods). Thus, regulatory texts define what an "existing substance" is, and thereby perform an ontological work. In Europe, the REACH regulation (Registration, Evaluation and Authorization of Chemicals) defines a "substance" in this way:

> <u>substance</u>: *means a chemical element and its compounds in the natural state or obtained by any manufacturing process, including any additive necessary to preserve its stability and any impurity deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.*[1]

REACH considers that two substances are distinct if they have different chemical composition (i.e. they are made of different elements), or different "physical parameters", defined as such, in a non-exhaustive manner:

> *The other specific main identification parameters to be added depend on the substance. Examples of other main identifiers can be elemental composition with spectral data, the crystalline structure as revealed by X-ray diffraction (XRD), Infra Red absorption peaks, swelling index, cation exchange capacity or other physical and chemical properties.*[2]

Measuring these physical characteristics implies that instrumentation is available in order to identify them in an unambiguous manner[3].

In the U.S., the *Toxic Substance Control Act* (TSCA) considers as "existing" a substance listed in the TSCA inventory. A substance is "new" if it is not listed in the inventory, that is, if it can be

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[1] REACH, title I, chap.2, art.3: 1.

[2] European Chemicals Agency, 2007, *Guidance for identification and naming of substances under REACH*, ECHA: 29.

[3] Instruments need to be standardized in order for their measures to be comparable. See (Mallard, 1997) for the work needed to do so. Section 2 of this chapter will explore this topic further.

distinguished from the existing ones. The criteria used to draw the distinction are relative to the chemical composition and physical parameters, most notably crystalline arrangements, isotopy, and allotropy. In the American as in the European case, measurable criteria are used to establish the existence of substances. In the latter, the existence of a substance implies constraints for industrialists, in particular that of information distribution through legally defined instruments (e.g. "safety data sheets" for the REACH regulation). This then allows the European administration to impose restrictions on the most dangerous substances[1].

Thus, what makes a chemical exist is an infrastructure made of legal texts, standardized measurement instruments, technico-administrative instruments such as labeling and registration dossiers, and institutions able to stabilize the criteria being used. This infrastructure produced classifications that are, in Bowker' and Star's words

both conceptual (in the sense of persistent patterns of change and action, resources for organizing abstractions) and material (in the sense of being inscribed, transported, and affixed to stuff).[2]

Through the instruments on which it is based, the data it circulates, the standardized measures it mobilizes[3], and the management tools it constructs, the infrastructure does an ontological work that problematizes nanotechnology: it defines existences for chemicals[4] at the same time as it defines the problem of the health and safety risks of substances and ways of dealing with it.

The case of carbon nanotubes, and, more generally, of nano substances, raises additional issues. The existence of nano substances is far from straightforward: if two substances differ from each other because of the size of their components, then the criteria of the chemical composition cannot be used (the atomic composition is the same). The distinction according to physical characteristics – for instance, crystalline arrangements – could be possible. This allows regulators to distinguish between graphite and diamond, two varieties of carbon[5]. According to the same logic, one could consider that nanotubes are an allotropic variety of carbon, and can thus be made "existing". But if the atomic

[1] The two texts follow different approaches: REACH forces industries to provide information (controlled by the European Chemicals Agency, ECHA), and to demonstrate the safety of their products (Fisher, 2008). TSCA asks EPA to demonstrate the existence of risks in order to impose restrictions, while the federal agency cannot force industries to provide data on their products. See (Sachs, 2009) for a comparison between the two texts and a critique of TSCA. Sachs insists on the limited number of cases where EPA could impose restriction measures.

[2] Bowker and Star, 2000: 289.

[3] About the importance of standardization activities in scientific practice see (Latour, 1989; Latour, 1990).

[4] This example is another illustration of the importance of the study of classification operations in order to understand the constitution of the social (Bowker et Star, 1999; Bowker et Star, 2000).

[5] European Chemicals Agency, 2007, *Guidance for identification and naming of substances under REACH*, Helsinki, ECHA. Another case is that of substances "of Unknown or Variable compositions, Complex reaction products, or Biological material" (UVCB), which encompasses compounds of several chemical elements produced by organic synthesis, or biological materials themselves. This latter case does not apply to nanotubes (made of a single element, carbon), nor to other nano substances (as their chemical composition is not questioned).

structure is considered as a criterion, why not then differentiate between "multi walls" and "single walls", "rigid" and "flexible", diameters inferior or superior to a certain limit? The question is all the more acute as companies do use these criteria (and many others) to differentiate between their products when they patent them[1]. In order to know what is the parameter that matters for toxicological regulation, it would be necessary to establish a link between the physical or chemical characteristics chosen as a criterion and toxicological properties. This is predictive toxicology, the very approach that is impossible to undertake. Hence, the situation is uncertain, including for the experts of the European Chemical Agency (ECHA) in charge of the evaluation of REACH registration dossiers. David Bertrand thus explains:

So far, nanotubes have been registered within graphite. This is the same identification number. And within graphite, the situation is not settled. It's still being discussed with ECHA. There was a time when they distinguished 10 or 15 different types of nanotubes. Then when they saw we could not characterize, they wanted to put everything within graphite… They are getting back to the initial position, do we don't know where we are right now.

Hence, the existence of carbon nanotubes as a chemical substance is not determined. It could multiply, as in the patent domain, where there are as many nanotubes as industrial processes, or shrink to the sole graphite[2].

<u>Containing unknown materials</u>

Faced with the impossibility of predicting potential risks and characterizing the products, and the multiplicity of carbon nanotubes, David Bertrand "had no other choice" than "to apply the precautionary principle". For him the precautionary principle translated as a maximal containment of substances. Once the pilot production line was installed in A***'s production factory, Bertrand and his team set up a containment system that transformed the production process: rooms were closed, the air filtered, and workers were asked to wear protection suits – "the same ones as those one uses for

[1] A few court cases has been filed at the time of writing, but they all confirmed the patentability (and thus the novelty) of nano substances based on different processes, and having different size characteristics than already patented ones (Baluch et al., 2005). A much heard concern among IP commentators is the growing use of "patent thickets" which would cover wide ranges of nano substances (e.g. O'Neill et al., 2007).

[2] After several years of uncertainty about EPA's position concerning carbon nanotubes, the federal agency recently announced that carbon nanotubes could be considered as new substances in TSCA's sense. EPA now encourages industries to follow the procedure of declaration of new substances, which seems to suggest that several nanotubes will be registered. Nanotubes would then be the first nano substances to enter TSCA inventory (EPA–HQ–OPPT–2004–0122; FRL–8386–6, Toxic Substances Control Act Inventory Status of Carbon Nanotubes). A*** received EPA's authorization to put its nanotubes on the US market in June 2010, after it requested a registration as new materials. For other nano substances, the situation is potentially more complex, since many of them do not differentiate from their "non nano" counterparts by a physical shape (like the nano "tubes").

hazardous biological material", that is, the highest level of protection. Containment extended to the very product that A*** started commercializing: at the end of the process, nanotubes were dispersed in solid matrix, from which they could not escape. The company refused to sell nanotubes to customers planning to use them in aerosols, as it would have implied the dispersion of nanotubes in the air.

The choice of containment is tied to decisions related to industrial strategic management. From the start of the production process of nanotubes at A***'s, Bertrand expressed a concern for health and safety risks. Then, A*** deliberately adopted a strategy based on containment, and tailored its investments accordingly. For the members of the cross-ministry administrative groups in charge of nanotechnology within the French administration, A*** is regarded as a good student (*bon élève*)[1]. The company "plays the game" and it "collaborates" with the public bodies in charge of occupational safety. Since 2005, David Bertrand has belonged to the small group of industrialists that participate in the French delegations at the International Standardization Organization, the *Comité Européen de Normalisation*, and the O.E.C.D. (see section 2). A*** was one of the very few companies that answered a questionnaire sent by the French agency for environmental and occupational health to the French firms suspected of producing nano substances[2]. Similarly, A*** registered its nanotubes in the U.S. within a voluntary approach proposed by the Environmental Protection Agency (EPA), the *Nanomaterial Stewardship Program*[3]. A*** was involved in numerous public events. It actively participated in the Bordeaux nanotechnology exhibit by adding panels on which it presented its carbon nanotube activities (cf. chapter 2).

The "strategy of transparency" adopted by A*** is not only a matter of displaying information related to its production processes. It also implies that the company strictly controls the information that circulates about it. Thus, David Bertrand told me the following anecdote:

> *I was at a conference on the health risks of nanomaterials. A graduate student did a presentation on the risks of nanotubes… and she used ours (I don't know how she had got them) and she said 'here are the effects of A***'s nanotubes'. She told the company's name! I intervened immediately. I made her stop immediately.*

This seemingly anecdotal episode is telling. For A***, the containment strategy was not only material, in the very production site, and in the characteristics of products. It also implied a control of

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[1] These expressions were used by a civil servant at the French ministry of health, and a member of the inter-ministry group on nanotechnology (Interview, Paris, November 14 2008).

[2] AFSSET, 2006. The low rate of answer was acknowledged by the agency, which explained it by the uncertainties about the definition of "nanomaterials".

[3] The NMSP was a way for the EPA to deal with nanomaterials without transforming the existing regulatory framework (EPA, 2004, *Concept paper for the Nanomaterial Stewardship Program under TSCA*, EPA-HQ-OPPT-2004-0122-058). A***'s documents describing its products were by far the most developed, as compared to the other companies participating in the initiative.

the flow of discourses and information. Bertrand was indeed very proud of his somewhat violent intervention when telling it to me: in the context of the interview, it was a visible proof that he was able to move about in different contexts, and maintain the control of information flows about his company. Hence A***'s transparency strategy went with as much (if not more) investment as with a strategy of secrecy. Being transparent was not a simple task, and did not imply that just anyone could talk about A***'s activity. It required work to ensure the controlled diffusion of information, including media training for A***'s employees (which Bertrand had been used to) and investments to participate in the production of science exhibits in ways that convey both an overview of A***'s activities, and its implication in the management of the potential risks of its products. Be they nanotubes or external information, what could potentially flow from A***'s industrial activities needed to be controlled by the company.

This strategic positioning is not a universal choice. David Bertrand himself compared A***'s strategy with that of some of its competitors, which do not follow the same approach:

> *And there are other chemical companies, which tell us "we don't want to tell because people will tell us we have it done secretly and put the population at risk". It's really frightening. R**** (a French chemical company) *has the same position when they say they don't produce nano silica (…) Except that Michelin says "we buy nano silica from R***". As for ourselves, we chose to tell things openly: "we did all this when we were younger, we tell this openly, there was no harm".*

The differences in strategic choices are often linked to differences in investment possibilities. This is what a member of the cross-ministry group in charge of nanotechnology within the French administration explained:

> *In the early 2000s, companies started to produce nanomaterials in large quantities. We had meetings with them to see what they had to do. And each time, we advocate for containment, protection equipment, air filtration – what A*** does, for instance. But the problem is that it is very expensive. And for small companies, it's absolutely not possible. They would always tell us: "so you want us to close down our companies?"*[1]

A*** could do this at the time, because it could benefit from high investment capabilities. It was not the case at the time for many of the industrial SMEs active in the production of nanomaterials, and the situation might have evolved in later times, as A***'s investment possibilities had decreased. Thus, A*** gradually became a reference about the containment strategy, as its position took shape with that of national health agencies. In its report on the safety of nanomaterials, the French agency for occupational

[1] Interview, Paris, May 2009

safety mentioned the only industrial production unit for carbon nanotubes in France[1] in order to insist on the need for containment devices[2].

Multiple and contained nanotubes

The example of A*** shows that the strategy of the carbon nanotubes' producer is not separable from the making of nanotechnology policy programs, not only because public money was invested in the development of nanotube-related activities at A***'s, but also because the interactions are numerous between nanotechnology industrial strategy and public policy programs. These interactions occurred through the circulation between the American nanotechnology policy and A***'s strategic development, the coordination of networks gathering companies and public laboratories in France, and the construction of the containment strategy at A***'s as the position of national health agencies took shape. In these processes, the actual construction of carbon nanotubes appears closely tied to the initiatives meant to ensure the safety of nanomaterials. As it will appear in later examinations (chapter 5), the case of A*** is a component of a situation which, in France, leads public and private actors to experiment with devices meant to deal with nanotechnology substances and products.

Both public and private actors need to deal with an ontological uncertainty related to nano substances. In the case of A***'s carbon nanotubes, "dealing with the ontological uncertainty of nano substances" consists in ensuring the material and discursive control of carbon nanotubes, of the industrial process in order to obtain the desired properties, of the nanotubes inserted in solid matrix, and of the public discussions and debates in which the name of the company is mentioned. Hence, the ontological uncertainty is displaced: containment is a way of dealing with the impossibility of precisely defining what is produced and what the safety risks are. Thus, the company and the administrative actors can avoid entering the ontological work of the characterization of new substances. Thereby, A*** proposes a model of collective organization in which the circulation of materials and information is controlled by the company, who, in turn, is engaged in public operations of display of its activities (be they science exhibits or public reports of public agencies). Containment, in this sense, is a technology of democracy at the same time as it is a technology that allows the company to produce carbon nanotubes[3].

For public policy actors and industrial companies, carbon nanotubes are reassuring substances. They are produced by a limited number of big companies with large investment capabilities, and they can be contained. This is not the case for all nano substances. Few of them can be controlled as much as

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[1] AFSSET, 2006, *Nanomatériaux et Sécurité au travail*: 31.
[2] *Ibid:* 137
[3] Containment is not the only option though. David Bertrand could have "applied the precautionary principle" by tailoring the process according to the toxicological properties of the produced substances. This would have been a "safe by design" approach, which I will discuss in chapters 5 and 6.

the nanotubes. Some of them are included at the surface of consumer products, from which they can more or less easily escape, and which are so widespread that a precise control of customers' usages is out of question. Other ways than containment to deal with the ontological uncertainty must then be envisioned. The paradigmatic case to illustrate such situation is that of silver nanoparticles. The second part of this first section will show in what ways.

Granting or refusing existence to nano substances. The case of nano silver

Nano silver becomes a public issue

Among nano substances already in use in the chemical industry and promised to future developments, silver compounds hold a special place. Silver nanoparticles – silver compounds made of about 100 to 1,000 atoms - were not the first nano substances mentioned in the nanotechnology programs. Contrary to carbon nanotubes, identified in the early 1990s, which quickly became major references in nanotechnology research and policy[1], silver nanoparticles were rarely mentioned in the early years of the construction of nanotechnology programs. Discussions about safety risks – which quickly emerged about carbon nanotubes – did not consider at first the case of silver nanoparticles. For instance, the U.S. National Toxicology Program did not include silver nanoparticles in the initial lists of nano substances it examined under its "nanomaterials safety initiative"[2].

The first concerns about nanoscale silver originated in the U.S., from industrialists commercializing products using silver, with a quality claimed to be "nano". The Korean firm Samsung launched a marketing campaign in 2007 that praised the benefits of a washing machine with increased biocidal properties. The advertisement distributed in the U.S. was based on the promotion of "silver nano", which would make the washing machine "anti bacterial". The biocidal properties of silver ions were well known[3]: the "silver nano" would increase their degree. The product commercialized by Samsung caught the attention of several American NGOs, most notably the *National Resource Defense Council* (NRDC), which had been advocating for chemicals and pesticide regulation in the U.S. since the 1970s. Concerned about the circulation of silver released by the washing machine in the environment, the NRDC asked the Environmental Protection Agency (EPA) to regulate Samsung's machine as a pesticide. Since the company claimed that its product held biocidal properties, so the NRDC's

[1] E.g. in (Roco and Bainbridge, 2002).

[2] My information about the US National Toxicology Program comes from the website of this public body, and from an interview with Nigel Walker, head of the Nanotechnology Safety Initiative (phone interview, November 2009).

[3] The oldest patents for antibactericide silver were granted in the 1960s (e.g. Degoli, Werner, "Silver ions bactericidal compositions", US patent 3035968, filled Aug 29, 1960, issued Mar 1962)

arguments went, then it should have registered it at EPA, and provided the impact studies requested by the *Federal Insecticide, Fungicide and Rodenticide Act* (FIFRA)[1]. This led EPA to clarify its position regarding the "ion generating devices"[2]: Samsung "silver nano" was indeed presented as a device that released silver ions at a regular pace. Worried about the "nano" label of the Samsung machine and the implications its initiatives about ion generating devices may have conveyed in terms of a potential step toward the regulation of nano substances, EPA made it clear that its objective was "not to regulate nanotechnology"[3].

The Samsung washing machine episode is interesting in many respects. It made nanoscale silver an object of public concern in the US. The expression "nano silver" then became widespread as a topic in public debate[4], and started designating nanoscale silver compounds integrated in consumer products. Nigel Walker, director of the National Toxicology Program said that the Samsung affaire was the origin for the inscription of "nanoscale silver" in the nanomaterials safety initiative in 2008[5]. The central question in this program – and the Samsung case is an illustration of it – was to assess the so-called "zero hypothesis": is silver nano toxic because of the silver ions it releases (in which case its "nano-ness" does not transform the known biocidal effects of silver ions)? Or does it convey specific toxicological properties? In other terms, is the toxicity of nano silver reducible to well-known toxicity of silver ions? The zero hypothesis then became the main issue about nano silver, and appeared as an entry point to interrogate the novelty of nano products in terms of risk evaluation and management.

The intervention of the EPA – which, after the Samsung case, also fined a company for failing to register as pesticides a product claimed to be "anti-bacterial"[6] - and the transformation of nano silver into a public issue had effects the NGOs did not expect. Several companies that had previously advertised the presence of nano silver in their products eliminated the label, as it had evolved from commercial argument to public communication liability. This not only made invisible the industrial activities related to nano silver for the NGOs that just started to question its potential toxicity, but it also made it difficult for administrations to request the registration of the product as a pesticide. The

[1] "Registration of Nanosilver as a pesticide Under FIFRA", NRDC's letter to Jim Jones, director of the *Office of Pollution Prevention* de l'EPA, Nov. 22, 2006.
[2] EPA, 2007, "Pesticide Registration. Clarification for ion-generating equipment", *Federal Register*, September 21, 2007, 72(183).
[3] *Ibid.*
[4] NRDC also identified several companies using nano silver, for applications in medicine or in the food industry (Sass, 2007).
[5] Phone interview, N. Walker, November 2009.
[6] Letter from NRDC to EPA about the *FresherLonger* company. In at least one other example, EPA fined a company commercializing unregistered anti-bacterial nano silver (in the Matter of: ATEN Technology, Inc. d/b/a IOGEAR, Inc., Docket # FIFRA-09-2008-0003, *Consent Agreement and Final Order Pursuant to Sections 22.13 and 22.18,* February 27, 2008).

director of the Office for Pollutions and Pesticides at EPA thus explained in the press that "unless you're making a claim to kill a pest, you're not a pesticide"[1].

Other organizations joined NRDC's positions in favor of making the presence of nano silver explicit in consumer goods. The *International Center for Technology Assessment* (ICTA), a Washington-based NGO, which had been working on pesticides, published a list of nano silver products available on markets in 2008. A think tank, the *Woodrow Wilson Center*, which started a project on "emerging nanotechnologies" (PEN) in 2006, released an inventory of "nano consumer products". Based on the declaration of industrialists, the inventory quickly made it clear that among the existing nano products, nano silver was the most common substance. Yet when making inventories, ICTA and PEN faced the same problem as EPA did: by grounding the process on industries' claims, inventories could not include companies that erased their claims, while encompassing products using colloidal solutions christened as "nano" with no available information about the actual distribution of sizes, "ion-generating devices" the nature of which remains mysterious including for companies themselves[2], food additives and medical devices using nano silver, and experimental compounds produced in small quantities by SMEs and public laboratories[3]. Thus, the industry landscape of nano silver appeared extremely dispersed. It comprised small production units close to private R&D or university research centers[4], and large companies distributing products on a worldwide basis[5]. Whereas regulators could identify the producers of carbon nanotubes, the case of nano silver proved to be more complex.

Getting back to the case of silver

Following up on the inventory work on nano products, which had made the major share of nano silver visible, the PEN ordered a report about nano silver to the toxicologist Samuel Luoma in 2007[6], a renowned specialist of the impacts of metal pollutants on the environment. His report, entitled *Nanosilver: old problems or new challenges?*, focused on the issue of the novelty of nano silver related to toxicological effects. One of its very first remarks insisted on the widespread use of nano silver in consumer products, from which it could easily be released (contrary to the case of A ***'s carbon

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[1] "EPA to regulate nano silver as germ-killing", *Washington Post*, 23 Novembre 2006.
[2] Interview with the director of PEN, Washington DC, March 2009.
[3] E.g. synthesis through micro-organisms (Mukherjee et al., 2001).
[4] There is no systematic study of the nano silver industrial landscapes. For a local example, see California Office of Toxic Substances Control, 2009, *Nanomaterial Company visit report*, retrieved from http://www.dtsc.ca.gov/TechnologyDevelopment/Nanotechnology/upload/Nanomaterial-Company-Visit-Report.pdf (accessed July 2, 2010)
[5] Samsung washing machines were distributed in Australia and Sweden, where they caught the attention of *Friends of the Earth*, which was in close contact with ICTA.
[6] See (Laurent 2010d) for a more detailed narrative of this episode.

nanotubes dispersed in solid matrix)[1]. Yet Luoma explained that efficient methods of risk analysis existed. Based on the quantification of environmental release of silver ions (Ag^+) throughout the trajectories of products in the environment[2], they had been applied to silver before the development of nanoscale production technologies. Luoma applied the same approach in the case of nano silver. In the face of an uncertain situation in terms of the identity of nano silver, Luoma preferred to follow the zero hypothesis. For Luoma, specific phenomena might have occurred, but the available scientific literature could merely provide hypothetical elements on the possible behavior of nano silver.

The central point of the Luoma report consisted in considering the overall concentration of silver ions as a relevant variable. This was a way not to distinguish between silver ions, silver nanoparticles and colloidal silver[3], since the overall concentration of silver was considered the sole relevant parameter. These instruments also allowed Luoma and, at a later stage, the PEN to demonstrate the scientific validity of their approach: since the nature of nano silver was uncertain, sound expertise was to be bound on a known case. This was not meant to prevent from undertaking research projects about silver nanoparticles. Quite the contrary, Luoma as the other PEN reports constantly insisted on the need for the development of research about the potential risks of silver nanoparticles, their fate in the environment, and the physico-chemical characteristics that could impact their toxicological profile. Thus, the director of PEN testified several times in Congress in 2009 during the debates preparing the renewal of the NNI, and argued for an increase in the federal budget devoted to environmental, health and safety issues[4].

Making nano silver an object for social mobilization

The Woodrow Wilson Center was not the only organization concerned with nano silver. As seen above, NGOs were interested at first in industrial activities highlighting the biocidal properties of their nano silver products. Following these initial initiatives, a petition was sent by the ICTA to EPA in 2007[5]. Supported by a coalition of NGO brought together by ICTA, the petition asked EPA to regulate nano silver as a pesticide[6]. ICTA's position differed from that of the Project on Emerging Nanotechnologies. For the NGO, the point was to prove that nano silver was a new pesticide, not

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[1] This is the case for the majority of nano silver commercial applications. In other cases (e.g. medical devices), nano silver can be included in solid matrix.
[2] This is known as the "source-pathway-receptor" approach in environmental toxicology.
[3] Luoma introduces the distinction at the beginning of his report. Colloidal silver denotes silver solutions in which the size of particles belongs to a 1-1,000 nm range.
[4] Interview with the director of PEN, Washington DC, March 2009.
[5] Another petition had been addressed to the FDA in 2006 by the same group of NGOs. This previous petition asked the FDA to regulate the use of nanomaterials in the food and cosmetic industries.
[6] *Petition for Rulemaking requesting EPA regulate nanoscale silver products as pesticides.* Federal Register: November 19, 2008, 73(224).

reducible to existing products using silver in a "non nano" state. In the American legislation, the text regulating pesticides, FIFRA, defines pesticides as "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest"[1]. Thus, using FIFRA was a way for the NGO to enter the legal discussion about the existence of nano silver. Choosing nano silver and targeting FIFRA was not arbitrary. One of the persons in charge of the Washington office of ICTA thus explained:

Pesticide law is stronger than toxic waste law. If you want some part of nano regulated, you'd better use, you know, the law that gives you more tools. Right now, it's where we are. (…) But for the moment, with what George [the author of the petition] *had with silver, it's where we were able to move things forward.*[2]

Using pesticide law (i.e. FIFRA) rather than toxic law (i.e. TSCA) was a decision based on the difficulty ICTA perceived in the mobilization of TSCA in order to grant nano silver a legal existence. As seen above, making nano silver enter the TSCA inventory of existing substances is not straightforward. Contrary to the case of fiber-shaped nanotubes, for which a physical criterion (e.g. atomic arrangement) can be used, silver nano differs from silver ions only by the size of the set of silver atoms it is made of, which is not a sufficient basis to demonstrate the need for a new entry in TSCA inventory. When ICTA wrote the petition, EPA had already made this point explicit:

EPA's rationale for considering this group of nanoscale substances to be existing chemicals is based on the TSCA definition of "chemical substance." Although a nanoscale substance that has the same molecular identity as a non-nanoscale substance listed on the Inventory differs in particle size and may differ in certain physical and/or chemical properties resulting from the difference in particle size, EPA considers the two forms to be the same chemical substance because they have the same molecular identity[3].

As compounds of silver atoms bound by Van der Waals forces, nano silver could not be differentiated from silver ions within this approach.

The writers of ICTA's petition were lawyers aware of the environmental jurisprudence, who knew that the inscription of a new substance in TSCA's inventory might have been easily cancelled by a judge if the validity of the criteria was questionable[4]. Thus, the sole size parameter (either in terms of length,

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[1] P.L. 75-717; Title 7, Chapter 6, Subchap.II, §126 (u).

[2] Interview with Jaydee Hanson, ICTA, Washington, March 28, 2009.

[3] EPA, 2006, *TSCA Inventory Status of Nanoscale Substances – General Approach*, EPA, Washington DC.

[4] Bergeson and Plamondon provided an example: "An administrative law judge rejected EPA's motion for summary judgment in a TSCA enforcement matter where EPA asserted that sub-molecular differences between an existing chemical substance and the chemical subject to the enforcement action allowed EPA to treat the latter as "new", *In the matter of concert trading corp., Docket No. TSCA-94-H-19 (July 24, 1997)*" (Bergeson et Plamondon, 2007: 635).

diameter, or specific surface area) would risk being discarded as a means to establish the existence of nano silver. In comparison, it was easier for ICTA to claim the novelty of nano silver as a pesticide, since FIFRA deals with products and their properties, and not the chemical identities of substances. At stake for ICTA was then to make EPA ask industrialists for specific measures, by preventing them from arguing that the available knowledge on "non nano" silver could describe the toxicological effects of nano silver.

In order to prove the novelty of nano silver, ICTA's arguments in the petition were both legal and technical. A first one considered patents as ontological devices. As carbon nanotubes have been patented in many different ways, so silver nanoparticles had been patented as such, the novelty being argued as related to the size of the silver compounds. A second type of arguments in the petition was based on EPA's previous positions: since the federal agency had asked companies claiming the biocidal properties of their products comprising silver nanoparticles to register them as pesticides, it should logically have asked all companies putting similar products on the market to register them. The third and last group of arguments was related to the toxicological effects of nano silver. On the one hand – and the petition followed Luoma's argument on this point– nano silver was described as a source of silver ions, and consequently toxic in that it increased the total amount of silver being released in the environment. On the other hand, ICTA claimed that nano silver induced new toxicological effects. This critique of the zero hypothesis was based on a series of scientific works that had attempted to isolate silver nanoparticles. For instance, the ICTA used a scientific publication that described the extraction of silver nanoparticles from the matrix in which they had been included[1]. The authors of this publication could then analyze the various shapes of the nanoparticles, and the effects they had on living cells. Through a study such as this, silver nanoparticles appeared as isolated substances, which differed from non-nano silver, and could even be differentiated from each other, based on their size or shape. Imaging technologies and physical tools of extraction were needed to perform such work. They complemented the legal tools that ICTA was using in the petition in order to isolate nano silver as a new substance.

Isolated by ICTA in the petition, nano silver then became a stake for social mobilization. Nano silver could then be identified as an object NGOs needed to mobilize for since, as ICTA's argument went, EPA was reluctant to deal with it in spite of its specific identity. For ICTA, the mobilization of NGOs could make the regulation of nano substances move forward, that is, grant existence to previously not legally recognized nano substances[2]. These actions implied alliances and collaboration among NGOs: ICTA initiated a partnership between U.S. and international consumer and environmental organizations and trade unions, which released "principles for oversight of nanotechnology" in 2007.

[1] Elechiguerra et al. 2005

[2] The importance of social mobilization for ICTA is clearly visible in the narration of the origins of EPA's actions concerning nano silver: the petition made it clear that EPA's initiatives originated from NGOs' activism.

These principles called for the integration of nano substances as new substances in regulatory frameworks, and the involvement of "civil society stakeholders" in this process. For George Kimbrell, a lawyer at ICTA, writing these principles and collectively supporting them was both a matter of organizing a social mobilization, and making visible the issue of the novelty of nano substances:

Writing these principles was a novelty for us. It was the first time we managed to collaborate with unions, consumer groups, and international organizations... But it was a necessary condition to make it clear that nanomaterials are new substances! This issue crosses boundaries, you need to have NGOs from all across the spectrum.[1]

Collective organization could back a position that was clear for the ICTA: nano silver was a substance that needed to be made existing. At this point, the difference between the ICTA's position and that of the Luoma report appeared not only at the level of the existence of nano silver, but also at that of the collective organizations they implied. In using the expertise of Luoma, and in the very report, stressing the importance of known techniques of environmental impact assessment, the main point of the Woodrow Wilson Center's Project on Emerging Nanotechnologies was to mobilize expert works in order to base the evaluation of risks on rational approaches. This important feature of the PEN was a condition for what its director called "the neutrality of the Woodrow Wilson"[2]. While acknowledging that the Center got funding from Congress, he was also keen to insist on the fact that his actions were not involved in "political decisions". This position of neutral expertise does not mean that PEN is not concerned with situations of uncertainty or controversy. Yet the approach to such situations was consistent with the expert position: an expertise about nanotechnology's "public" was to be developed in order to measure the social expectations and concerns. The director of PEN was thus proud to explain during an interview that his organization was "one of the few places where the public's concerns were systematically measured". Indeed, PEN had been running focus groups on topics related to nanotechnology, and used their results to argue for the need to increase federal funding for risk research. In the meantime, informing citizens and consumers about nano substances and their potential risks was an important task. Remember that the WWC was actively cooperating with American science museums in the making of exhibits and information diffusion processes (cf. chapter 2). ICTA did use the Luoma report, notably for its illustration of the increase of the total amount of silver released in the environment because of the development of nano silver applications[3], but eventually adopted a different

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[1] Phone interview, G. Kimbrell, March 2009.
[2] Interview with the director of PEN, Washington DC, March 2009.
[3] Thus, the situation is not reducible to an opposition between hazard and exposure evaluation (in which Luoma would discuss the evaluation of hazard, while arguments about increased exposure would be mobilized by ICTA).

scientific and political position, explicitly advocating a constitutive "stake", that is, the existence of nano silver, and considered it a mobilization topic for the constitution of a global social movement.

Industries got in

For EPA, ICTA's petition made nano silver an issue to deal with. The Agency commissioned an expert committee, FIFRA *Scientific Advisory Panel* (SAP), which examined the nano silver issue during a 3-day public meeting in November 2009[1]. The meeting was an opportunity for several actors to present their arguments. Among them, ICTA representatives advocated another time for the existence of silver nano. The main opponent of ICTA was then a federation of silver-related industries, the Silver Institute. Having remained silent until then, the Silver Institute had reacted to the ICTA's petition by creating the *Silver Nanotechnology Working Group* (SNWG), described as

an industry effort intended to foster the collection of data on silver and nanotechnology in order to advance the science and public understanding of the beneficial uses of silver nanoparticles in a wide range of consumer and industrial products[2].

Directed by a chemist based at the university of North Carolina, and gathering about ten researchers, SNWG made its positions clear during the SAP meeting. It attempted to demonstrate[3] that colloidal silver (that is, solutions made of silver compounds of various sizes in solutions) and nano silver were but one single chemical substance[4]. Accordingly, the contributions of SNWG to SAP use a series of "historical" products containing nano silver. In its PowerPoint presentation, it displayed sanitary products based on colloidal silver, some of which had been registered within FIFRA for years:

In selecting information to include as background, the EPA paper fails to acknowledge that the majority of existing registered silver products are nano silver, including the algaecides and water filters that have been in use for decades. In fact all EPA registered silver products through to 1994 were nanoscale silver. The fact that these nano

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[1] In this sub-section, I use transcripts and interviews with ICTA and the Silver Institute.
[2] www.silverinstitute.com/snwg.php (accessed September 2010).
[3] Before the SAP meeting, a public file was opened for interested parties to contribute. The analysis of the silver industries' positions is based on this public documentation, completed with an interview with the executive director of the Silver Institute, and email correspondence with Rosalind Volpe, in charge of the Nanosilver Working Group. Dr Volpe sent me additional documentation about the Working Group activities.
[4] Delattre, James, Murray Height et Rosalind Volpe, 2009, "Comments of the Silver Nanotechnology Working Group for Review by the FIFRA Scientific Advisoty Panel", EPA–HQ–OPP–2009–0683 ; Height, Murray, 2009, "Evaluation of Hazard and Exposure Associated with Nanosilver and Other Nanometal Oxide Pesticide Products", presentation at SAP-FIFRA, 3-6 Novembre 2009.

silver products have been used commercially for decades with no incidents of significance reported in the EPA OPP IDS incident database should be taken into consideration by the Panel.[1]

SNWG then insisted on the fact that nano silver was not a new substance, but identical to colloidal silver, which had never been demonstrated to be hazardous, could be managed properly using the zero hypothesis, and was already regulated within FIFRA. SNWG then concluded that no new measures were necessary – a position that could be held by not drawing the distinctions ICTA did in the petition between shapes, sizes and states of aggregation[2].

Multiple and uncontrollable nano silvers

According to a process that had become widely used at EPA, the intervention of SAP allowed EPA to avoid the opposition among "vested interests" (those of ICTA as well as those of industrialists) by calling for a scientific examination of nano silver based on "sound science"[3]. In the background paper that EPA delivered to SAP, and during the panel meeting, the question was that of "bridging": could one extrapolate the available knowledge on the toxicity of silver ions to the case of nanoscale silver? In other words, was the zero hypothesis valid?

The discussions at SAP did not simplify the question. For types of nano silver multiplied as experts were examining the zero hypothesis[4]. Using a series of recently published scientific papers, the panel members considered that size played a role on the toxicological properties of the substances, most notably on the rate of silver ion release: silver nanoparticles of different sizes therefore appeared likely to hold different toxicological properties. Following these considerations, the panel stressed that the behavior of the "big nanoparticles", of a 100 to 1,000 nm size range, was unknown. The situation got even more complex as the panel noticed that many of the products using silver nanoparticles comprised a wide distribution of particle sizes. In addition, size was not the only considered parameter: the properties of the surfaces on which the silver compounds are deposited (for disinfection and sanitization

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[1] SNWG, 2009, Comments on the SAP background paper: 7.

[2] The silver institute leaders displayed explicit contempt for ICTA's actions during interviews. The answer to a question asked about the petition was: "those idiots! They just haven't done their homework." (Interview, M. di Rienzo, silver institute administrator, Washington, November 28, 2009).

[3] Scientific Advisory Committees (among which FIFRA SAP), as well as the Scientific Advisory Board have been ways for EPA to answer criticisms of the alleged "low quality" of the science the agency mobilized (because of its openness to legal contestation) (Jasanoff, 1990; Jasanoff, 1992). In turn, these authorities have had to renegotiate on each topic the boundary between science and politics, by reconstructing stable scientific objectivity and administrative procedures. Conflicts between EPA and its expert committees were numerous (Jasanoff, 1990: chap.5). The nano silver case will be shown to be different.

[4] The discussions at the SAP meetings are reported in: EPA, 2010, *Meeting Minutes of the FIFRA Scientific Panel Meeting held November 3-5, 2009 on the Evaluation of Hazards and Exposure of Nanosilver and Other Nanometal Pesticide Products*, Office of Prevention, Pesticides and Toxic Substances Memorandum. Quotes in this paragraph are excerpts from these meeting minutes.

applications) were explained to impact the release rates of silver nanoparticles as the products were used. Silver compounds could not even be regarded as unique, isolated substances. Thus,

The panel expressed concern for complexes containing nanoscale particles (…) because this would affect the mobility within humans or environmental exposure. Nanosilver contained in a complex is likely to have a different nature, environmental fate (…) than nanosilver itself. The fate and effects of the complex will be controlled to a significant extent by the properties of the complex (i.e. size, chemistry, etc).[1]

In addition, the panel followed Luoma and ICTA as it stressed the fact that silver nanoparticles may agglomerate, which could modify their toxicological properties. Understanding agglomeration processes would imply a better knowledge of the circulation of substances in the environment. Yet the panel remarked that the construction of circulation models able to account for the fate of nano silver in the environment would require a huge amount of data (describing, for instance, the capability for bounding with naturally occurring substances in water), which would be potentially different for each product:

These models should incorporate 1) additional metrics for dose and exposure such as particle size (mean and distribution) ; surface area ; particle shape ; agglomeration state and rate of agglomeration/de-agglomeration or stabilization in application environments ; surface chemistry (coating, charge, reactivity) of nanoparticles ; and rate of dissolution. For example, information is lacking on dissolution rates for nano-forms of 1) pure Ag0 ; *2)* Ag0 *with impurities, surface imperfections or non-crystalline or amorphous coatings ; and 3) the effects of organic or inorganic surface coatings.*[2]

Thus, the exchanges during the SAP meeting made nano silver multiply. If differentiated according to their toxicological properties, nano silvers could be as many as the combinations of size range, agglomeration capabilities, and possibilities for bounding with nitrates or other natural substances in water. The SAP concluded that the determination of the substances' hazard required the evaluations of:

Particle size and size distribution ; agglomeration state and aggregation ; shape ; overall composition (including chemical composition and Crystal structure) ; surface composition ; purity (including levels of impurities) ;

[1] SAP meeting minutes: 30
[2] SAP meeting minutes: 22

surface area ; *surface chemistry (including reactivity and hydrophobicity)* ; *surface charge* ; *stability and context/media*[1]

The bridging issue ("can one use silver ions data in order to evaluate the toxicological properties of nano silver?"), which was a key question in the commissioning for SAP by EPA, was thus displaced. Not only did the available data appear insufficient for the panel members, but the relevance of the bridging question itself appeared doubtful. Indeed, even if one considered that the mechanism determining the toxicity of nano silver was the action of the silver ions it released, then the modalities of the circulation of nano silver in the environment (or the human body) – which depend on physical and chemical characteristics, not necessarily the same across the range of nano silver products – impacted the quantity and the frequency of the released silver ions. Thus, the opposition between "there are risks that are specifically linked to nano silver" (ICTA's position) and "nano silver risks are reducible to those of silver ions" (Silver Institute's position) could not hold anymore. The zero hypothesis could not be at the center of the discussion, which Luoma himself acknowledged two years after he had written his report for PEN (he was then involved in a federally funded project assessing the hazards of a range of nano substances):

This (the zero hypothesis) *is not that important* (…) *what if the capacity for silver ion release is altered according to the capping agents, or the circulation of the nanosilver in particular places?*[2]

The displacement of the zero hypothesis is similar by many respects to that of the distinction between the evaluation of hazards ("intrinsic properties" of the substance) and that of exposure. As the hazard of nano silver depends on the conditions under which it may release silver ions, the conditions of exposure impact the measurement of hazards. The panel was thus led to consider that the modalities of the circulation of nano silver in biological or natural environments (which relate to exposure in classical risk analysis) were not separable from its hazards, since the physical and chemical parameters of the environment affected the potentiality for silver ions release. Hence, small scale, model cell toxicology appeared insufficient to evaluate the risks of nano silver.

<u>*Calling for more science*</u>

Faced with the proliferation of potential nano silver, and the impossibility of performing classical risk analysis, EPA did not attempt (as ICTA beforehand) to make nano silver exist as a new chemical

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[1] SAP meeting minutes: 24
[2] Phone interview with S. Luoma, May 2010.

substance in the FIFRA framework[1]. The federal agency continued after the SAP meeting to regulate companies' claims: if a company declares that a product has biocidal properties, it then must register it as a pesticide, whereas no specific requirement for nano silver is specified. SAP suggested that future research should work on the physical and chemical characteristics of silver nano (e.g. size, specific surface area, shape) and link them to the hazards of the substances. In addition, it called for the evaluation of the total quantity of silver in consumer goods using nano silver[2]. Hence, the difficulty to deal with the uncertain existence of silver nano and the impossibility of controlling substances led EPA experts to call for "more science", more precisely "more predictive toxicology"[3]. The dynamics between the legal oppositions among stakeholders and the (non) resolution of controversy by the call for science has been descried in other examples at EPA since the creation of the federal agency[4]. In the case of nano silver, it led the EPA not to determine the existence of nano silver, while simultaneously arguing for the necessity to do so, at a hypothetical future time when "more science" would be available[5]. In this situation, the existence of nano silver was discussed in a binary way that followed the dynamics of the oppositions between stakeholders. The advocates of existence argued with the defenders of non (specific) existence in the legal arena. Eventually, the recourse to a call for more science resulted in the postponing of constraining regulation. For calling for "more science" on nano silver faces the difficulties already mentioned about carbon nanotubes, only on a much larger scale. Nano silver does not stand still in the products in which it is used, its fate in the environment and the human body is uncertain, administrative agencies (and industries buying it as raw materials) do not know where it is used, its existence is not defined, and companies' claims are a shaky ground for regulation-making. Here, the difficulty of predictive toxicology is even more manifest than in the case of carbon nanotubes.

Current research projects use silver nanoparticles that are synthesized on stage, as industrial products are poorly characterized[6]. That is why SAP insisted on the fact that a critical stake was related to standardization. Indeed, this would be a necessary condition in order to build the infrastructure through which the "unique properties" of nano silver could be made visible, as well as those of "nano

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[1] Within EPA *Nanomaterial Stewardship Program*, a single file mentions silver. It was registered by General Electric, and does not differentiate between nano and non nano silver.

[2] SAP report: 37-38.

[3] In other examples, SAP had to deal with alternative constructions of science for public decision-making (e.g. legal actions, public interventions of NGOs in the press, etc.), which sometimes originated from EPA itself (Jasanoff, 1990: 123-151). In the case of nano silver, the positions of SAP and EPA are remarkably aligned.

[4] Jasanoff, 2011; Laurent, 2010e

[5] One can see a similar endpoint in Europe ("more science"), but with a different legislative evolution, which grants existence to nano substances in some cases. Examples will be examined in chapter 5.

[6] For instance, Luoma's newest project does not use industrial products, which are considered to be "poorly characterized": "We synthesize the nanoparticles ourselves. We're lucky enough to work with chemists who know how to do that. (...) The field can only move forward if the studies are based on well characterized nanoparticles." (Phone interview, S. Luoma, May 2010)

silver agglomerates, or incorporated by ligands"[1]. In this perspective, the objective of public action is to stabilize an infrastructure that would determine the parameters to be taken into account, the measurement devices, and the regulatory modalities of the instruments able to monitor industrial work. As long as such an infrastructure is not in place, regulatory approaches can easily be re-opened and questioned. The next section thus considers the work of standardization agencies related to nano substances.

Answering ontological uncertainty by containment or binary oppositions

So far, I have described different fashions in which the problem of the existence of nano substances is dealt with. While it can be avoided in some cases at the price of total containment, it sometimes leads to direct and binary opposition between stakeholders with confronting interests, solved by a call for "more science", which postpones any regulatory action. In all cases, the technical work goes with ways of organizing democracy, whether it implies the control of the diffusion of information and thus the type of actors who can voice concerns, or takes shape with legal confrontation of "stakes" related to the existence (or the nonexistence) of substances. The two cases considered here provide illustrations of contrasted technologies of democracy. While the French producer of carbon nanotubes experiments with an original containment system, the American actors re-enact a well-stabilized mode of management of public concerns based on the oppositions among stakeholders and the eventual recourse to science.

The next section will explore how nano substances are brought to existence, in ways that are more complex than the mere binary opposition (new/old) or the move away from the ontological uncertainty through containment. It does so by considering the international standardization of nano substances: the discussions at the International Organization for Standardization (ISO) and the Organization for Economic Cooperation and Development (OECD) lead international partners to explore the possible existence of nano substances. As the next section will make it clear, these discussions are constrained by both technical (im)possibilities and the format of international negotiation. The dynamics of international negotiation and the problem of the existence of nano substances will thus appear intertwined.

[1] SAP report: 38

Section 2: Multiple ontologies. Standardizing nano substances in international organizations

ISO Technical Committee for nanotechnology

The controversies about the existence of nano substances routinely lead industrial and science policy actors to call for norms and standards that would provide common terms of language, methods of measurements, and techniques of risk evaluation. At an early stage in the development of nanotechnology policy programs, science policy leaders (including the most prominent of them, Mihail Roco, director of the U.S. National Nanotechnology Initiative) insisted on the need for international cooperation among countries involved in the development of nanotechnology. At an international meeting in 2004 in Alexandria, VA, where American and European science policy officials gathered at the invitation of Roco, an "international dialogue for the responsible development of nanotechnology"[1] was launched. For the participants in the Alexandria meeting, standardization could both "facilitate the functioning of the nanotechnology market" and "provide sound grounding for future regulations" of nano substances. Roco later explained that normalization was above all about producing common terms of reference, since

Exchanges of correct and reliable information are important in the communication among various actors, in public perception and in the framing of a new technology.[2]

ISO Technical Committee on nanotechnology, TC229, was created in June 2005, and received the mandate to develop standards "in the field of nanotechnologies that include either or both of the following":

1. Understanding and control of matter and processes at the nanoscale, typically, but not exclusively, below 100 nanometers in one or more dimensions where the onset of size-dependent phenomena usually enables novel applications,

2. Utilizing the properties of nanoscale materials that differ from the properties of individual atoms, molecules, and bulk matter, to create improved materials, devices, and systems that exploit these new properties.

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[1] Interview with F Roure, Paris, October 2008. Roure was a senior adviser for the French minister of economy and co-author of the 2004 report *Nanotechnologies. Ethique et Prospective Industrielle*, which grounded the French nanotechnology policy. Quotes in this paragraph are excerpts from this interview.

[2] ISO Focus, April 2007.

My objective in this section is not to describe extensively all the projects led at TC229. Rather, I am interested in the ways in which the Technical Committee, through its originally three, then four, working groups, each divided in at least a dozen projects, grants existence to nano substances. I examine how the committee faces constraints related both to technical difficulties and to the dynamics of international negotiations in the ISO arena, and how, consequently, it overcomes the destabilizations introduced with nano substances and thereby re-stabilizes technical options and collective organizations. I will briefly contrast the work of TC229 with other approaches in the standardization of nano substances, most notably within the OECD.

The ISO delegates had to deal with the very same issues that the previous section described (poor characterization of nano substances, no predictive toxicology), while at the same time being caught in a very specific position, both related to public regulation and private company strategies. Indeed, albeit a private organization expected to serve the interest of private companies, ISO production is also tied to the construction of public regulation. The participants in ISO are national standardization institutions, which are themselves hybrid organizations gathering public and private actors[1]. The imbrication of public and private interests in standardization activities has been noticed and the circulation of individuals across private and public bodies within the standardization organizations described[2]. This has led scholars either to question the delegation of public interest to private actors or to celebrate the "flexibility" and the "democratic" feature of international voluntary standards over "rigid" and "technocratic" legal directives[3]. I am less interested here in these binary debates than in the analysis of a hybrid mode of public action through standardization, which participates not only in the construction of a market, but also in the construction of nanotechnology objects, programs, concerns and publics, and thereby stabilizes forms of democratic organizations. As such, the production of standards at ISO TC229 is a technology of democracy, which can be analyzed through the study of the actual process of standard-making[4].

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[1] For instance, the French AFNOR Group is a "public-benefit organization" which "conducts some of its business in the competitive arena" (http://www.afnor.org/en/group/about-afnor/about-us, accessed Sept. 20, 2010). Civil servants are members of the board. French delegations to ISO, while headed by representatives of private companies, comprise civil servants as well.

[2] (Dudouet et al., 2006; Cochoy, 2000; Mallard, 2000).

[3] Brunsson and Jacobsson make this point, which is also explicitly advanced by standardization organizations themselves (Brunsson and Jacobsson, 2002).

[4] For examples of empirical analyses of standard-making see (Mallard, 1997, 2000; Cochoy, 2000). Many studies are concerned with the motivations of companies for participating in normalization procedures and adopting standards (Dudouet et al., 2006), the determinants of the influence of experts in normalization processes (Demortain, 2008), and, more generally, the economic analysis of incentives and coordination issues related to industrial relations mediated by standards (see a literature review in Diaz et al., 2009). I am not attempting here to identify "incentives" or "determinants" in standard-making.

The case of nanotechnology is specific in this respect, as normalization occurred early in the development of actual substances and products. The leader of one of the Working Groups of TC229 thus explained:

Nano is an abnormal group. We've never done this before. It's really about taking the beginning of the scientific basis to understand what we're talking about. It's quite abnormal. Usually, we're looking at products. But we're ignorant of what nanotech is. We haven't reached the point of being precise in the language. So why is nano different? The simplistic view is that we got into it early. But I think that nano is fundamentally different. We did talk about enabling technology before, we had information technology. But there was a big industry, the ICT industry, which developed standards. Biotech had a less central core, but there is the pharmaceutical industry. When you come to nanotech, there will be absolutely no verticality. It's a purely horizontal technology, manifested as elements of other technologies.[1]

Hence, the standardization of nanotechnology cannot be grounded on a stable basis. There is no such thing as a consistent set of industrial products needed to be standardized, a domain of industrial activity with clearly defined expectations, or even common reference terms. Not only is nanotechnology characterized by an early involvement of standardization, but it also implies that standardization has to create no less than a scientific discipline, a market domain, and new definitions of chemicals.

This work is undertaken at TC229, chaired by the British Standardization Institute (BSI), through projects devoted to nomenclature (working group 1), metrology and instrumentation (working group 2), and health and safety issues (working group 3)[2]. TC229 comprises delegations from 36 countries, made of members of public administrations as well as private companies. The composition of the most numerous delegations is a sign of the tight link between the construction of ISO standards and that of science policy. The leader of the American delegation is Clayton Teague, director of the National Nanotechnology Coordination Office, a White House-based body that coordinates the whole set of nanotechnology federal programs. The French delegation comprises the civil servants in charge of nanotechnology within the French administration, as well as industrialists – the delegation is led by David Bertrand, of A*** (cf. section 1 of this chapter).

Within working groups, projects are launched at the initiative of the national delegations that have particular expertise in the field and/or are interested in developing specific standards. Proposing a project in never a neutral choice, as it also implies that particular technological aspects will be privileged over others, possibly at the benefit of particular industrial or research sectors. I will provide in the

[1] Oral intervention, ISO TC229 meeting, Maastricht, May 2010.

[2] A fourth WG on the specification of nanomaterials was later added to the first three, at the initiative of the Chinese delegation, which pushed for the inclusion of works related to particular substances, e.g. calcium carbonates.

following some illustrations of this process. Thus, the process of international cooperation that was pushed forward by science policy leaders at the Alexandria meeting will appear ambivalent, as international standardization is a place where public or private national strategies compete against each other, within the overall objective of the "responsible development of nanotechnology".

Once selected, projects are led by a member of a country delegation, who proposes drafts of reports and normative documents. These documents are then annotated and commented on by the participants in the projects, who meet twice a year in person during plenary meetings[1], and more often through teleconferences. Comments are compiled and presented in a matrix, where the project leaders can respond to them. Some comments are discussed in meetings. Texts are then validated by votes, and have different statuses, according to their normative strength and the level of consensus that is achieved. Apart from "international standards" which constitute the normative production of ISO, "Technical Specifications" are issued "when the subject in question is still under development or where for any other reason there is the future but not immediate possibility of an agreement to publish an International Standard"[2]. TS are meant to evolve into International Standards. This is not the case of "Technical Reports" (TR), which are "entirely informative in nature and shall not contain matter implying that it is normative"[3].

In the following sections, I discussed some of the TC229 projects meant to lead to TR, TS, or international norms[4]. I first consider the work being done to define the "nanoscale" and, accordingly, "nanomaterials" according to a size criterion. I then turn to alternative approaches, which attempted to define the "nano-ness" of substances according to their (toxicological) properties and explain the process that made them fail to be stabilized within ISO. Eventually, I contrast the work done at ISO with that of OECD. The construction of standards at ISO TC229 will thus complexify the approaches described in the first section of this chapter. It will illustrate the multiple ontologies of nano substances.

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[1] Plenary meetings of TC229 were in Bordeaux (2008), Seattle (2009), Tel Aviv (2009), Maastricht (2010), Kuala Lumpur (2010).

[2] ISO, 2004, *ISO/IEC Directives. Procedures for the technical work:* 31.

[3] *Ibid.*: 32

[4] The material for this section of this chapter and for chapter 5 is based on interviews with members of the French delegation to TC229 and participations to the French nanotechnology committee meetings. I also used a series of documents, including numerous drafts (at least one per project), comments from delegations, and meeting notes. This material does not cover the whole range of TC229 activities, but it allowed me to complement the information gathered in interviews. In most of the cases, I use publicly available documentation. In the others, I did not reproduce the name of the involved delegations.

Solidifying a size criterion to define the nano-ness of substances

Defining the nanoscale. A "science-based" process

Faced with a field that was to be entirely defined, TC229's approach consisted in "grounding the work on science", and, in WG1, crafting definitions "from the most basic" to the most complex. The first of them was that of the "nanoscale":

The first term we needed to define was the nanometric interval, the nanoscale. So, after a year of discussion – it was long! – we finally got to a consensus. Nanoscale goes approximately from 1 to 100nm.[1].

Getting to a consensus about the nanoscale was not an easy process and took one whole year (two plenary meetings and a series of conference calls gathering members of the terminology sub group).

The 100nm limit originated from the many science policy reports that had defined national nanotechnology programs in various countries or international organizations. The American National Nanotechnology Initiative was based on the 100nm limit[2]. The 2004 British *Royal Society* report (which made explicit the British strategy in nanotechnology) restated the 100nm limit[3], as did the O.E.C.D.[4]. In these documents, the 100nm size limit was commonly referred to as an indication of a size range where "new properties may emerge"[5]. As a science policy concept, the 100nm size limit was both an umbrella term able to bring together the many research projects related to the exploration of properties emerging at the atomic scale, and a technological indication characterizing new properties and products. Consequently, the 100nm size limit was considered in all the above-mentioned documents and by the actors involved in TC229 as an "order of magnitude", a "typical but not exclusive" dimension. It was a device able to synthetically define public funding programs for scientific research, while taking into account a wide range of scientific works converging in a common direction ("new properties at dimensions in the range of the tens of nanometer") rather than a boundary uniquely sustained by a laboratory instrumentation[6].

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[1] Interview with a member of WG1, Paris, May 2010. The "approximately 1 to 100nm" definition was part of a TS released in 2008 (*Nanotechnologies – Terminology and definitions for nano-objects – Nanoparticle, nanofibre and nanoplate*, 2008, ISO/TS 27687).

[2] "Dimensions between approximately 1 and 100 nm are known as the nano-scale" (NNI strategic plan, 2007).

[3] "typically under 100nm", The Royal Society and The Royal Academy of Engineering, 2004, *Nanoscience and nanotechnologies*: 5.

[4] "The size range typically between 1 and 100 nm" Summary Record of the 2nd meeting of the WPMN ENV/CHEM/NANO/M(2007), April 2007: 22.

[5] Interview with a member of WG1, Paris, May 2010.

[6] This is clearly visible in NNI reports, where a broad diversity of scientific projects is gathered under the umbrella of the manipulation at the nanoscale.

Distinguishing what is "nano" from what is not consists in not being "too big". This was the role of the 100nm size limit, which TC229 did not question. It also means that the scale should not be "too small". For if bare molecules enter the nanoscale, then what should happen to organic molecules produced by the petrochemical industry? They could then become as "nano" as carbon nanotubes and silver nanoparticles, thereby diluting the specificity of the field. In order to avoid the inclusion of too small objects in the nanoscale, discussions at WG1 converged towards an inferior limit set at 1nm. Yet consensus was more difficult to reach in that case, as a member of the WG1 reported during an interview:

The discussions lasted for a long time because the English did not want an inferior limit for the nanoscale. They wanted us to define the nanoscale as smaller than 100nm without inferior limit. Scientific publications diverged on this point, so they did not want to integrate it in the definition[1].

The argument was simple, and related to chemical substances such as fullerenes. These football-shaped carbon compounds (C_{60}) were synthesized and described by Richard Smalley, one of the fathers of nanotechnology, in the mid-1990s. Yet:

Fullerenes are considered as molecules. C_{60} *is a molecule and some people would say that molecules needed to be excluded from the definition of nano objects. And a fullerene has a size smaller than 1nm. But we couldn't exclude fullerenes from the set of nanomaterials. This would have been an aberration…*[2]

Indeed, the definition of the nanoscale is but a first step prior to the definition of nano objects and nanomaterials. Should the nanoscale be defined in such a way that it did not comprise fullerenes' dimensions, these compounds would risk not being included among the nano objects. And it was "absurd" to exclude fullerenes since these compounds are "the starting point of nanosciences and nanotechnologies. When they open, then nanotubes grow. They are the basic structures of all carbon-based nano materials"[3]. Even more, "fullerenes are the starting point of all the nano programs" since they are above all "Smalley's discovery" and have been used as examples for the construction of nanotechnology programs[4]. Thus, science policy was as much a component of the nanoscale as the reduced physical dimensions of substances. Accordingly, the "science-based" process according to which a consensus was to be reached on the construction of common nanotechnology terminology was as

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[1] Interview with a member of WG1, Paris, April 2010.
[2] *Ibid.*
[3] The *Royal Society* report proposes a "typically from 100nm down to the atomic level (approx. 0,2nm)" definition (The Royal Society and The Royal Academy of Engineering, 2004, *Nanoscience and nanotechnologies*: 5).
[4] Cf. the origins of the US nanotechnology programs (McCray, 2005; Laurent, 2010a: 21-53).

much (if not more) about international negotiations and science policy considerations as about technical examination.

The discussion about the nanoscale was eventually settled by the addition of the adverb "approximately" at the two limits of the nanoscale. This could account for the fact that "nano phenomena can intervene beyond 100nm and below 1nm", and to include smaller than 1nm objects like fullerenes.

From the nanoscale to nano substances

The construction of definitions went on from that of the nanoscale. 11 sub-groups within the WG1 were set up to craft a series of definitions (such as "nano-devices", "nano-processes", etc.), according to the needs of the other working groups of TC229. What interests me at this stage is the work done, after the nanoscale, in order to grant an existence to nano substances. WG1's first task after the definition of the nanoscale had been settled was to craft that of the "nano objects". It defined nano objects as substances with at least one dimension falling within the nanoscale. For instance, a nanoparticle was defined as a three-dimensional nanoscale object, a nanotube as a substance with two nanoscale dimensions (i.e. the transversal section), and a nanoplate as an object with only one nanoscale dimension[1].

The definition of the various nano objects followed directly from the definition of the nanoscale, but that of "nanomaterials" was much more controversial. As in the case of the nanoscale, the construction of a boundary between what was nano and what was not was at stake. Members of WG1 agreed to consider that "nano objects" as they had defined them were indeed "nanomaterials". This was done at the price of the opposition to national delegations that did not want to include "ultrafine particles" within the scope of nanomaterials. Ultrafine particles were substances that had been gradually constituted as a specific topic of activities among toxicologists who had been studying the hazards of chemicals released in fumes, and for some of them had then applied their tools and methods to the study of airborne nanoparticles[2]. As nanomaterials gradually became synonymous with "substances with uncertain risks", more and more actors were reluctant to expand the scope of substances that, albeit already in use, could then be regarded as risky, and be potentially subjected to more investment in order to demonstrate their safety. Should a new regulation be implemented for nanomaterials, ultrafine particles could then, if included within the nanomaterials class, be subjected to more stringent controls. This is the reason why some participants of TC229 refused the extension of the set of nanomaterials.

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[1] Nanotechnologies – Terminology and definitions for nano-objects – Nanoparticle, nanofibre and nanoplate, 2008, ISO/TS 27687:2008.
[2] Oberdörster et al., 2005

But excluding ultrafine particles would have implied that objects with dimensions at the nanoscale would not have been included in the set of nanomaterials, and, as such, would have contradicted the "science-based" approach.

The question of the "novelty" of nanotechnology was thus recomposed within the standardization organization. Substances which were in use, routinely put on markets or released in industrial or usage processes could then be considered "nano", and be consequently scrutinized as they had never been before. Within ISO, the novelty of nanotechnology was not just about "new substances" created out of revolutionary processes such as molecular manufacturing, but something that needed to be crafted as an administrative and technical category, which may well have implied the re-qualification of existing products as "nano".

The reduction of the terminology discussion about "nano" to the qualification of the nanoscale did not end all controversies. A central issue was the reduction of nanomaterials to nano objects. Members of WG1 added the "nanostructured materials" to nano objects in the nanomaterials category. "Nanostructured materials" were defined as having an internal structure characterized by at least one nanoscale dimension. Including nanostructured materials in the definition then rendered possible the inclusion of aggregates of nano objects (bigger than 100nm, but with nanoscale structural regularities) in the class of nanomaterials. The inclusion of nanostructured materials caused vigorous opposition from some delegations. Indeed, if specific risk evaluations were asked for each different nanomaterial, then a producer of aggregates of nano objects would be required to provide additional studies. A vote eventually stabilized the inclusion of nanostructured materials in the definition of nanomaterials. The inclusion of nanostructured materials could indeed ensure that the logic of the approach "grounded on science" (or "science-based") was followed. As the objective was to define "nano-ness" according to criteria based on the nanoscale, materials not made of individual nano-objects, but nonetheless displaying nanoscale regularities in their internal structure had to be included.

Once the definition of nanomaterials was settled, the definition of nano ness in terms of size could be accepted. Accordingly, one of the projects of WG1 produced in 2008 an *Outline of nanomaterials classification* based on a "nano-tree", that is a graphical organization of all nano-objects, sorted out by their dimensions, and, at later stages, shapes and properties - properties being the final elements to evaluate in order to characterize the substances. The size-based definition was thus adopted as a way of crafting a new scientific domain and new realms of market activities. Yet its success should not conceal the fact that it was not the only possibilities for the definition of nano substances.

A (toxicological) property-based definition of nanomaterials?

Alternate definitions of nano substances

The 1-100nm limit was criticized outside of ISO, and the addition of the adverb "approximately" did not answer all the concerns. Outside ISO, NGOs voiced concerns about the definition of the nanoscale related to the 100nm size limit. The European Environmental Bureau (EEB), a federation of European environmental associations, and Friends of the Earth feared that too strict a limit would prevent any future regulation from taking new properties into account[1]. Indeed, the properties of particles bigger than 100nm, but smaller than 1,000nm, could well hold specific toxicological properties (like silver, cf. above). Accordingly, EEB and Friends of the Earth questioned the validity of the 100nm size limit: as a science policy convention, did it not ignore the reality of the development of the actual nano substances? For if the industry produces nano substances, so their argument went, new properties, and not the sole smallest size, matter the most. EEB and Friends of the Earth thus considered it important to expand the size limits. For them, any regulation related to nano substances should include substances that are within a 0.3 – 300 nm size range[2].

Determining the nano size range as such was no less a science policy decision than the 1-100nm one, only less equipped in terms of connections with science policy programs. Yet EEB also added another aspect to its proposal, when including substances "having nanomaterial-like properties (...) even though they fall beyond the official size range"[3] in the proposed definition. In this latter proposition, the "nano-ness" would be characterized by specific properties, not necessarily related to the substance's size. The "nanomaterial-like properties" were not specified by the EEB. Yet some researchers follow a similar line in proposing to define inorganic nanoparticles "from an environmental, health and safety perspective"[4]. This would lead regulators to define a nano object according to "size-related properties instead of size itself"[5]. For instance, specific surface area, oxidation rate or ion release rate could be considered. Another research group proposes to study the "protein corona" of nanoparticles in a biological environment, that is, proteins linked to the surface of nanoparticles, which could provide an indication of the surface characteristics and "possibly also the biological impacts"[6]. One could then

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[1] These actors intervened from outside of ISO, while the nanoscale terminology had already been adopted. Their positions are presented in: European Environmental Bureau, 2008, *EEB Position paper on nanotechnologies and nanomaterials. Small scale, big promises, divisive messages*, February 2008; Friends of the Earth, 2008, *Discussion Paper on Nanotechnology Standardisation and Nomenclature Issues*, August 2008.

[2] The 300nm size limit, in this perspective, is linked to the maximal size for the diffusion across the placenta to the human foetus.

[3] *EEB Position paper*: 10.

[4] Auffan et al., 2009.

[5] *Ibid*: 641

[6] Lundqvist et al., 2008: 14269

determine a "biological identity" (an expression used by G. Oberdörster, a well-known figure in nanotoxicology, in a review article) of the nano substances[1]. These proposals attempt to render more complex the size-based science policy criteria, and operationalize them in a more detailed manner, considering that what matters is less the sole size of the substances than their new toxicological properties. What these new properties are is then the main issue at stake.

Defining "nano-ness" according to the properties of the substances was mentioned during the discussions within the WG1. The idea was consistent with the TC229 mandate, which included the standardization of

the properties of nanoscale materials that differ from the properties of individual atoms, molecules, and bulk matter, to create improved materials, devices, and systems that exploit these new properties.[2]

The property-based definition of nano substances was more explicitly explored in one of the projects of WG1, which proposed a "taxonomic framework" for the terminology of nanotechnology. Based on a list of concepts produced by the project group members and existing ISO standards[3], five "framework diagrams" were proposed: "fields of activity at the nanoscale", "nanomaterial", "processes", "nanosystems and nanodevices", and "properties". The last one explored ways in which nano substances could be classified according to their properties. The problem the group faced was to define the ways in which "properties (e.g. electric properties), phenomena (e.g. quantum optical phenomena) and states (e.g. crystalline states) were associated with each other"[4]. Classifying properties eventually appeared the most relevant when based on the "nanoeffects of nanomaterials", the "nanoeffects" concept being "a pragmatic, measurable observation"[5]. For instance, the "nano-ness" of silver nanoparticles could then be defined as a combination of state (specific surface area), phenomena (delivering silver ions), and properties meant for specific applications (e.g. anti-microbial). This definition linked the toxicological profile of the substance, and the conditions of its use and circulation in natural or biological environments.

This approach was considered "pragmatic" in that it was meant to describe nano-ness according to the actual use of nano substances. Within this pragmatic approach, the "nano-ness" of a given substance could be defined as the outcome of an articulation between physical or chemical characteristics linked to size (but not necessarily size itself), new properties, and applications. These articulations could define "nano effects", which could have been the basis of the definition of nanotechnology itself. Indeed, the

[1] Oberdörster, 2009: 95
[2] TC229 Business Plan
[3] *Ibid.*: appendix A.
[4] *Ibid.*: 8
[5] *Ibid.*: 19

nano-tree was meant to be used to account for the development of nanotechnology. As this approach did not determine a rigid association between properties, phenomena and states, it was expected to produce later descriptions as nanotechnology objects were developed.

So the property-based definition of a nano substance was indeed discussed at TC229. Yet the initiative did not result in the elimination of the 1-100nm size criterion, for reasons that come as much from technical (im)possibilities as from the reproduction of existing organizational and cognitive categorization in the management of chemical risks, as I will now detail.

Re-stabilizing the international organization through the size-based definition of nanomaterials

The work of WG1 was clearly separated from that of WG2, which focused on instruments and measurement, and that of WG3, focusing on Environment, Health and Safety. Several of the WG3 projects led the delegates to list physical and chemical characteristics that could possibly have an impact on the toxicological effects of nano substances. For instance, PG5 related to the parameters to be taken into account for toxicological testing. This is of particular importance in a context where the link between the characteristics of nano substances and their potential hazards is poorly known. The initial scope of PG5

…focused on establishing a framework for physico-chemical characterization; specifically, what were the relevant parameters and methods to be considered[1].

In so doing, the toxicological assessment of nano substances was tied to the crafting of a list of descriptive parameters. Following this approach, one could indeed get to a definition of "nano" based on the toxicological property: a set of parameters, methods to use them, and thresholds of toxicological effects would define the "nano-ness" of substances. Thus, PG5 was initially consistent with a property-based definition of nano-ness.

Yet the initial objective of PG5 was to evolve. First of all, as WG1 was in charge of terminology, participants expressed concerns during PG5 early meetings about the fact that the definition of "nanomaterials" "ha(d) not yet been finalized by ISO/TC229"[2]. This however, could be dealt with. Indeed, the inclusion of agglomerates and aggregates in the nanomaterials category was not settled at the time, but PG5 members nevertheless included "agglomeration" and "aggregation" state in the list of characteristics. One of the working documents of PG5 thus listed a series of characteristics (size, shape,

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[1] PG5 meeting notes, Tel Aviv, 2009: 2.
[2] Meeting notes, Tel Aviv meeting, nov. 2009: p.3. Quotes in this paragraph are excerpts from the same document, same page.

solubility, dustiness), based on the propositions of delegates, who referred to the multiple reports from public agencies, such as the American National Institute for Occupational Health and Safety and the *Agence Française de Sécurité Sanitaire de l'Environnement et du Travail*, which proposed lists of potential parameters. For each of the parameters deemed relevant for any nano substances, PG5 proposed methods of measurement, standardized through existing ISO standards and OECD guidelines. Yet their validity for nanomaterials appeared to be questionable. For a part, the issue seems here to be that of time management: as the standardizations of terminology, toxicology methods, measurement instruments, and nano substances were done simultaneously, not all the data were available in order, for instance, to use appropriate standards for nanomaterials measurement devices when needed. Indeed, the work took (and is still taking) a lot of time and money, and faced technical difficulties. The work of WG2 was thus far from accomplished when PG5 crafted its first drafts of the technical report it was expected to release. The group eventually decided to include measurement methods in the technical report, without proposing a hierarchy among them.

Yet the time needed to overcome technical difficulties was not the only constraint for a definition of "nano" based on a set of characteristics and methods to measure them. The dynamics of multi-party negotiations within the international organization also prevented other definitions of nanomaterials than size from making their way towards international consensus. Consider for instance another project of WG3, which initially focused on methods for the characterization of silver nanoparticles for inhalation toxicity testing. Developing a project like this could lead to a redefinition of the "nano-ness" of silver nanoparticles according to their behavior in the inhalation toxicity testing, which consists in measuring the effects of airborne substances on animals. This would imply selecting physico-chemical characteristics according to the test to be run, and defining measurement methods accordingly. Thus, this could also provide the much-needed information about measurement techniques and toxicology methodologies for PG5. But the specific nature of the project raised issues for the participants, who questioned the relevance for the international organization of focusing solely on the case of silver nanoparticles. In the early meetings of the project, the work was thus extended to *all* nanoparticles. Consequently, the adaptability of the proposed methods, specifically tailored for specific silver nanoparticles, to other nano substances appeared questionable. Throughout the discussions, what was originally an asset - a precise technique for a specific substance, with determined measurement methods- became a liability. Certain delegations expressed concerns about the document:

We have strong reservations about this document. The purpose of a characterization standard specific for inhalation toxicity testing is debatable, as this is an extremely narrow application. (...) It is not at all clear that the use of a method has been well validated by a number of laboratories. Without further evidence that the technique has been well validated we believe that serious consideration should be given to publishing this document as a TS *and possibly even as a PAS. We consider that this is sufficient technical ground to reject the document.*[1]

Indeed, too early a standard in a situation where many techniques were used, and still being discussed, may have led to solidifying a particular technique giving an advantage to the actors (private companies or public bodies) who were experts of or owned it. In ISO's technico-international arena, standards are also recognitions of the scientific and technical value techniques to be used by industries to meet regulatory requirements. This explains why the early solidification of a toxicity testing through a normative document was a sensitive issue:

There are many variations among researchers and laboratories in the methods of inhalation toxicity testing with nanoparticles, including nanoparticle characterization, and the development of the testing method is still currently taking place. Standardization of the inhalation toxicity testing method under this circumstance must be done cautiously with well-defined focuses, so that standardization would not prohibit or slow down the advancement of the testing method[2].

The inhalation toxicity project, still on the way at the time of writing, shows the importance for country delegates to remain at a level of generality that does not solidify a choice that could constrain future technological practices or regulatory activities, and provide competitive advantages to countries that master the chosen technology. This has direct consequences for the type of projects that can be led within the international organization, as solidifying a measurement technology in a standard too early in the process is bound to be met by resistance from ISO members.

Even if it had had all the time and money to run many tests and if delegates had agreed on measuring instruments and properties, PG5 would have been constrained by the repartition of work about Working Groups, and by the logic of the construction of international norms. Defining "nano-ness" as a set of properties/measurement instruments/thresholds would lead to the identification of nano substances according to properties that can comprise toxicological properties. This threatens to cross the line between the "science-based process" that TC229 advocated and "national policy choices" regarding, for instance, the regulation of nano substances. Indeed, TC229 "science-based process" is not expected to suggest that certain substances should be subjected to risk regulation (this would be a national "political" decision). Yet defining "nano-ness" according to toxicological properties could be interpreted as such. This meant that no hierarchy among parameters could be proposed, and by no means associations of characteristics-methods that would have redefined the identity of nano substances.

[1] Results of ballot N 378 CD 10808 Nanotechnologies – Monitoring silver nanoparticles in inhalation exposure chambers for inhalation toxicity testing, 31/07/2008, comments.
[2] *Ibid.*

The parameters examined in PG5 were eventually dealt with through a series of separations. Once the nanomaterials defined by WG1 projects, PG5 was concerned with their identification through the size criteria, regardless of their properties. Then risk evaluation could occur, through toxicity testing methods that still were to be refined by other WG3 projects. In PG5 as in other WG3 projects, the separations were institutionalized in the allocation of work among the working groups, and carefully maintained during the projects. It meant that the types of questions being asked, the technical issues being examined, and the writing style used in the documents had to be carefully monitored, in order not to hint at property-based definitions and potential regulations, and maintain the boundaries among WGs. Thereby, property-based definitions of nano substances could be avoided and no preference for measurement instruments be made explicit.

The technical difficulties of the characterization of nano substances and the constraints of international negotiation translated into the careful solidification of boundaries between PGs and WGs, and, consequently, a preferred reliance on existing standards. Methods precisely tailored to one particular object, which would focus on substance-device-property association, could not make their way, in order for the international process to be consensual enough. Consequently, proposals to define nano substances according to their (toxicological) properties were not heard, while the level of generality necessary for the international negotiation to succeed threatened to make reaching the assigned objectives of WG3 (e.g. listing relevant parameters, or defining risk management methodologies) impossible[1]. In other words, as the work of WG3 directly faced the uncertainty about the definition of nano substances, it could not propose definitions of nano substances based on their toxicological properties, while it kept expanding the list of characteristics that might affect their risks.

For members of WG1, defining a common terminology was what mattered the most, even though other working groups were stuck in technical difficulties and the subtleties of international negotiations. As one of them explained in an interview:

We had to move forward before measurement standardization was done, in order to have a scientific basis on which to ground the other definitions.

Thus, the "scientific basis" was the smallest common point among the parties: the size criterion, inherited from nanotechnology public policy programs, was stabilized by the possibilities (or rather, the impossibilities) of measurement and characterization of the substances the industries produced. This was an answer to the difficulty the convener of WG1 had made explicit, that nanotechnology is an "enabling technology", not specific to an industrial domain, even less to a product or a type of

[1] Many of the documents produced by WG3 so far have been "technical reports", that is, informative texts not supposed to lead to international standards.

substances. It ensured that the separation between the identification of substances, their characterization, the evaluation of their hazards, and the eventual risk management could be maintained, while not privileging one toxicity testing over another. The size criteria allowed the standardization body not to consider the particularities of each material (with properties related to a wide range of physical and chemical characteristics), and not to target the development of standards about nano substances for future risk regulation. It was both a technical criterion (one needs to measure, in one way or another, the size of substances), and a science policy one (public funding programs define a transversal sector: that of the substances with a size "approximately" below the 100nm limit). This is how the size criteria could get stabilized within the standardization body: contrary to the property-related propositions, which could not rely on the infrastructure they needed to get stabilized and threatened to connect the definition and regulatory works, the definition of the nanoscale as it emerged at the TC229 could hold without costly new technical investments and ensured the stability of a science-based process that did not enter the realm of national policy choices. This did not prevent, as seen above, lively discussions about where to set the size limits. But the size criteria could eventually stabilize the definition of the nano objects, settled the nanomaterials debate, and maintained the technical and organization boundaries on which the "science-based process" was based.

What to do with nanomaterials defined by size? Limitation of exposure and relational definitions

The definition of nano substances based on size could not automatically lead to a full evaluation of their risks. Indeed, as the list of characteristics to consider kept expanding, the measurement techniques were not stabilized, and the causality links between substances and toxicological effects were thereby impossible to draw. Faced with the impossible task of defining a common, standardized approach for the evaluation of hazards of all, and still un-defined, nanomaterials, the easiest approach thus appeared to limit the exposure to substances that could be hazardous[1]. This was, as we saw in the first section of this chapter, the choice of A***, which applied the strictest containment of its production process, based on techniques being used for hazardous biological material (that is, containment that blocks substances at the molecular size). This required costly investments and careful monitoring, and considerably slowed down the production process. Consequently, industrial and public actors would

[1] This work followed other recommendations from national public agencies (e.g. the American NIOSH, and the French AFSSET) recommending the limitation of exposure.

routinely ask for tailored measures, which could be adapted to the state of knowledge about nano substances, and possibly be less costly than total containment[1].

PG1 of WG3 focused on "health and safety practices in occupational settings relevant to nanotechnology" and particularly about exposure limitation techniques. PG8 of WG3 was proposed by the French delegation, and led by a physicist at CEA, in order to develop a "control banding" methodology for nanomaterials. The control banding approach contends that one can situate an industrial process within a matrix defined by "hazard" and "exposure" scores, defined according to their severity and probability. The matrix then defines levels of risks, which in turn correspond to actions to be undertaken (e.g. total containment, light protections such as gloves and hoods, etc.).

Unsurprisingly, the situation gets difficult when neither "severity" nor "probability" can be measured. This is where disagreements among proponents of the method might occur. Thus, the members of the French delegation tended to contend that "when you are in such an uncertain case, the risk level has to be set to 'maximum', and full containment applies"[2], while other proponents of control banding suggested that this would put too much of a burden on industries, and proposed instead to count "75% of the maximum scores"[3] in situations of uncertainty.

The discussions about the details of the control banding method would sound familiar after the previous sections: measuring hazards is based on a series of parameters that the projects mentioned earlier discussed as well. Hence, group project members spent hours of discussion trying to expand the list of characteristics that might impact the location of an industrial process within the risk matrix. Yet in this case, an explicit ontological approach was proposed in order to sort nanomaterials in risk categories. For instance, a potential organization of the control banding process was based on yes/no questions about the substance being considered (e.g. "there is an analogous material", or "solubility time shorter than 1h"). Each of the answer then corresponded in shifts in the risk level of the situation being considered. Here the substance was defined by association to a "mother substance" (for instance bulk silver for silver nanoparticles) or an "analogous substance" (for instance another crystalline variety, e.g. graphite for carbon nanotubes). The risk level of the nano substance would here be increased by one as compared to its mother or analogous substance. Additional criteria were mentioned: solubility and bioavailability, which influence the circulation of the substance in living organisms. Such an approach thus proposed a relational existence of nano substances, as a way of dealing with practical, industrial situations.

Apart from the necessity for agreements on the conventional shift from one risk level to another (why add 1 risk level as compared to the mother substance, and not 2?), another issue was that of the

[1] See e.g. (Paik, 2008).
[2] Interview AFSSET, October 2009. This paragraph on control banding is based on this interview, and on my participation in meetings at AFNOR during which this approach was discussed.
[3] Paik, 2008

instruments of exposure limitation, for risk levels that were not supposed to be total containment. How to use filters for instance (proposed to be used in the second band of the classical control banding approach)? They would need to be adapted to the characteristics of different types of nanoparticles. And considering "different types of nanoparticles" would bring back the problem of the choice of "relevant parameters". Hence, the ontological work, based on case-by-case analogies between "nano" and "non-nano" as proposed by control banding approaches faced the same technical and organizational difficulties as the other projects of WG3, when translated into instruments for exposure limitation.

Avoiding the size criteria by constructing international single nanomaterials. The case of OECD

The philosophy at ISO is that the international standardization of nanotechnology should be based on "science" (the 100nm size limit) in order to construct a scientific discipline, industrial standards for risk evaluation and management, and common terminology. The approach is independent of the substances, and is directly inspired by previous standards. While the specificity and uniqueness of nanotechnology was uniformly made explicit as TC229 started its activities, the technological constraints for the measurement of nano substances and the logic of international negotiation made it easier for delegates to prefer the size criteria for the definition of substances rather than a more complex, property-based definition that would have required a complete re-organization of the international organization, the standardization of an enormous number of measurement instruments, and would have threatened to connect the definition of substances with regulatory choices supposed to be outside the scope of international expertise. This happened at the price of the difficulty to do "nano specific" risk assessment, and of the exclusion of too specialized examinations (e.g. characterization method for inhalation toxicity testing for silver nanoparticles). Concurrent attempts were made to ground the existence of nano substances, either described by a never-ending list of parameters that need new measurement instruments to be evaluated, or as compared to "parent" or "mother" materials as in the control banding project. In the last few pages of this chapter, I contrast briefly the initiatives undertaken at ISO to define "nano-ness" in general with a different approach. At OECD, "nano-ness" was defined according to concrete objects to be used as material standards.

When discussing the international cooperation in the field of nanotechnology, the Alexandria process also decided to propose the constitution of a Working Party within the OECD Environment Directorate that would specialize in nanotechnology. A specific Working Party on Manufactured Nanomaterials (WPMN) was created in September 2006, with the aim of assessing existing guidelines for chemicals and possibly proposing new ones. The production of guidelines for the assessment of chemicals is indeed an important component of OECD activities. As two members of the OECD Environment Directorate put it:

A major activity of OECD's Environmental Health and Safety (EHS) Programme is the development of harmonised test methods. The OECD Test Guidelines are considered the leading international standard for safety testing and the development of new Test Guidelines as well as the updating of existing ones are key to the work on testing and assessment. OECD Test Guidelines (...) form an integrated part of the Council Decision on the Mutual Acceptance of Data. It is stated in this Council Decision that: "Data generated in the testing of chemicals in an OECD Member country in accordance with OECD Test Guidelines (...) shall be accepted on other Member countries for the purposes of assessment and other use relating to the protection of man and the environment".[1]

Consequently, companies submitting request for registration of chemicals use OECD guidelines. Their international validity is based on the "mutual acceptance of data" (MAD) approach, which

helps saving millions of dollars by avoiding duplicative testing and minimising non-tariff barriers to trade.[2]

The most important project of WPMN in terms of investment of people, time and money from the national delegations is the "sponsorship program" under which member countries use national resources in the evaluation of the risks of a selection of substances. Its objective and aim are defined as such:

Objective: To test an agreed representative set of manufactured nanomaterials using appropriate test methods.

Aim: To understand the types of information on intrinsic properties that may be relevant to exposure and the effects assessment of manufactured nanomaterials[3].

The substances to be tested were chosen in the early stages of WPMN, at the request of member countries. They were the following: fullerene, single-wall carbon nanotubes (SWCNT), multi-wall carbon nanotubes (MWCNT), silver nanoparticles, iron nanoparticles, carbon black, titanium dioxide, aluminum oxide, cerium oxide, zinc oxide, silicon dioxide, polystyrene, dendrimers, and nanoclays. Each of these substances was allocated to one or two "lead sponsors", that is, countries that agreed to

[1] Koëter and Visser: 110
[2] *Ibid.*
[3] Kearnes, Peter, 2008, presentation of the OECD Working Party on Manufactured Nanomaterials, Vienna, slide 14.

take the lead in risk assessment. Co-sponsors and contributors followed the work with a smaller involvement. For instance, France became co-sponsor of titanium dioxide with Germany, and of silica dioxide with the European Commission.

The national delegations and the OECD secretariat defined a list of "endpoints", in the following categories:

- Nanomaterial Information/Identification (9 endpoints)

- Physical-Chemical Properties and Material Characterization (17 endpoints)

- Environmental Fate (15 endpoints)

- Environmental Toxicology (6 endpoints)

- Mammalian Toxicology (9 endpoints)

- Material Safety (3 endpoints)

For instance, the category "Physical-Chemical Properties and Material Characterization" proposed the following endpoints:

Agglomeration/aggregation; Water solubility; Crystalline phase; Dustiness; Crystallite size; Representative TEM picture(s); Particle size distribution; Specific surface area; Zeta potential (surface charge); Surface chemistry (where appropriate); Photocatalytic activity; Pour density; Porosity; Octanol-water partition coefficient; Redox potential; Radical formation potential; Other relevant information (where available).[1]

The succession of "endpoints" thus provided a long list of characteristics, which, according to a member of the French delegation, were meant to collect "all the parameters that could possibly impact the toxicological effects of substances"[2]. For each of them, testing was to be done according to previous OECD guidelines, one of the objectives of the sponsorship program being to evaluate their adequacy with the sponsored substances.

PG5 of ISO TC229 WG3 was used in order to provide a list of measurement methods to be applied. And quite similarly to PG5, the sponsorship program was attentive to how they defined the scope, so that it did not hint at potential regulatory choices. In the first phase of the program (still under way at the time of writing), substances were tested according to the expected endpoints. This was expected to "lead to the development of dossiers for each nanomaterial describing basic characterization,

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[1] Guidance manuel for the testing of manufactured nanomaterials: OECD sponsorship program, first revision 2009: 11

[2] Interview with N Thieriet, AFSSET, member of the French delegation to the OECD, Paris, October 5, 2010.

fate, ecotoxicity and mammalian toxicity information"[1]. The process was deemed to be "of an exploratory nature, science-based and without any consequences for existing regulatory datasets"[2]. In a context where the very definition of nanomaterials was controversial (as seen in the previous section), and where the regulation was already under way[3], the formulations used in WPMN documents carefully avoided any hint of a potential preferred risk management strategy. Hence, Phase 1 was explicitly intended to be "science-based", in a way expected to be consensual among member countries: no attempt would be made to enter the territory of risk management, and no examination of the overall definition of nanomaterials would be pursued. Rather, the careful examination and description of a limited set of substances would be performed by member countries before any work on "risk management" could be done, in a latter "Phase 2".

This of course was based on the classical division of labor between "risk assessment" and "risk management", although Phase 1 was meant to be even more upstream than the evaluation of risks, and limited to a mere description of the substances. This was later restated in the first revision of the "guidance manual for the testing of manufactured nanomaterials":

There is a preference for exploration of sponsored MN properties in Phase 1 testing rather than developing specific data for risk management purposes. It is not the intention that addressing the endpoints in Phase 1 will support development of a risk estimate. Rather, specific properties relevant to characterizing risk are becoming clearer through exploratory research. Therefore, further research of an exploratory nature is needed in order to inform the development of test methodologies and choices for which sponsored MN variations would potentially be carried forward to Phase 2 testing so that the resulting data developed in Phase 2 are relevant to risk management purposes.[4]

As at ISO TC229, OECD delegates were concerned about the stabilization of boundaries between the "scientific examination" and explorations related to potential risk management approaches[5]. Here again, the "science-based" description was expected not to enter the territory of risk evaluation for fear that it would cross the line between international expertise and national regulatory choices. Yet the work on the definition of substances was different from that of ISO. Contrary to the standardization organization, WPMN did not attempt to provide standards for the definition of nanomaterials in general. Rather, it preferred to select a series of substances for which extensive studies could be done –

[1] List of manufactured nanomaterials and list of endpoints for phase one of the OECD testing programme, July 2008: 11
[2] *Ibid.*: 11
[3] This will be further explored in chapter 5.
[4] *Guidance Manuel…*: 20, emphasis in the original.
[5] Other examples will be examined in chapter 5.

"extensive", in that they were expected to gather all the possible parameters that are used to describe chemicals. This was possible as long as precise concrete substances were selected.

The core of the research was then about the evaluation of endpoints. This is where the nano substances raise issues, for no two carbon nanotubes or silver nanoparticles are identical (see the previous section). WPMN solved the problem by selecting "reference materials" on which tests were to be done. For each of the sponsored substances, "principal" and "alternate" nanomaterials would then be tested, the former being worked upon in priority. The process could then be made "science-based" in that it hoped to describe single nano substances, regardless of their multiple variations. This meant that precise substances had to be selected: they were material, industrial products, produced and put on markets by one single company through one single production process. For instance, A***'s nanotubes were reference materials for MWCNT. Then, contrary to the construction of guidelines expected to be applicable for all substances (like those of ISO), WPMN's objective was to propose a reference matrix against which each producer of nano substance could situate its products. As a member of the French delegation to OECD explained:

A producer could then put its substance in a matrix, and be able to tell "I am thus far from titanium dioxide"… "that far from silver nanoparticles"…

Interviewer: What would "far" mean?

That's the issue… for the moment we have 59 criteria… that would be 59 dimensions to consider… But that's the objectives of the sponsorship program: trying to discriminate among parameters.[1]

Hence, the substances chosen for the test are bound to become a "standard" against which future products will be evaluated. The selection of the "international nanomaterials" was thus a high-stake task, and, as we shall see, not always an easy process. As seen in the first section of this chapter, some companies could suffer the liability of being called "nano" and preferred distancing themselves from the label. On the other hand, there were important motivations for companies to participate in the sponsorship programs. First, a participant in the sponsorship program could advertise its products accordingly. For instance, a small California producer of silver nanoparticles heralded on its website that it was "proud to announce" that it had "been selected to provide silver nanoparticle toxicological standards by the OECD", which "had been extensively purified to remove residual reactants"[2]. More than that, providing the reference nanomaterials had economic significance for the company producing the standards. Once selected, the substance was tested in a distributed manner: members of the

[1] Interview, member of the French delegation to the OECD, Paris, October 2010.

[2] http://www.nanocomposix.com/silver-nanoparticle/oecd-silver-nanoparticle-standards.html, accessed September 15, 2010.

national delegations would perform in-house experiments in public facilities, or push public and university laboratories to use the reference materials and run the tests. Throughout the testing work, public and private investments were bound together, in a process that appeared as a way for private companies to ensure that costly testing works were performed by many actors, including public ones. For instance, a French health agency launched in 2010 a European-funded project called Nanogenotox, which gathered multiple public research institutions in France and Europe, in order to develop test guidelines for a series of nano substances, including TiO_2 and SiO_2, for which French was a sponsor within WPMN. Overall, the overwhelming majority of laboratories involved in the conduct of WPMN testing belonged to public bodies[1].

Consequently, enlisting as a sponsor for the study of a substance has no reasons to be neutral. Nor does the selection of products supposed to be the standard against which all products would be evaluated. Both are indeed matters of international negotiations, which involve both public and private actors: as OECD delegations are made of representatives of national administrations and public agencies, as well as private company representatives, either represented through BIAC (Business and Industry Advisory Committee), which holds a separate delegation, or members of the national delegations (as it is the case at ISO), private companies were directly involved in the sponsorship program, and in the selection of products.

The case of the French delegation is telling. France is co-sponsor of titanium dioxide (TiO_2) with Germany, and of silica dioxide (SiO2) with the European Commission. When France joined the TiO_2 project, a material had already been selected by the German delegation: the "P25", a 20-nm TiO_2 produced by Evonik, a major player in the German landscape of chemical industry, and a leading company in nanotechnology. The French delegation requested to co-sponsor the TiO_2 project at the initiative of both the French health ministry (whose representative had been very active in the inter-ministry task group on nanotechnology) and the French Agency for Environmental, Health and Work Safety (AFSSET). The AFSSET employee in charge of the TiO_2 project pushed for the extension of the list of reference materials. She later explained in an interview that:

Evonik and the Germans were happy with P25. They had designed their program of tests according to P25. But you can't just impose one substance over all the others.[2]

While the German delegation pushed for a 10nm TiO_2 (also produced by Evonik), in order to control the size parameter, the French delegation justified the addition of other reference products by

[1] 3 "private institutions" and 41 "public" bodies contribute to the testing programs.
[2] Interview with N. Thieriet, AFSSET, member of the French delegation to the OECD, Paris, October 5, 2010.

the need to cover some applications seen as crucial ("we needed to cover applications in cosmetics") and to draw differences among crystalline varieties of TiO_2 (rutile and anatase). Eventually, four products were added to the initial P25 (which remained the principal reference material): two rutile TiO_2 used in cosmetics (with different surface coatings), one anatase, and a control material. The enlargement of the list had not been straightforward. Neither was the conduct of the studies, as P25 continued to be the preferred tested materials for the German delegation. Testing the others was a motivation to launch the Nanogenotox program (see above). Once the reference materials were selected, controlling the tests could be contentious as well, as products could be bought by the entities doing the tests, provided by industries producing it, circulated (or not) among sponsors and contributors of testing programs. The differences of approaches between the two co-sponsors translated into conflictual relationships among the industrial actors as, for instance, the German delegation preferred to buy all the products Evonik's competitors produced, rather than cooperate with them on refining their characterization[1].

The case of TiO_2 illustrates the process of construction of "international nanomaterials", which is highly dependent on the conduct of negotiations among national delegations and professional organizations, and on the industrial strategies of the companies involved. For TiO_2, Evonik's strategy was characterized by a will to control the production of knowledge about the substances. In other cases, the situation might be different, whether the company providing the reference materials ceases its activities altogether (that happened in the case of MWCNT, and that is how A***'s MWVNT became the principal reference materials), or the opposition is less among national delegations than between industrial and public actors. The case of silica, in which the French delegation and Evonik were involved as well (the former was the sponsor of the project, while the latter was the head of the professional association of silica producers) is an illustration of such a situation. When the French delegates pushed for testing a variety of reference materials in order to look at different states of agglomeration of SiO_2, silica companies were holding a common position: "SiO_2 is not nano", and, "even if it is, there is still one single element"[2]. This was not the opinion of the AFSSET representative, for whom

Each chemical or physical characteristic might play a role. We couldn't assume that there was just one relevant agglomerate. Silica has been used for years, including under its nano form, and is certainly not the most dangerous material. But it is a total new way of doing risk assessment here... And as the selected materials will be used as reference, you need to make sure there is minimal variety in the range of characteristics of materials.

In this case, the type of applications was the basis for the selection of materials. After several months of discussions, two silicas were selected, one used in tires, the other in the food industry.

[1] A member of the French delegation to OECD WPMN told me this anecdote.
[2] Interview with N Thieriet, AFSSET, member of the French delegation to the OECD, Paris, October 5, 2010.

International construction of nano-ness

Initially a tool for industrial companies to ensure that market exchanges were possible, standardization has evolved since the 1960s and become a process expected to answer market constraints and consumer attempts[1]. Accordingly, it appears that the process of standard writing is not separated from the construction of market domains: normalization experts construct standards, and thereby define the characteristics of goods, and modalities of exchanges[2]. The case of nanotechnology provides an illustration of this process, only at a more fundamental scale: throughout the discussions at ISO and OECD, standards are constructed in a process that articulates the categorization of objects for public decision-making, the definition of a research domain for public funding and the potential regulation of chemicals, and the definition of industrial strategies for private actors. The ontological work of ISO is clearly different from that of OECD: while the former is concerned with the production of encompassing standards independent of the particularities of substances, the latter seeks first to characterize reference materials which will then be the basis for the evaluation of all the other nano substances. Yet in both cases, what matters is the "science-based" process, which separates the "description" of nano-ness (either through the 1-100nm size criterion or through concrete reference materials) from the evaluation of risks. This prevents from defining nano-ness according to specific properties (particularly toxicological).

Standardization, even if its objective is to "simply" define "common terms of reference" is an inherently strategic process, and a matter of international negotiation. The "international dialogue" much called for by the participants at the Alexandria meeting is as much a matter of competition among states holding strategic national interests and companies advancing development strategies as it entails cooperation among states and private actors interested in structuring a market for nanotechnology where products are standardized and risks are taken care of. The "coopetition"[3] relationships among actors involved in the international arena cannot be separated from the work on definition they undertake: the complexity of nanotechnology and the many uncertainties of nano substances could be dealt with as long as the international organizations were able to re-stabilize their modes of actions, thereby making specific nano substances exist ("approximately 1 to 100nm" materials, or concrete reference materials). Constructing nano-ness as such leads to re-stabilize separations between the

[1] Cochoy, 2000

[2] Mallard, 2000

[3] The term is used in organization studies in order to point to informal lateral bodies, as opposed to units related to each other in a hierarchical manner (Tsai, 2002). My use of the term here aims to convey the idea that in cases such as those examined here, the distinction between "competition" and "cooperation" is of little help to account for the process of standards production.

description of substances, the evaluation of their risks, and their management – the latter step being possibly tied to national regulations, and not dealt with in the international arena (in the case of ISO), or postponed to a hypothetical time where the tests would be conclusive (in the case of OECD). Controversies occur at each stage of the process. They relate as much to the technical construction of substances as to international relationships and industrial strategies. Throughout these controversies property-based definitions of nano substances are explored – only to be eliminated because of technical and organizational constraints -, while exposure limitation methods suggest granting relational existences to nano substances.

Conclusion. Politics of existence for nano substances

What to do with undefined, untraceable, and possibly hazardous nano substances? All the actors involved in the debates and processes described in this chapter are concerned with this question. They follow various approaches in order to answer it, but in all cases, their initiatives articulate the strategies of private companies engaged in the production, use and circulation of nano substances, the formulation of national public funding programs, the development of risk assessment and management methodologies, the construction of the first elements of potential future regulations, and the definitions of the substances themselves. These initiatives imply collective decisions involving public bodies, private companies, and NGOs. Thus, this chapter has shed light on technologies of democracy that are quite different from those described in part 1, but which nonetheless can be described in the same terms, as infrastructures of the problematization of nanotechnology. As compared to the technologies of representation described previously, the role of technologies of democracy in crafting material existences - their ontological role - has been made explicit. This means that the separation between technologies of democracy and nanotechnology manifests itself in different fashions in this chapter and in the cases described in the first part of this dissertation. Here, actors attempt to craft collective instruments meant to identify and deal with nano substances.

The approaches described in the previous pages are diverse. Some of them move away from the ontological uncertainty by ensuring a total containment of the substances as well as the information about them. Other actors opposed each other about the novelty of nano substances – controversies that are often settled by a call for "more research", which results in the postponement of constraining decisions. In these approaches (that were described at length using the examples of carbon nanotubes and silver nanoparticles in the first section of the chapter), the existence of nano substances is not explored: either it is deemed too complex to be defined, or it is considered an already solved issue. In the first case, the control exercised by the company that contains the substance extends to the information being circulated. In the second, the stable technical positions ("nano silver exists or not") cannot be held without equally stable stakes, arguing against each other in legal arenas.

The second section of this chapter has analyzed other sites where nano substances are taken care of, which propose other articulations of ontological undertakings and collective organizations. They are based on international negotiations, in which public and private actors, and national delegations are engaged in a process of "coopetition". At ISO, the existence of nanomaterials was based on a size criterion that reproduced the definitions of "nano" chosen in science policy programs, while more complex property-based definitions could not overcome technical and organizational difficulties. At OECD, the choice of "reference nanomaterials" bound to become standards for all nano substances was all that mattered. Processes of risk assessment defined in international arenas shape collective organizations, based on international negotiations in both OECD and ISO, which were concerned about not hinting at potential constraining regulations. This translates into the organizations of projects, the technical questions being asked, and the writing style of international standards[1].

While the dynamics of international negotiation and technical constraints rendered impossible the success of the property-based definitions of nano substances, the international arena is nonetheless a place where the existence of nano substance is discussed in a way that is more complex than a binary yes/no. We encountered various existences of substances, some controversial, many of them still in the making at the time of writing. The ontologies of nano substances are "multiple", to borrow a word used by Annemarie Mol[2]. This implies that the existence of chemical substances themselves become problematic, as well-known substances (e.g. silica and ultrafine particles) become "nano", become subject to previously unsuspected scrutiny and potentially to stricter regulations. The multiple ontologies of nano substances define hybrid modes of public action in which public and private activities are intertwined[3].

These multiple ontologies are not equal. Some require a complete reconstruction of infrastructure. The property-based definitions of nano substances would link the evaluation of the risks of nano substances according to the particularities of their functions, use, and conditions of transport in environmental milieus or living organisms. They would not base the evaluation of risks on traditional dose/effect methods, but would integrate "risks" into the very definition of the substance. Chapter 5 and 6 will provide some examples of the operationalization of this approach. At this stage, I have demonstrated that it is not compatible with existing approaches for the quantification of risks, cannot mobilize a stable technical infrastructure, and conflicts with the organization of an expertise separated from "political choices" related to the public management of risks. On the contrary, the size-based definitions add a criterion to the existing methods of classification. They are not based on the evaluation of risks, being related to umbrella scales of action (e.g. "1-100nm") meant to define science policy programs. This means that the proponents of ISO international expertise do not consider as "political" the science policy choices that had defined "nanotechnology" as the activities related to the 1-100nm

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[1] See (Gayon, 2009) for an example at OECD about employment policy.

[2] In her book based on an ethnographic study of atherosclerosis treatments in a Dutch hospital, Mol clearly shows the various and fragmented existences of the disease, each based on articulations of technical devices, professional expertise, and patient practices (Mol, 2002). The ontological question of nanotechnology objects will be explored further in chapter 5, and discussed in chapter 8.

[3] The ambivalence between the "technical" activities of the experts involved in standard-making and the "political" interests of national delegations have been noticed by commentators (Salter, 1993; Wood, 2005), and seen at play in this chapter in some cases. I am not interested here in unraveling the various meanings of the adjective "political" within ISO (including the "hidden" ones that the social scientist could locate), but rather want to stress that standard-making activities produce forms of political orders, in ways that need to be permanently reconstructed, and thereby are potentially subjected to displacements. Accordingly, the account I propose here differs from the critique of the "depoliticized" character of standards by highlighting the political discussions and controversies that occur within the very process of standard-making.

size range. This also means that the size criteria problematize nanotechnology in ways that exclude the integration of toxicological properties in the very making of nano substances.

The various ways in which nano substances are dealt with ultimately define the public problem of nano substances, and the modalities of their transformations into objects for public action (e.g. research funding or risk regulation). The problematization of nanotechnology they propose articulates ontological works, collective organizations, and infrastructure building[1]. In this perspective, the "novelty" of nanotechnology is redefined: whether "nano" is indeed new or not is of little analytical interest. More interesting is the re-stabilization of existing forms of collective actions or the destabilizations introduced when trying to cope with the uncertain existence of nano substances. This chapter has described problematizations based on containment in which nano-ness is not defined, on the binary alternative about the existence of substances discussed in American legal arenas, and on the mobilization of "science-based" international expertise in standardization organization for size-based or reference-based definitions. The following chapters will propose other examples, and continue the exploration of the construction of nanotechnology's objects on the next level by focusing on "nano products", that is, consumer goods expected to make use of nanotechnology.

[1] Wood (2005) explains how standardized codes of conduct (e.g. ISO 14001) problematize the environmental crisis in ways that do not question the primacy of economic growth. My use of the problematization idiom is close to Wood's, in ways that insist more on the constant infrastructure building work that is indeed in order to stabilize it and cope with complex issues (e.g. nano substances). Chapter 8 will develop this point further.

CHAPITRE 5 : DES NANOMATERIAUX INTERNATIONAUX, EUROPEENS ET FRANÇAIS. UNE GEOGRAPHIE DES PROBLEMATISATIONS.

Le chapitre 5 poursuit le travail entrepris au sujet de l'identité des substances nano en ce penchant sur la définition des « produits nano ». Il s'agit ici de s'interroger sur les critères et les instruments choisis pour définir ce que serait un marché des produits qualifiés de « nano ». Cette discussion en recoupe partiellement une autre : celle qui concerne la définition des nanomatériaux. A l'ISO (première section), les tentatives pour labelliser comme « nano » des produits contenant des nano-objets échoue. Il importe, au sein de l'instance d'expertise internationale, de s'assurer du succès d'un processus « fondé sur la science » (*science-based*), seul garant de la qualité de la standardisation internationale. Le fait d'être « fondé sur la science » impose, à l'ISO, que les décisions « politiques » soient séparées des examens « techniques » : dans le cas des nano-produits, cela signifie que seul le critère de taille sera susceptible de définir le caractère « nano » d'un objet. La situation est d'autant plus remarquable qu'elle diffère profondément des tentatives menées par les institutions européennes pour définir des nanomatériaux « d'un point de vue de politique publique » (*from a policy perspective*). Dans le cas européen, les tentatives de définition se fondent sur le risque potentiel de produits qui devront faire l'objet d'une attention administrative : le lien entre le risque potentiel et le caractère « nano » est ici directement tracé, et s'opérationnalise sur le modèle de la discussion entre parties prenantes s'affrontant pour fixer notamment les limites de distribution de taille.

Les nanomatériaux « internationaux » et « européens » actualisent des espaces au sein desquels la problématisation des produits nano est cohérente. Les frontières entre ces espaces ne sont pas toujours fixes. La seconde section de ce chapitre décrit les tentatives du Comité Européen de Normalisation (CEN) pour établir un guide censé permettre la labellisation des nanomatériaux. L'écriture de ce futur standard s'appuie sur un document publié par le British Standardisation Institution (BSI) et propose une définition fondée sur un critère de taille, qui rend possible une flexibilité dans l'identification des produits nano comme des destinataires de l'information diffusée par le label. Le travail d'écriture de la norme CEN consiste alors à éliminer la flexibilité introduite de telle sorte que le label ne fournisse qu'une information limitée à la taille inférieure à 100nm (indépendamment des conséquences sur les propriétés physiques ou chimiques), à destination d'un consommateur individuel (et non d'entreprises). Cette évolution de la norme est une conséquence des contraintes issues de l'accord de Vienne, selon lequel la norme développée par le CEN doit être d'application ISO. Elle ne suffit pas à assurer, au final, l'acceptation du projet dans l'enceinte européenne et internationale. Mais elle met en évidence la porosité de l'espace européen de la normalisation des nano produits.

Jusqu'à présent, les controverses décrites ont trait aux différentes manières de tracer la frontière entre « nano » et « non nano ». Or les produits nano peuvent être problématisés d'une façon différente. La dernière section se penche sur un projet initié par la commission « nanotechnologies » de la commission française de normalisation (AFNOR), visant à produire une « norme nano-responsable » qui permettrait aux producteurs de définir des nanomatériaux « responsables » en fonction des problèmes rencontrés et des exigences des groupes concernés. Le projet est fondé sur l'internalisation des externalités de la production industrielle, et donc sur une définition souple et intégrative des nano produits. Il fait exister une forme politique fondée sur l'exploration technique et sociale, et sur l'intégration des parties prenantes à la construction du marché des nano produits. Il devient une composante importante de la définition de la position française, telle qu'elle apparaît dans la construction des programmes de politique publique, et telle que défendue dans les institutions européennes et internationales.

CHAPTER 5. International, European and French nanomaterials. Problematization spaces for nano products.

Defining nano products

Even if one accepts the ontological uncertainty of nano substances, much is still to be done in order to manage with the material objects of nanotechnology. For nanotechnology industrial and research activities produce not just single chemicals, but also consumer products, that is, products destined to a large number of consumers. Recall the example of the company A***, which developed its carbon nanotubes for integration in materials for construction, or the case of nano silver, used as biocide in numerous medical products and textiles. Following up on the study of the construction of nano substances, this chapter focuses on the assemblage of "nano products". I use "nano product" in the same way that I have been using "nano substances", that is, as an expression that allows me not to define beforehand the identities of products qualified as "nano", in order to describe variety in the definitions of these products. As in the case of the expression "nano substances", the use of "nano product" does not limit the analysis to a nominalist approach: definitions require physical criteria, measurement instruments, and collective decision-making processes.

In the examples described in chapter 4, the "nano-ness" of products had an ambivalent status for industries. Some of them (e.g. A***), within a strategy of containment, could abstain from characterizing the existence of their products. The American silver industries were cautious *not* to qualify their products as "nano", while concerned environmental groups attempted to use their nano-ness as a basis for their qualification as new pesticides. The "nano-ness" of the medical products developed within *Nano2Life* (see chapter 1) was part of a development program of nanobiotechnology that was to realize the European Action Plan on nanotechnology. These examples illustrate the importance of the definition of nano products for the strategic management of private companies, regulation and science policy-making, and for environmental movements trying to locate health concerns related to the development of nanotechnology.

This chapter analyzes different definitions of nano products, and the democratic orders and geographic zones they enact. So far, the definitions we encountered were that of nanomaterials. At ISO, they are defined by means of the 100nm size limit. But how to qualify products containing nanomaterials? The first section of this chapter described the extension of the "science-based" process of international standard-writing to nano products. I then contrast the international standardization of nano products with European attempts to problematize nano products as objects that need to be regulated. European institutions introduced a definition of nanomaterials for "policy-making". The second section of the chapter explores the negotiation of "European-ness" through the construction of a European guidance for the labeling of nano consumer products. The definition of nano products might be based on boundary-drawing between what is "nano" and what is not. This is not the case in the example I consider in the third section, that of a French standard for the "responsible development" of nano products, which proposed to jointly construct nano products and stakeholders' interests.

In all cases, the consumer of the nano products is at stake, as producers, civil servants and NGOs claim to act in his/her name. Among the publics of nanotechnology, consumers of nano substances, be they industries or individuals, have attracted considerable interests, not least because of the pervasive argument of the "nanotechnology market" - the cause as much as the consequence of growing public and private funding. The consumer public was mentioned in several of the examples I analyzed in the previous chapters. In museums and consensus conferences, talking to the consumers about the benefits and risks of nano products was a way not to represent nanotechnology as a global program, in order to favor a case by case presentation of practical applications. In the meantime, constructing devices directly aimed at the consumer, especially labeling, is a requirement of many NGOs, who hoped to be able to gain information about new products, if not to ban some of them from the market. As described in the previous chapter, recognizing nano silver as a pesticide was an attempt to define a "nano product" based on silver, which would then be registered as such under the U.S. pesticide law. This chapter pursues these descriptions by analyzing instruments that were developed in order to define nano products, and, by the same token, users of the definition and consumers of the products.

In this chapter, the technologies of democracy I am interested in are processes of standard and regulation-making. They are devices that have to mitigate the interests of consumers and that of industries – the interests of both groups have then to be identified. One should be cautious about what could seem a simpler allocation of roles: private interests for private organizations, like ISO, or, in France, AFNOR (French Association for Standardization), and consumer interests for public bodies, like the European Commission. The situation is much more complex. Private standardization institutions gather members of national administrations, representatives of companies' associations and of consumer organizations. They are expected to develop standards for the interest of private companies, but are also listening to consumers' concerns[1]. We saw in the previous chapters that delegations at ISO had tight links with national regulatory institutions. The case of a standard developed for nano products at the French AFNOR (section 3 of this chapter) will provide another example of close interactions between public and private actors within a standardization organization. As for regulatory public bodies, like the European Commission, they are also called to listen to the voices of industries, especially in a

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[1] Describing the evolution of standardization, Cochoy insists on the gradual integration of concerns related to consumers' expectations and concerns in the making of industrial standards (Cochoy, 2005). The examples described in this chapter will offer illustrations of devices aimed to represent the consumer's interests. They are not meant to explore his or her behaviors, as psychological analyses have done (Miller and Rose, 1997).

context where the Lisbon strategy makes “competitiveness” a major concern of European institutions. The second section of this chapter will focus on the case of the Comité Européen de Normalisation (CEN), a standardization institution that is explicitly asked to implement the general directions provided by the European Commission[1].

Therefore, this chapter argues for the analysis of technologies of democracy beyond the public bodies and the devices explicitly aimed to engage “publics”. Democracy is at stake when roles for consumers and industries are defined, when public and private interests are represented, when technical constraints are worked through – in short, when nano products are standardized, classified, and dealt with. And this happens, as this chapter will make it clear, in standardization institutions as well as (if not more) in regulatory public bodies. These empirical sites bring together the making of collective technical choices and the construction of markets for nano products. As we began to see in the previous chapter, the case of nano products will show that the ontological discussions cannot be separated from the organization of democratic life. That democratic life contains economic relations involving private actors will be even more visible in this chapter. Defining nano products and stabilizing national and international democratic orders will thus appear as the two sides of the same coin.

This co-productionist stance directly echoes other examples, such as biotechnology, where the construction of new objects is tied to the making of modes of public objectivity and democratic legitimacy[2]. The cases that I focus on in this chapter also highlight the geographic construction of the definition of nano products. Standards indeed define “technological zones”, to re-use an expression introduced by Andrew Barry, which are defined by comparable definitions and normalized instruments meant to maintain them. But the making of standards is also tied to that of geographical entities, such as the nation-state or supranational bodies like the European Union. This chapter provides an analysis of the making of international, European, and French zones for nano products. These zones are not lying passively next to each other. The European zone will appear permeable to international concerns and interests. The French nano products are elements of a national position that is to be defended in European and international arenas. Throughout this chapter, the problematization of nano products will appear tied to the making of geographical zones in connection with one another.

[1] This is the core of the so-called “New Approach”. The second section of this chapter will explore this further.
[2] Sheila Jasanoff’s works analyze these points (Jasanoff, 2002; 2005).

Section 1. International "science-based" nanomaterials vs. European nanomaterials "for regulatory purposes"

How to define products containing nano substances and available to consumers? This section shows that ISO considered the question, but eventually stuck to the "science-based" definition of nanomaterials, and used it as a basis to define any other nano product. The European Union, on the other hand, proposed different definitions for nanomaterials. They considered not only nano substances, but also products available to consumers, and which were meant to be "for regulatory purposes".

International "science-based" definitions of nano products

ISO Technical Committee on nanotechnology - ISO TC229, which I described in the previous chapter - attempted to define many more objects than nano substances. Thus, WG1 undertook projects to define a wide range of objects, from the basis of the initial definitions of the "nanoscale", "nano-objects", and "nanomaterials". In 2009, WG1 activities related to the vocabulary of nanotechnology were divided into 8 projects: "Core terms", "Carbon nano-objects", "Nano-objects — Nanoparticle, nanofibre and nanoplate", "Nanostructured materials", "Bio/nano interface", "Nanoscale measurement and instrumentation", "Medical, health and personal care applications", "Nanomanufacturing processes". According to the French delegate at WG1, each of these projects used the "core terms" as starting points, in order to classify further the terms of nanotechnology. In 2008, the "core terms" comprised "nanoscale", "nano-objects", and "nanomaterial" (cf. the previous chapter), and, in addition to these three:

nanostructure, nanostructured material, engineered nanomaterial, manufactured nanomaterial, incidental nanomaterial, nanomanufacturing, nanomanufacturing process, nanoscale phenomenon, nanoscale property.[1]

The definitions of the core terms were all based on the initial definition of the nanoscale, discussed in the previous chapter, as the "size range from approximately 1 nm to 100 nm". Many more objects were then to be defined, which caused numerous discussions among TC229 participants. Consider for instance the case of "medical, health and personal care applications of nanotechnologies

[1] ISO TS 80004-1ISO TS 80004-1.

and nanomaterials". When it was proposed as a new work item for WG1, the importance of the sector was an explicit motivation:

The purpose of the technical specification is to provide stakeholders, including manufacturers, consumers, technologists, patent agents, regulators, NGOs, etc., with a comprehensive list of terms and definitions relevant to medical, health and personal care applications of nanotechnologies and nanomaterials. Pharmaceuticals and healthcare is projected to be responsible for around 20% of the estimated $1 trillion "nano-enabled" market in 2015. Between 2002 and 2006, the average growth rate for nano-biotech was close to 25%, and nano-enabled drug delivery is expected to represent nearly 7% of the world market for pharmaceuticals by 2015. Hence, it is both timely and appropriate that terminology for the area should be collected, collated and harmonized.[1]

The argumentation is of interest here, since it makes the logic of the production of definitions at TC229 explicit. The organization of nanotechnology policy programs required that a future "nano enabled market" should be made visible, for public funding to be granted, research programs to be organized, and companies' strategies to be directed. The facts and figures used here came from a report prepared for the European D.G. Research and released in 2006[2], which foresaw that the nano-enabled drug delivery market volume (measured in U.S. dollars) would be multiplied by a factor 20 between 2005 and 2012, so that

In 2012, about 4.8 billion US Dollars will be earned with nanotechnology on the drug delivery market, which would be a market share of 5.2 %.[3]

The author of the report used a graph that came from another publication, which was based on the work of a consulting company[4]. This other publication did not define nanotechnology, nor the "nano-ness" of the "nano-enabled drug delivery" products it considered. But the accuracy of these more or less exact anticipations is not what really matters. For when inscribing future economic perspectives in graphs and figures, public actors could perform the reality of nanotechnology by directing public funds, reflect on the conditions of success, stimulate companies, and encourage organizations like ISO to undertake normalization work on this promising market[5]. Consequently, a shared representation of nanotechnology was needed for programs to be efficient and manageable, and to make funding, patents,

[1] New Work Item Proposal for medical, health and personal care applications of nanotechnologies and nanomaterials.
[2] The previous quote cited (Hullmann, 2006a).
[3] Hullmann, 2006a: 12
[4] Moradi, 2005
[5] Cf. chapter 1 for an exploration of the performative dimension of science policy instruments. Other examples will be provided in chapter 6.

and publications explicit. That they based their expectations on non-existent terminology or companies' or laboratories' claim did not matter: voicing promises and crafting definitions go hand in hand in the solidification of nanotechnology as a future-oriented technology program.

This, however, did not prevent members of TC229 from arguing at length over the definition of terms for nano products. Some of the initial propositions were contested. Participants would be reluctant, for instance, to define "nanocosmetics" or "nanopharmaceuticals"[1], deemed to be too general, and would spend numerous meetings crafting the details of definitions such as "nanocarrier", i.e. "a nano-object that is able to transport a diagnostic or therapeutic agent either on its surface, within its bulk structure or within an internal cavity", or "nanocapsule", i.e. "a nano-object with more than one chemically or structurally distinct wall layer enclosing a hollow or solid core and which is designed to carry analytical, therapeutic or image-enhancing components".

The definition process at ISO, for all the discussions and disagreements it caused among the members of WG1, could be conducted with international agreement because it was "based on science" (as one of its members said to me), that is, it originated from the definition of the nanoscale, then from that of nano objects and nanomaterials. It was at all stages based on the size criteria definition ("approximately 1 to 100nm"). Starting from the nanoscale, TC229 WG1 could then hope to define all the nano products, from nanoemulsion to nanodevices, from nanosystems to nanocarriers.

The "science-based" process constructing definition from the 100nm size limit was not the sole option considered at TC229. The question of the condition under which one could qualify a product as "nano" was raised when the definition of nanomaterials was discussed (cf. chapter 4). One of the participants of WG1 thus recalls:

Some participants proposed that any object containing nanomaterials be a nanomaterial. There were countries that defended this position: it was eventually rejected because we thought it would qualify too many products as "nano", and could eventually damage the image of these products. For instance, a tire with carbon nanotubes will not be called a "nano tire".[2]

The proposition to expand the nanomaterials category to all products containing nano objects was pushed by the national delegations that were arguing for a "nano" label. In their opinion, a "nano-inside" label could be used to identify high-tech products, thereby offering a marketing argument[3]. Consumer and environmental associations, such as the European Environmental Bureau then voiced a

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[1] This was mentioned by a member of WG1 during an interview. It was also present in the comments on a draft document (ISO TS 12843 Terminology for medical, health and personal care applications of nanotechnologies).
[2] Interview, member of WG1, Paris, April 2010.
[3] Interview with F. Roure, Paris, October 2008; Interview with B. Croguennec, AFNOR, Saint-Denis, October 2008.

similar request for an opposite objective, as they argued for the need to identify "nano free" products[1]. Whether they consider the nano label as an asset (in the case of the "nano-inside" label) or as a liability (e.g. expected to help the consumer choose the "nano-free" products), these initiatives translated the boundary work attempted at the level of substances (see chapter 4) into that of products.

But within ISO TC229, nanomaterials were eventually not defined as "any product containing nano objects". The discussion about nano products ended up stabilizing the "science-based" process, according to which definitions were crafted one after the other, starting with the "nanoscale" and the size criterion, continuing with "nano-objects", and pursuing with more complex entities (cf. the "core terms" mentioned earlier). The "science-based perspective" was a way for TC229 to reach international consensus, by making it clear that the definitions were not crafted for regulatory objectives, or meant to provide competitive advantages. It follows that this "science-based" perspective was not of a direct help for practical questions raised in regulatory spheres. For instance, were nano-enabled drug delivery objects "medical products" or "medical devices"? In Europe, the two are classified in separate regulations, the former being subject to more constraining risk assessment than the latter. Was it necessary to create a new category of objects for nano products, for regulatory purposes? These questions were directly asked, particularly in the European Union[2], where requests for labeling were heard from NGOs. They could not be dealt with within ISO, where nano products were defined within a "science-based" process using the size criteria as a way not to hint at regulatory choices. The next sub-section explores the ways in which the categorization of nano products was discussed in Europe, through the crafting of definitions of "nanomaterials" that were different from that of ISO.

Toward a general definition of nano products: European nanomaterials

As ISO was crafting definitions of nanomaterials, the legislative evolution in Europe made nano products a concern for regulation-making. The main body of the regulation of chemicals in Europe is the REACH regulation, which does not consider nanomaterials as such, as seen in the previous chapter. But as nanotechnology was developing in European member states, REACH was in a revision process (the new version is to be issued in 2012). Member states would argue for (or against) the integration of nanomaterials in the updated version of REACH, and about the way of doing so. France, for instance, regularly pushed for the integration of nanomaterials as new substances[3]. In comparison, the U.S. regulatory landscape was far less systematic in the reflection on the potential integration of nano

[1] EEB discussion paper, 2009: 11.
[2] A report of the European Group on Ethics on nanomedicine, for instance, discussed the classification of medical nano products and raised these issues. Chapter 6 will discuss the EGE report further.
[3] Interview, Direction Générale de la Santé, Paris, October 2008.

substances in the law. It was done mostly through the consideration of pesticides in FIFRA (cf. the previous chapter) according to companies' request. In Europe, the activism of the European Parliament (EP) as well as some of the member states led to a systematic reflection on the definition of nanomaterials and the legal treatment of nano products.

The EP appeared much more concerned about the regulatory existence of nano substances and products than the Commission. Replying in 2009 to a communication of the Commission about the regulation of nanomaterials, the EP refused to follow the Commission in considering that the existing regulatory framework could deal with nanomaterials, and preferred to consider them as new objects[1]. Accordingly, it added amendments specifically targeted at nano substances and products in regulatory texts. For instance, the EP added an amendment to the November 2009 cosmetic regulation that asked companies to label products containing nanomaterials. In this amendment, nanomaterials were defined as follows:

'nanomaterial' means an insoluble or biopersistent and intentionally manufactured material with one or more external dimensions, or an internal structure, on the scale from 1 to 100 nm[2]

This definition restated the 100nm size limit that had been used at ISO (see chapter 4). It also added two conditions, insolubility and biopersistence, which made it clear that the definition was to be used as an instrument for the regulation of risks for human health. In translating the 100nm size limit into a regulatory text, the EP had also to eliminate the adverb "approximately" that was used in the ISO definition[3]. The constraints of legal writing[4] solidified this rigid limit. This caused NGOs to worry about the possibilities offered to companies wishing to escape the mandatory labeling to use slightly bigger than 100nm substances (e.g. 110nm) but nonetheless displaying enhanced properties because of their

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[1] European Parliament resolution of 24 April 2009 on regulatory aspects of nanomaterials (2008/2208(INI)). The resolution responded to the following document: "Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee regulatory aspects of nanomaterials (SEC(2008) 2036). It also answered the conclusion of the Competitiveness council on 25 and 26 September 2008 No. prev. doc.: 12853/1/08 REV 1 RECH 264 COMPET 311, Subject: "Council conclusions on responsible nanosciences and nanotechnologies research".

[2] Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products: Art. 2.1, alinea k.

[3] One can track back the link between the definition proposed by the cosmetic directives and earlier formulations. The report for the Commission for Environment, Public Health and Safety of the European Parliament related to preparatory works for the cosmetic directive (Rapport de la Commission de l'Environnement, de la Santé Publique et de la Sécurité Sanitaire du Parlement, 2008, rapporteur Dagmar Roth-Behrendt, PE 412-426) used the definitions of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). SCENIHR used the definition of the British Standardization Institution (BSI), which, as leader of TC229, in turn strongly influenced the work done at ISO.

[4] As a member of the permanent French representation at the EU who participated in the negotiation of the text put it: "you could not have a legal text with 'approximately', this was not legally acceptable" (personal communication).

sizes[1]. This was a reason for the EP to consider the nanomaterials amendment as a first step, which could be "adjusted and adapted" according to "technical and scientific progress and to definitions subsequently agreed on at international level" (article 2.3).

Through this amendment, the EP solidified a legal existence for nanomaterials for the first time. It later undertook similar regulatory actions for the novel food and the biocide directives, in which it added amendments requiring additional risk evaluation for nanomaterials. These initiatives, and the EP's own request to the Commission, pressed the European Commission to reflect on a common definition for nanomaterials that would be adapted to regulatory purposes. Two reports of the European bodies examined the question in 2010, one published by the Joint Research Center (JRC), the other one by the Scientific Committee for Newly Identified Health Risks (SCENIHR). I examine successively the two approaches and the final propositions issued by the Commission in the following pages.

How to define nanomaterials for policy-making: JRC minimalist solution

The Joint Research Center (JRC) is a Directorate-General of the European Commission in charge of scientific and technical advice, which conducts research in a variety of fields. In nanotechnology, the JRC is active in

surface science, radiolabelling of nanoparticles, nanotoxicology, N&N risk assessment, metrology for size determination of dispersed nanoparticles (including standardization and certification of reference materials), nanocomposites for fuel cell technology[2].

The JRC provides experts in international arenas, where the European Commission is involved. At ISO TC229 and OECD, JRC members regularly participate in the discussions.

The JRC released a report in the fall of 2010, entitled "Considerations on a Definition of Nanomaterials for Regulatory Purposes". The report acknowledged the variety of industrial and research sectors in which nano substances were used. They were domains where nano products were distributed, sold and bought, transformed, and disposed of. The report mentioned:

medical and pharmaceutical sector; bio-nanotechnology, bio-sensors; energy sector, including fuel cells, batteries and photovoltaics; environment sector including water remediation; automotive sector; aeronautics sector;

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[1] Comments, European Environmental Bureau.
[2] Joint Research Center - FP7 - WP2009, Action n° 23008 - TP: NanoTech - Impact of nanotechnology on society.

construction sector, including reinforcement of materials; composite materials; electronics and optoelectronics, photonics.

The JRC's definition would be "with regulatory relevance" if it could be used across all these sectors with no transformation. By the same token, it could also be an instrument of solidification for the field of nanotechnology.

The criterion to distinguish "nano" from "non nano" was not meant to be "a purely scientific criterion" as in TC229, but was to be connected with the regulation of the risks of nano products. From this starting point, the elaboration of the definition led the JRC to re-interrogate basic terms. The first one was "material". The regulatory relevance of the future definition was at stake at this point, and made the European "material" different from others, such as the international materials defined at ISO's:

Of the 28 ISO documents which currently provide a definition for 'material', most describe it as a 'single basic substance or uniformly dispersed mixture of substances'. 'Material' is here, thus, related to the term 'substance', and indeed 'material' is often used synonymously with the term 'substance'. However, 'substance' is already defined (see Chapter 2) in the REACH Regulation, which should also cover nanomaterials, and applies to chemical substances, on their own, in 'mixtures' or in articles.[1]

Following REACH's definitions would mean that nanomaterials are considered either "substances" or "mixture", that is, a combination of substances, which…

… means a chemical element and its compounds in the natural state or obtained by any manufacturing process, including any additive necessary to preserve its stability and any impurity deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition (REACH : Chap.2, article 3 : definitions[2]

But the JRC argued that nanomaterials could not be considered as substances for:

There are many examples of (nano)materials that are engineered at the nanoscale, e.g. well-defined coatings, specific surface functionalisations, complex geometrical shapes and functionalities (e.g. hollow spheres as carriers for other substances). Such materials therefore exhibit a well-defined structural organisation and combination of various

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[1] Joint Research Center, 2010, *Considerations on a definition of nanomaterials for regulatory purposes*, Brussels, June 2010 (hereasfter: JRC, 2010): 22
[2] *Ibid.*

substances in the nanometre range. [1]

Similarly, considering nanomaterials as “mixtures” would prevent from including, for example, “coated nanoparticles, which are not just mixtures but contain a certain degree of order and organization”[2]. Consequently, a new definition of material was proposed, in order to allow the definition of nanomaterials to include the range of products the JRC considered as having to be regulated:

The term ‘material’ is proposed to refer to a single or closely bound ensemble of substances at least one of which is in a condensed phase, where the constituents of substances are atoms and molecules.[3]

Such a definition allowed the JRC to move the discussion away from single nanoparticles and other nano-objects, and to exclude single molecules (it also excluded other objects, which had been central in the definition of the nanoscale at ISO, most notably fullerenes). The JRC’s definition of materials could include microscopic as well as macroscopic objects, and allowed regulators to shift the concern to actual nano products, produced, used and distributed on the European market. It also implied that only “engineered” or “manufactured” nanomaterials were to be considered for future European regulation[4].

Thus, the main issue became the identification of the criteria that could distinguish nano “materials” (in the sense used by the JRC) from non nano ones. As in ISO TC229, the discussion about the size criteria, or the property related to toxicological effects in certain conditions of use was considered. The JRC, from a “regulatory perspective”, was clearly in favor of a unique criterion: size was to be considered, since any other properties would be too dependent on the material being considered (see the previous chapter). For example, the specific surface area was indeed considered to be related to the toxicological profile of substances, but…

… no generally applicable method exists for the measurement of the surface area of particles suspended in liquids.[5]

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[1] *Ibid.*
[2] *Ibid.*
[3] *Ibid.*
[4] JRC, 2010: 31
[5] JRC, 2010: 26

The JRC insisted on the whole work of infrastructure building if one was to use a size-related property as a criterion. It concluded that

since there is no unique relationship between size and physico-chemical properties which is valid for all materials, the only feature common to all nanomaterials is the nanoscale.[1]

The regulatory objective made it necessary to stabilize a criterion that would be identical for all nano products. The uniqueness, simplicity, and the fact that the 1-100nm limits had already been solidified, most notably at ISO, were "pragmatic reasons" for defining nano products through a nanoscale size range.

This does not mean that the size criterion was the only one to be used. In the previous chapter, we saw that ISO had introduced "nanostructure" in order to include aggregates and agglomerates of nano-objects in its definition of nanomaterials. The JRC also considered including in its definitions products that were bigger than the nanoscale, but nonetheless exhibited properties because of their nanostructures, or the nano-objects they contained. The JRC considered three options:

1. *To keep the upper limit of 100 nm and to introduce in the definition of nanomaterial one or more qualifiers based on structural features (…) and/or functional properties other than size.*
2. *To keep the upper limit of 100 nm and to particularly mention, in a specifying note, the concerned nanomaterials and nanomaterial formations larger than 100 nm (…).*
3. *To establish an upper limit (…) which also encompasses those materials.*

Option 3 was clearly the one favored by NGOs. Friends of the Earth, the European Environmental Bureau, and ICTA, regularly argued for the 300nm size limit (see chapter 4). The JRC however, did not support it, for, although the definition was "clear, broad and enforceable",

… in a regulatory context, the higher the upper limit chosen, the higher will be the inclusion of materials that do not exhibit specific properties or behaviours due to their nanoscale size.[2]

The JRC did not reduce the size criteria to a simple 100nm size limit either, nor did it accept the nanostructure condition that ISO had introduced. For a central concern of the JRC was to make sure that the definition would not encompass too many products. The nanostructure condition would mean

[1] JRC, 2010: 29
[2] JRC, 2010: 24

that materials containing carbon nanotubes or integrated electronics circuits displaying nanostructures would qualify as "nano". These products are based on "incorporated nanostructures" used to "create novel properties"[1]. The JRC however did not want to include them in the set of nanomaterials, as it considered "that

it is very unlikely that the nanostructured components would ever be released as 'free' particulate nanomaterials as a result of normal use.[2]

Consequently, it introduced the expression "particulate nanomaterial" in order not to include those products. "Particulate nanomaterials" were defined as "materials which are in a particulate form at the nanoscale, and which are mobile in their immediate environment". The JRC equaled "nanomaterials" with "particulate nanomaterials". This excluded nanostructured materials (e.g. nanostructured surfaces)[3], for the sake of the regulatory purpose of the definition. Thus, the JRC considered that health risks, if they were to occur, would be linked to the release of free isolate particles in the environment. Consequently, particulate nanomaterials were the only ones that mattered in the definition. Doing so could encompass nano-objects, as defined by TC229 WG1, and aggregates and agglomerates, ensembles of particulates bound by Van der Waals or weak forces, while also eliminating nanostructured materials from the scope of nanomaterials.

The regulatory purpose of JRC's propositions translated into a concern for a situation which ISO TC229 had not been interested in, that of a product containing a wide size distribution of objects, some of them being in the nanoscale, and others beyond it[4]. At this point, the interest of the JRC (and of European institutions in general) for nano products is visible: as the actual nanotechnology objects are, in many cases, constituted of fractions of nanoscale and non nanoscale materials, a threshold needs to be set in order to define a limit proportion. The JRC argued for taking into account the size distribution, without choosing a parameter among others (it could be "mass, number, specific surface area or another suitable parameter"[5]).

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[1] JRC, 2010: 26
[2] *Ibid.*
[3] Participants in the control-banding project of TC229 WG3 followed a similar approach (and referred explicitly to the JCR'S definition), when proposing to consider "nanoparticulate material" as the addition of "nano-objets, aggregates and agglomerates" in order to "get rid of the nanostructured surfaces" (member of the WG3 control banding project, AFNOR meeting, February 2, 2011, notes from my fieldwork notebook).
[4] JRC, 2010: 22
[5] JRC, 2010: 46

How to define nanomaterials for policy-making: SCENIHR maximalist approach

The Scientific Committee for Newly Identified Health Risks (SCENIHR), an expert body of the European Commission, followed the JRC in the reflection about the definition of nanomaterials. In 2010, the European Commission asked the SCENIHR to write a report on the definition of nanomaterials[1]. In SCENIHR's previous nanotechnology-related publications, the committee had stressed the difficulty in the characterization of nano substances[2]. The opinion it released in July 2010 proposed a "scientific basis for the definition of the term 'nanomaterial'". Yet as it will appear in the following, the "science" it proposed was neither that of ISO TC229, not that of JRC.

Like the JRC, the SCENIHR recommended that future European regulations focus on "engineered" or "manufactured" nanomaterials, in order to target actual products put on the European market[3]. The reduction of "nano" to a size criterion was also endorsed by the SCENIHR, but in a more sophisticated manner than the JRC. For:

At the moment, no scientific data are available to indicate that a specific size associated with special properties due to the nanoscale can be identified for nanomaterials in general.[4]

Consequently, the 100nm upper size limit could not be scientifically sustained, since it did not

take into account issues like size range, size distribution and specific properties (electrical, mechanical, optical) at the nanoscale.[5]

Therefore, the SCENIHR required a "more elaborate description", which could consider nanomaterials as actual nano products. Like the JRC, the SCENHIR explicitly targeted "aggregates and agglomerates". But contrary to the JRC, it did not consider that the limitation to "nanoparticulate materials" would be enough to include them. Indeed, the "aggregates and agglomerates" that the SCENIHR considered were not just assemblages of substances bound by Van der Waals or weak forces,

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[1] Request for a Scientific Opinion via Accelerated Procedure (see Rules of Procedure1): Scientific basis for the definition of the term "nanomaterial".

[2] Scientific Committee on Emerging and Newly Identified Health Risks, 2006, *Opinion on the appropriateness of existing methodologies to assess the potential risks associated with engineered and adventitious products of nanotechnologies*; SCENIHR, 2007, *Opinion on the scientific aspects of the existing and proposed definitions relating to products of nanoscience and nanotechnologies*. SCENIHR, 2009, *Opinion on the risk assessment of products of nanotechnologies*.

[3] Scientific Committee on Emerging and Newly Identified Health Risks, 2010, *Scientific Basis for the definition of the term 'nanomaterial'*, Brussels, SCENIHR (hereafter SCENIHR, 2010): 8.

[4] SCENIHR, 2010: 33-34

[5] SCENIHR, 2010: 11

but also “more complex multi-component nanomaterials”[1], such as those obtained through “coatings or functionalisation by long-chain organic compounds”[2]. Refusing to focus solely on “free particles”, the SCENHIR did not limit the scope of nano products to nanoparticulate materials. Rather, it considered “a multitude of possibilities for the application of coatings and surface modifications to nanomaterials”, which “can have a major impact on nanomaterial interaction with biological systems”. More than that, the Committee considered that the degradation of nanomaterials made it possible for a product with nanostructured internal structure (hence not included in the JRC’s definition) to release nanoscale objects. For the SCENIHR, this was a reason for the inclusion of nanostructured materials – precisely those the JRC had refused to consider as nanomaterials “for regulatory purposes”. Thus, the SCENIHR proposed to include “nanoporous and nanocomposite materials”, and also

more complex nanomaterials such as liposomes, e.g. loaded with drug particles or metal particles that are widely used in medicinal and cosmetic applications would typically have external dimensions greater than 100 nm for one or more external dimensions.[3]

“More complex nanomaterials” were meant to include not only existing nano products, but also future ones, such as

The next-generation hybrid nanomaterials (which) are already under development and are typically based on the concept of a hierarchical assembly of many components (e.g. quantum dot superlattices, dendrimers and polymers).[4]

Indeed, in nanotechnology roadmaps, the most common nano products were only the first step in the development of nanotechnology. The SCENIHR quoted Mihail Roco, the director of the American National Nanotechnology Initiative to refer to the “next-generation nanomaterials”. The American nanotechnology policy envisioned the development of nanotechnology through the succession of “generations of products”, all gathered in a roadmap that Roco reproduced in numerous places[5]. While the first generation was composed of the most common nano products, the second was defined as “active nanostructures”, e.g. “targeted drugs and chemicals”, “nanobio-sensors and devices”, and “tools for molecular medicine”. In Roco’s account, the third and fourth were foreseen to be

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[1] SCENIHR, 2010: 24
[2] SCENIHR, 2010: 13
[3] *Ibid.*
[4] *Ibid.*
[5] Roco, 2004. Cf. chapter 1.

developed in the future[1]. The former was to produce "heterogeneous nanostructures and supramolecular system engineering", that is, continuation of the active nanostructures of the 2nd generation, comprising more complex products, autonomous and tailored to specific (above all medical) applications. The latter was to fully realize the nanotechnology program, in developing "heterogeneous molecular systems, where each molecule in the nanosystem has a specific structure and plays a different role", these systems being able to allow new functions to emerge. Such a model of development, formulated by the head of the American national nanotechnology initiative, is not an abstract vision: it is enforced in nanotechnology funding programs, circulates from the U.S. to Europe, where road mapping exercises propose their own version of the future evolution of nanotechnology. These future prospects are then integrated, through calls for projects and coordinated actions, into the making of science policy (cf. chapter 1).

Thus, as the SCENIHR made the argument that "a reference to the internal structure should be included within the definition", in order to "capture complex assemblies provided the internal structure was within the specified range", it considers that any definition of nanomaterials was to include all nano products, including the 2nd to 4th generations. This was necessary "in order to avoid quickly becoming obsolete"[2]. The SCENIHR, for that matter, considered the future of nanotechnology as part of what was to be defined, contrary to the expert of ISO TC229, who were using naturalized representations of the future of nanotechnology as an argument for the crafting of definitions that could help keep pace with the development of nanotechnology seen as inescapable. Hence the argument: if the JRC was cautious about producing a definition that would allow the regulator to control nanomaterials in an effective manner, and thereby separated nano products that were easily identifiable from those that were potentially more complex, the SCENIHR used nanotechnology as it had been developed, that is, as a science policy program that was meant to produce more and more complex products as research projects were developing. In doing so, the SCENIHR made nano products not just a matter of risks for concerned consumers and thoughtful regulators, but also a matter of envisioning the future accomplishments of a science policy program.

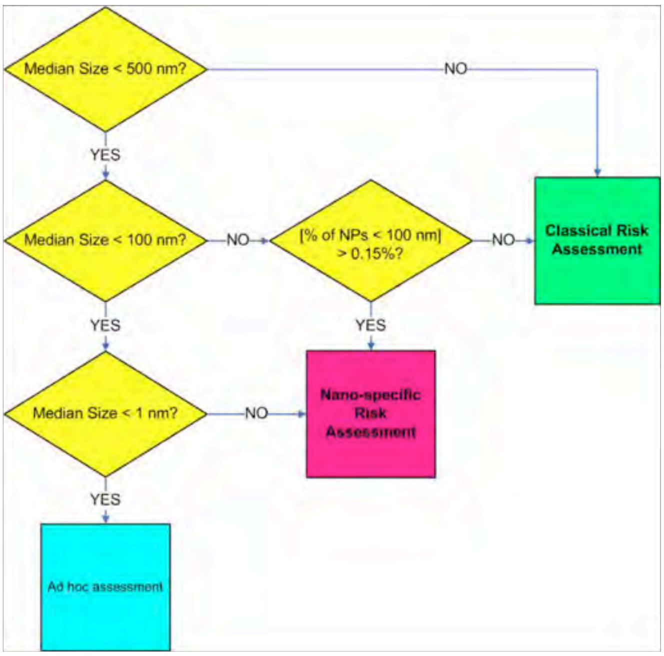
Once admitted, the need to include "internal nanostructure" still raised the issue of the size criteria to be chosen. As the JRC, the SCENIHR considered that what mattered was the products in which nano substances were used, and not just "nanomaterials" in the abstract and "scientific" manner ISO WG1 had adopted. Hence, like the JRC, it stressed the importance of the size distribution of a given material, and the fact that size distribution could be measured through different parameters. But unlike the JRC, which did not discriminate among them, the SCENIHR explained that what mattered

[1] 2010 for the third, 2020 for the fourth.
[2] SCENIHR, 2010: 13

was the number concentration and not the mass concentration, since a large number of nano substances could weigh far less than a smaller amount of larger particles, but nonetheless be more reactive[1].

The SCENIHR's approach differed from the JRC's not just in its more explicit stance on size distribution. Grounding its approach on the impossibility to sustain the 100nm size limit, it refused to stabilize a single size criterion ("100nm"). Acknowledging, like the JRC, the difficulties of a definition solely based on size-related properties instead of size, the SCENIHR however advocated for "a differentiated approach"[2] that would use different levels of size. Consider the following graph (fig. 5.1), which presents the SCENIHR's differentiated approach in the definition of "nano specific" risk assessment (notice that the definition of nano ness is crafted according to a risk evaluation objective).

Figure 1: Risk Assessment on nanomaterials, tiered approach



<u>Figure 5.1</u>: SCENIHR's approach for nanomaterials definition and risk assessment (SCENIHR, 2010: 29)

The graph distinguishes several possibilities, according to upper and lower thresholds. These thresholds are set at 500 and 100nm respectively, which the report explained to be possibilities among others. The upper threshold was introduced in order to include nano products with median size larger than 100nm, but which could nonetheless be considered "nano" through additional criteria. Thus, the graph above considers that if the median size is comprised between 100 and 500nm, and if the percentage (in numbers) of nanoparticles smaller than 100nm is higher than 0,15, then the material is included in the "nano" category. The percentage for the size distribution in particle numbers was calculated according to the following statement:

[1] SCENIHR, 2010: 15
[2] SCENIHR, 2010: 33

Using the number size distribution materials might be defined as NOT being a nanomaterial as the mean size plus or minus three times the standard deviation (SD) (meaning 99.7% of the data set or measured nanoparticles) indicates that 99.85% of the sizes are above a certain upper size limit. Or the other way around: any material is a nanomaterial when >0.15% of the material, based on number concentration, has a size below the upper limit.[1]

The SCENIHR added another criterion (not shown on the graph): for dry materials, the volume surface specific area was considered an additional qualifier, with a threshold defined as Volume Specific Surface Area (VSSA) > 60 m2/cm3[2].

Other conditions were also considered. For instance, the solubility of the material could be considered as a criterion. But integrating a feature such as solubility into a common definition of nanomaterial was not possible since it "can change for each individual nanomaterial depending on chemical composition, surface modification and the immediate environment of the nanomaterial"[3]. But within a differentiated approach, one could consider solubility as an additional criterion, used to determine, within a relational and incremental approach, whether a material satisfying certain conditions (e.g. related to median size, size distribution, or VSSA) required "nano specific risk assessment" or "ad hoc assessment". Consequently, the definition of nano products proposed by the SCENIHR was based on size criteria, but could nonetheless integrate additional, property-based criteria. The differentiated approach it proposed allowed the definition to escape from the opposition between size-based and property-based definitions of nano-ness that I described in chapter 4.

The SCENIHR's opinion caused considerable debate. The difference with the definition used by the JRC was manifest, and the JRC's definition was used by industries to criticize the much more complex vision of the SCENIHR. Thus, the Nanotechnology Industry Association (NIA), a Brussels-based advocacy group for nanotechnology companies, argued for the 100nm upper limit, which was deemed "conservative":

In contrast to the SCENIHR Opinion, we therefore support the JRC Reference Report in acknowledging that 'there are intrinsic nanoscale properties which result from the confinement of atoms and electrons within boundaries of a few nanometres. These effects are most dominant at sizes below a few tens of nanometres (less than about 30

[1] (SCENIHR, 2010: 15). Doing so, SCENIHR implicitly considered that size followed a normal distribution.
[2] A simple calculation show that this is the VSSA of a material of density 1 composed of 100nm diameter spheres.
[3] SCENIHR, 2010: 7

nm). They can considerably change fundamental physical material characteristics like the optical, electrical, and magnetic properties of the nanomaterial.'[1]

Consequently, the NIA did not accept the differentiate approach that the SCENIHR had proposed. Neither did it accept the ways through which the SCENIHR proposed to include the next-generations nanomaterials, that is, complex structures bigger than 100nm, but composed of "hierarchical assemblies of many (nanoscale) components". Again, the JRC's report was the reference:

We agree with the statement in the JRC Reference Report: 'It appears that only those materials which are in a particulate form at the nanoscale, and which are mobile in their immediate environments, raise health and environmental concerns.

Hence, as the JRC, the NIA pushed for the "particulate material" to be considered. It did consider, like the JRC and the SCENIHR, the inclusion of nano products in the definition, and consequently size distribution as a relevant criterion. But it argued against the number-based, and for a mass-based size distribution. This of course was far less inclusive since a large number of small particles can weigh less than a smaller number of bigger particles, in which case a material could be "nano" according to a number-based size distribution, but "non nano" according to a mass-based one. The NIA used different arguments to justify its position: where number size distribution was a totally new criterion in regulation, mass distribution is "often routinely proved in technical specifications of a material", and…

… commercial activities almost always refer to 'mass distributions', and many measurement techniques are laid out to provide this particular measurand.

This is, at this stage again, a negotiation on the novelty of "nano", only more sophisticated than the opposition about the novelty of nano silver. Here, the unavailability of the technical infrastructure necessary to introduce a new parameter is used as an argument to keep the existing criterion[2].

[1] The reference to the 30nm size limit was based on a scientific paper (Auffan et al., 2009, quoted in chapter 4), where the argument is more complex than the NIA's. Rather, the authors advocate a (toxicological) property-based definition of nanomaterials, which could, in some cases, include materials smaller than 30nm, but also others of higher sizes.

[2] Even if it was to accept the number-based size distribution, the NIA refused the 0,15% threshold that the SCENIHR had introduced. Its derivation on a normal distribution of size was rebuked, since "this is rarely the case for commercially manufactured materials, which are often manufactured to a technical specification that provides a highly unsymmetrical size distribution. In fact, for some materials an application of the described derivation would result in entirely nonsensical negative material sizes." The criticism of the "negative size" is based on a strict understanding of the SCENIHR's criterion ("the mean size plus or minus 3 times the standard

The NIA took inspiration from the German association of chemical companies (VCI)[1] in arguing for a mass-based distribution. It thus recommended

the use of a 10 wt-% threshold (cf. VCI (Verband der Chemischen Industrie e.V.) position on the definition of the term 'nanomaterial' for use in regulations laying down provision on substances (3rd February 2010): 'nanomaterials are intentionally manufactured [...] substances [...], which contain, when measured by standardized and recognized methods, at least 10 wt-% of nano-objects').

This definition based on nano-objects as defined by ISO TC229 used the 100nm size limit. It introduced a VSSA criterion in order to apply the 100nm size limit to aggregates and agglomerates, which, to the dismay of other chemical companies outside Germany, did not function with porous material[2].

European nanomaterials for policy-making

Once solidified into a negotiation about size limits, the discussion about the nano-ness of products implied a negotiation on how to set the various thresholds. Both the JRC's and the SCENIHR's definitions led to the same point:

The identification of a nanoscale range is likely to cause considerable controversy. Whereas the lower limit of 1 nm is probably broadly acceptable, the upper limit determines which materials will be subjected to special consideration in regulation. It will be the task of the regulatory body to establish this upper limit which will probably require a stakeholder consultation process involving academia, regulatory bodies, industries and possibly NGOs.[3]

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deviation indicates that 99.85% of the sizes are above a certain upper size limit") and targets distributions for which the mean size minus 3 times the standard deviation would equal a negative number. This of course does not invalidate the SCENIHR's definition, which would just need to add a non-negative condition, or explicitly state that the 0,15% threshold is conventional, albeit calculated for a normal distribution. But it does weaken the (arbitrary) condition chosen by the committee.

[1] The VCI had indeed argued that:
"Nanomaterials (should be) defined as intentionally manufactured, solid, particulate substances, either in powder form or as dispersions or as aerosols, consisting of nano-objects and their aggregates and agglomerates,
(i) which contain, when measured by standardized and recognized methods, at least 10 wt.-% of nano-objects,
(ii)or which have, when measured by appropriate methods, a volume specific surface area larger than 6x 1/100nm.

[2] Interview with the head of the French delegation to ISO TC229, Paris, April 2010.

[3] JRC, 2010: 30

Indeed, following the SCENIHR's report, the D.G. Environment of the European Commission undertook in October 2010 a consultation process on a recommendation on the definition of the term nanomaterial, which

... Member States, the Union agencies and Industry are invited to use (...) when adopting and implementing legislation and programmes concerning products of nanotechnologies.[1]

In its proposed definition, the commission followed the SCENIHR's opinion in including conditions of size distribution, and internal and surface structure, while preferring the 100nm size criterion to the more complex relational definition (which for the committee, was the only one able to avoid the size-based definition/property-based definition dichotomy), and choosing a higher threshold for the size distribution:

- *Nanomaterial: means a material that meets at least one of the following criteria:*
  - *consists of particles, with one or more external dimensions in the size range 1 nm - 100 nm for more than 1 % of their number size distribution;*
  - *has internal or surface structures in one or more dimensions in the size range 1 nm– 100 nm;*
  - *has a specific surface area by volume greater than 60 m2/cm3, excluding materials consisting of particles with a size lower than 1 nm.*
- *Particle: means a minute piece of matter with defined physical boundaries (ISO 146446:2007)*[2]

The consultation that followed, still under way at the time of writing, led industries, public agencies, and environmental NGOs, to comment on the definition, and question the selected criteria. The European Environmental Bureau was satisfied with the 1% size distribution threshold, and was ready to get rid of the 300nm size limit if the size distribution did not change:

In the meantime, signatories welcome the adoption of a reasonable and workable 1% threshold of the particle number size distribution as a way to include in the definition, and put under scrutiny, certain materials, which may exhibit nano specific hazardous properties in the larger size range. Should this 1% threshold be modified pursuant to this consultation, it is our position that the size range chosen in this definition (1-100nm) should also be modified to a higher range (such as 0,3-300 nm) to allow the definition to capture as much material as possible about which there are already concerns (including fullerenes).[3]

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[1] European Commission public consultation document on the definition of the term "nanomaterials": art. 1
[2] *Ibid.*: art. 2
[3] EEB's position on the SCENIHR's opinion, November 2010.

Industries were much more critical, and responded to the communication by pushing for a mass-based size distribution (which is less inclusive than the number-based one), and were reluctant to include nanostructured material other than aggregates and agglomerates in the definition. The NIA used the same arguments it had mobilized when replying to the SCENIHR. It argued for a mass distribution because of the lack of commonly used instruments to measure number size distribution. It criticized the 1% number size distribution threshold for the absence of "state-of-the-art technology available"[1] that would allow regulators and industrialists to measure such number appropriately, and claimed that

it is estimated that the proposed threshold of '1 % of the number size distribution' would result in defining up to 50% of all current materials and products as 'nanomaterials'.

Consequently, the NIA pushed for the VCI's definition it had suggested when responding to the SCENIHR. Hence the content of the discussion: the oppositions were about the threshold to be chosen, and the nature of the size distribution to be considered[2].

The results of the consultation and the final definition chosen by the Commission are still to be released at the time of writing. But more than the final threshold that the Commission will come up with, what interests me here is the process through which nano products are subsumed into a single class of objects, which can then be part of regulatory work. The type of discussion is then about the scope of nano-ness (i.e. well-defined nanomaterials of roughly 100nm, or more complex assemblages of nano substances, which are claimed to be the "next-generation nanomaterials"), and, when converging on parameters such as size distribution, on measuring instruments and thresholds to introduce. For that matter, whereas the 100nm size limit was already solidified at ISO when the European institutions started working on the definition of nano products, the 1% in size distribution that the Commission proposed was not. This caused (and is still causing at the time of writing) numerous discussions about where to set the limit, and how to measure it.

The negotiation among stakeholders in the regulatory arena is a form of democratic organization that we encountered in the U.S. about the existence of nano silver. In Europe, the discussions have reached a still further level, as the objective of the whole process is to construct a European zone (of

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[1] The NIA thus argued for "the clear identification of at least one measurement method that allows for a characterization of particle size distribution for nanomaterials in dispersion, similar to the BET method applied for dry, solid nanomaterials".

[2] Oppositions also appeared among industries: whereas the CEFIC mentioned explicitly the aggregates and agglomerates in their definition, neither the VCI nor the NIA did.

which the cosmetic regulation was a first attempt), with constraining measures, definitions targeted "for regulatory purposes", that, beyond the oppositions between the JRC and the SCENHIR, considered as their primary objectives their alignment with the objective of risk regulation of nano substances and products. The format of the collective discussion is then the oppositions among stakeholders, who are called to comment on the content of European expertise production, and can then mobilize the outcomes of this expertise in order to argue for their interests.

The European dimension of the initiative was not ignored by some actors, most notably industries, which argued against the extension of the scope of the nano products, and were tempted to push for international standardization against the Europeanization of the definition of nano products. The NIA thus supports...

... the utilisation of prior agreements on the international level, such as the adoption of the meaning of the term 'particle' outlined in this article in the Draft Commission Recommendation. We furthermore urge the Commission to seek further alignment with definitions agreed on by international fora both before setting the definition of the term 'nanomaterial', as well as during the review process recommended above.

Of course this would favor the 100nm criterion: if the European Commission had used ISO's definition of nanomaterials, it would not have been possible to identify nano products for regulatory purposes. In Europe, the construction of nano products was to be attached to a regulatory objective. This could not work at an international level, where the "science-based process", for all its arbitrariness (cf. "100nm" as the size limit), could gather international agreement because it did not imply future regulation.

The table below synthesized the definitions of nanomaterials we encountered so far. It contrasts the "science-based" definitions at ISO with the definitions proposed within European institutions. The second column connects the term I introduce for analytical reasons ("nano products", that is, consumer products containing nano substances) and explains its relations with nanomaterials. At ISO, nano products were not considered nanomaterials. In the European institutions the challenge was to define nanomaterials as nano products. Eventually, the table presents the forms of collective organization that enact these definitions, at the same time as they are further solidified by them.

	Nanomaterials	**Nano products**	**Democratic organizations**
ISO	100nm size limit	"Science-based definitions", from the core terms	International negotiation
EP	In specific regulation (cosmetics, novel food, biocides)	Nanomaterials	Parliament vs. Commission
JRC	100 size limit and nanoparticulate materials	Nanomaterials	Expertise as a resource for regulation-making and for the negotiation among stakeholders
SCENIHR	Relational and incremental definition	Nanomaterials	
EC	100nm size limit and size distribution	Nanomaterials	

Table 1: Five definitions of nanomaterials and nano products and their forms of democratic organization.

As seen in this section, the oppositions between these approaches were important, particularly through the implication of industries. Industrial companies regularly advocate limited definitions of nano substances and products. The international ISO definition, not related to any toxicological properties, and thus isolated from any potential regulation of risks, received a lot of support from industrial companies - many of which had been involved in its construction. It was the basis for the attempts made within the European institutions, but, with the exception of the JRC's propositions, these attempts were criticized by companies, and much better received by NGOs. The European Environmental Bureau, for instance, used the SCENIHR's definition to comment on the EC's proposition, deemed to be "a step in the right direction", and has been supportive of the European Parliament's action in adding nanomaterial-focused amendments in European regulations.

The opposition between the ISO's "science-based" definition (that is, independent from any regulation choice) and the European "policy-based" one (that is, connected to the regulation of risks of nano products) has now been refined. We have encountered references made by European actors to the ISO definition, but the negotiations between European and international actors have not been visible. So far, the boundaries of the European regulatory zone have appeared unproblematic. The next session considers in some details a European attempt to construct a label for nano products, this time specifically for consumers. In this project, the boundaries of the European zone were questioned.

Section 2. Negotiating a European zone for nano products

The problem of the existence of nano products is crucial when considering the labeling of these objects. As seen above, labeling was a request of NGOs, and a problem that public bodies faced when they attempted to survey the industrial and commercial activities in nanotechnology[1]. It is clear after the previous section that creating a label for nano products is bound to cause controversies. Labeling requires the construction of infrastructures able to produce and control the information to be provided to the consumers, be they individuals buying goods, or companies. In such a mechanism, "information" is not an unproblematic category. It is linked to the mobilization of particular publics (consumers vs. business, concerned citizens vs. informed consumers), and conveys elements about the material characteristics of products that are thought to be of interest for the label's users.

Soon after its creation in 2008, the technical committee on nanotechnology of the European Committee for Standardization (CEN) launched a project on the labeling of nanomaterials. This project, as it will be described in this section, attempted to take seriously the ontological uncertainty of nano products to elaborate a flexible label. The conduct, and eventual failure of the project will offer another illustration of the mutual construction of a definition of nano products and forms of policy-making. The nanomaterials labeling project undertaken within CEN offers an illustration of the difficult stabilization of a European space for nano products. Thus, I will describe the processes through which the initial choice of flexible labels for flexible consumers eventually failed to make its way within CEN, for reasons that are linked as much to technical difficulties as to the constraints of international negotiation. The case of CEN is of particular interest for that matter, since the standards the project was supposed to produce were meant to be European *and* international. Thus, as the project developed, the boundaries of the European zone, its specificity and the ways in which it could be integrated in the international zone for the circulation and commercialization of nano products were discussed.

Nanotechnology at CEN

CEN is by many respects a peculiar place. It is an international body that, like ISO, gathers national standardization organizations from European countries. Yet contrary to ISO, CEN is closely related to regulatory institutions. Within the so-called *New Approach*, the European Commission uses CEN for the operationalization of the general principles defined in directives and regulations. It is a

[1] Cf. the U.S. Nanomaterial Stewardship Program and the French AFSSET's survey of companies producing and using nano substances (chapter 4).

component of the distributed system of European governance meant to ensure "harmonization" among member states[1], and actively contributes to making of regulation[2]. The EC provides mandates to CEN, but the link with the expectations of the European institutions is not automatic. CEN is invited to work in certain areas, and answer certain concerns and expectations, but can only do so to the extent that (voluntary) members of technical committees agree to invest money and working time to work on these projects.

Following a first mandate released in 2004 by the European Commission, a working group was created within CEN to reflect on the need to create a nanotechnology specific technical committee. The group agreed to do so, and TC352 was created, at about the same time as the creation of ISO TC229[3]. That two nanotechnology committees were created simultaneously at CEN and ISO was not unanimously viewed in a positive perspective. Many countries were participating in both CEN and ISO nanotechnology committees and were reluctant to duplicate work. The German delegation, for instance, was opposed to the creation of the TC352. This was explained by a senior manager at the French organization for standardization (AFNOR) as follows:

European norms are automatically applied in the 30 member countries of CEN. The logic is that it serves as legal regulation. This is not the case at ISO. This is the reason why saying "we don't want to go through the European level" is also linked to the refusal of legal constraint… this is to avoid a document that will be imposed. For the Germans, the international standard was far more flexible[4].

Thus, the close links between CEN and the European regulation could appear as an issue for participating members[5]. But for the CEN nanotechnology working group, the link between CEN and European regulation was precisely the reason why the creation of a dedicated European nanotechnology technical committee was necessary. Its report explained the situation as follows:

Based on recent discussions at European standardization meetings it is becoming ever clearer that it makes sense to build a European position in nanotechnologies standardization. (…) Firstly, the status of ENs (European standards) in Europe is different from that of ISO (international standards) in other countries. European countries must adopt ENs as national standards when they become available. (…) CEN has an ongoing duty to elaborate

[1] For a presentation of the new approach, see (Pelkmans, 1987; Borraz, 2007). I will come back to the notion of harmonization in chapter 7, using Andrew Barry's comments on the notion (Barry, 1993).
[2] The New Approach is thus part of what Majone describes as a networked and information-based regulation-making system in the European Union (Majone, 2001).
[3] This episode was told to me by a member of the French delegation to ISO TC229 and a head of department (*chef de service*) at AFNOR (AFNOR, Saint-Denis, October 2008).
[4] Interview, *chef de service*, AFNOR, Saint-Denis, October 2008.
[5] I am not interested here in deciphering whether or not the Germans indeed thought so. I am more interested in the ambivalence of the support for standardization.

specific European standards in response to needs that clearly differ from other regions of the world, e.g., when societal perspectives differ in Europe from elsewhere, or in response to the regulatory framework in Europe. (…) For these reasons, it is appropriate to have a viable and active European standardization structure such as CEN/TC 352.[1]

Hence, CEN was to operationalize the European specificity in standard-making, particularly in areas where regulation was to be enforced, and in those where "societal perspectives differ in Europe from elsewhere". This somewhat cryptic expression was straightforward for its readers: the European nanotechnology policy had been concerned about the integration of the "societal impacts" of nanotechnology in the making of programs in order to avoid what was perceived as a European skeptic attitude toward new technologies. Thus, CEN could be a way of integrating in standards the principles of "transparency", "inclusion", and "sustainability" the European nanotechnology policy was based on[2].

Eventually, CEN delegated much of the work to ISO TC229, while TC352 was asked to work on general tasks:

- *To take stock of current standardisation relevant to nanotechnologies and nanomaterials (…) which may need a revision in the light of risks associated with nanotechnologies and nanomaterials;*
- *Identify the need for new standards;*
- *Identify the need to develop standardisation documents other than standards in relation to the above mentioned priority areas;*
- *Identify the availability of stakeholders in the European Economic Area with a view to associate them when necessary in the standardisation process*[3].

Meanwhile, it also pursued the reflections on the future mandate from the Commission to CEN[4], while starting three projects (compare with the dozens of projects TC229 was undertaking): one of them was cancelled because of a lack of involvement on the part of the participants, another one was related to the technical specification of a measurement device. The third project was undertaken at the initiative of the British delegation. Based on a British Publicly Available Specification (PAS) providing a

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[1] "Report from CEN/TC 352 about the Commission Mandate M/409 addressed to CEN, CENELEC and ETSI for the elaboration of a program of standards to take into account the specific properties of nanotechnology and nanomaterials", April 2008: 20-21.
[2] The next chapter will explore at further length the importance of moral principles in the making of European nanotechnology policy. (Hullmann, 2006) is a report of the European activities in the field of the "ethical, legal and societal aspects" (ELSA) of nanotechnology, which insists on the "European specificity" to call for ELSA studies.
[3] European Commission, Enterprise and industry directorate-general, 2007, "Mandate addressed to CEN, CENELEC and ETSI for the elaboration of a program of standards to take into account the specific properties of nanotechnology and nanomaterials", M/409 EN, Brussels.
[4] The next mandate is in discussion at the time of writing.

"guidance for the labeling of products containing nanoparticles", it attempted to craft a similar guidance at the level of CEN. I will focus on this labeling project in the remainder of this section, as it is another attempt at defining nano products. By the same token, and due to the roles of CEN and the constraints it faces, it also provides an illustration of the construction of a European zone in which the problem of nano products and their consumers is defined and (tentatively) dealt with.

A British ethicist, Geoffrey Hunt, who had conducted the preparatory work for the nano labeling PAS, led the CEN labeling project[1]. The composition of the group working on the CEN labeling project is of interest for several reasons. First, the presence of NGO representatives was significant: two participants in the 10 member groups belonged to federations of NGOs aiming to represent "civil society interest" in standardization activities (ECOS, European Environmental Citizens Organization for Standardization, and, ANEC, the "European Consumer Voice in Standardisation"). That the head of the group was an ethicist, and, throughout his writings[2], very much in favor of dialogue with civil society organizations, made the group quite different from those of ISO TC229. Second, although the group belonged to CEN TC352, and as such was expected to provide elements for the future European nanotechnology regulation, it comprised non-European participants, from Japan, Canada, and the United States. The first two were scientists; the American participant was a member of a lobbying company in Washington DC defending the interests of the chemical industry.

The active presence of non-European participants in this CEN project was not exceptional. The nano labeling project was indeed developed under the "Vienna agreement", according to which work developed in either CEN or ISO can then be used in the other organization. The Vienna agreement, signed between ISO and CEN in 1991, recognizes both the specificity of the European zone, and the need for unified international standards:

Essentially, the agreement recognises the primacy of international standards (stipulated notably in the WTO Code of Conduct). But the agreement also recognises that particular needs (of the Single European Market for example) might require the development of standards for which a need has not been recognized at the international level. The prioritization of ISO work is also such that in some instances CEN needs to undertake work which is urgent in the European context, but less so in the international one[3].

Thus, the nano labeling example provides an illustration of attempts to problematize nano products through "European values" (such as "sustainability", "traceability" or "upstream engagement":

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[1] G. Hunt told me that he headed this group because he had met the head of CEN TC352 during a conference where he had argued for the labeling of nano products.
[2] Hunt, 2006a; Hunt, 2006b
[3] International Organization for Standardization (ISO), European Committee for Standardization (CEN), *Agreement on Technical Co-operation between ISO and CEN (Vienna Agreement)*: 1.

three principles that were heralded as core rationale of the BSI PAS, and in the early versions of the nano labeling TC352 document), while at the same time having to include extra-European concerns and expectations.

The Vienna agreement defines the conditions under which a normative document can be developed within CEN, and used as an international standard by ISO members, or vice versa. The development of standards can be done by either of the organizations, while the other might in a later step accept or refuse the standard once it is done[1]. Accordingly, the CEN labeling guidance was prepared as a future technical specification meant to be used as an international document. As a European norm, the guidance labeling was meant to operationalize the European principles. As a standard developed under the Vienna agreement, it had to be developed while taking into account the expectations of international participants (in this case, American, Canadian and Japanese). It meant that the European principles that were presented as the basis for the standardization initiative were to be discussed and re-opened, in order to explore in what ways these principles could be used at the international level, whether they were, as a participant from the US repeatedly said, "globally relevant" or not. These discussions occurred throughout the process of standard writing, while participants commented on the type of information to provide on the future labels, and the objectives of the guidance. Thus, examining the construction of this standard makes visible arguments and propositions for assemblages of both nano products and "nano consumers", and the construction of permeable European boundaries. The process of standard writing is itself a specific collective organization: it gathers NGO and industry representatives, European and non-European participants; it seeks to speak for the European consumer while making room for the interest of the international one; it attempts to define "nano-ness" at the level of products, while many of the components that could make it possible to represent these products (standards, instruments, technical criteria...) are absent. Hence, the political and technical work performed in this arena is likely to face considerable challenges.

[1] The processes of co-operation can take various forms, and "technical co-operation" is possible through various channels. CEN and ISO agree to ensure "regular exchange of information", and "mutual representation at meetings of technical entities". A given project can be undertaken by either CEN or ISO, and then be adopted as a European or international standard by the counterpart. Technical cooperation then occurs "when ISO and CEN agree to submit relevant and approved work items within the same scope to parallel procedures, with agreement on leadership (ISO-lead decided by CEN, CEN-lead decided by ISO)" (Vienna Agreement: 2). The process is codified: a project can start as a CEN document, and later be adopted under a different statute by ISO, or eventually be rejected as an international norm.

A flexible definition for a flexible consumer

As a normative document about labeling, the project was to perform boundary work (that is, drawing the "nano / non nano" limit), at the level of consumer goods. This implied a reflection on the technical instrumentation able to measure concentrations of, or "effects" related to nano substances, while considering the expectations of those who were supposed to use these future labels. The detailed exploration of the process of elaboration of this document will allow me to describe how these expectations played out. As I will detail in this section, the technical constraints incited the initiators of the project to propose a flexible definition, able to encompass the variety of nano products and targeted to a diversity of potential consumers.

The very first version of the CEN guidance, submitted for comments by G. Hunt to the project group members reproduced the BSI PAS[1]. It defined "manufactured nanomaterial" as a "solid entity with size from approximately 1 nm to 100 nm in at least two dimensions that has been produced by a manufacturing process"[2]. As in ISO TC229, the definition was using a nanoscale size criterion and considered only objects produced by human intervention. Like the BSI PAS, the initial document introduced a definition of nano products:

2.5 product containing manufactured nanomaterials (PCMNP)

any product in which MNMs are intentionally added, mixed, attached, embedded or suspended[3]

Not all PCMNPs were supposed to be labeled in this initial proposition. The initial version of the guidance recommended labeling for MNMs, and the PCMNPs that could release MNMs. For the latter, the conditions were the following:

- PCMNMs, *except where the nanomaterial component of the product is intimately bound and could not be released under reasonable and foreseeable conditions of use or disposal.*
- PCMNMs *which are components of complex systems (e.g. a vehicle, mobile phone or game console), which could be expected to release* MNMs *under reasonable and foreseeable conditions of use or disposal.*

In addition, "by-products" were also included in the "nano" label:

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[1] The initial focus on "nanoparticles" (which were defined as in ISO TC229) was displaced to "manufactured nanomaterials".

[2] First revision after the BSI's proposal: 16/10/2009.

[3] Unless otherwise specified, quotes in this paragraph are excerpts from the BSI PAS on labeling.

• *By-products, where MNMs, generated as by-products, are present in MNMs and PCMNMs and might affect the technical properties of the product or pose a risk to health or the environment.*

How to label these objects was not strictly defined. Rather, the document offered flexibility in the type of information that could be provided, which rendered the initial definition of PCMN far more encompassing than the sole size criterion might have led to think:

Examples of general label statements relevant to MNMs and PCMNMs might include those listed below. (...)

- *Contains manufactured nanomaterials of X [chemical substance];*
- *This product contains manufactured nanomaterials of X;*
- *Contains 0.1g nanomaterials of X;*
- *Contains a dispersion of manufactured nanomaterials of X in Y.*
- *Titanium dioxide, approximate size range X nm – Y nm, specific surface area: Z m2 gp1.*
- *Contains nanotubes of carbon, with an aspect ratio of 1:20*

Although the BSI PAS adopted a criterion of size for the definition of nanomaterials, it also proposed a wide range of products to be labeled (according to effects, conditions of use, or specific surface area), and, accordingly, considered different types of information to be conveyed. This was a central concern of the leader of the project: the objective of the project was *not* to enter a complex definition work to define detailed criteria (this was undertaken in other places, for instance at ISO, or within the European Commission). Rather, it was to take seriously the ontological uncertainty of nano products in order to convey relevant information under the format of the label. Hence, as proposed in the *guidance*, the "nano-ness" of the product was defined according to the effects, use, expectations, and did not follow a simple boundary according to one single criterion[1]. Considering the impossibility of unambiguously defining the "nano-ness" of products, the initial proposition considered that the situation of un-definition of nano products and substances required that different types of definitions be allowed, according to the multiple channels through which the products might cause risks for the consumer (e.g. use of the packaging, consequences of various uses and disposal, whether nanoparticles are bound to a matrix or not). The document proposed a series of potential information that labeling could provide, among which "whether the MNMs were bound in a solid matrix", "the descriptions of the function(s) of MNMs (e.g. use of the material in nanomaterial form ensures more complete

[1] Reflecting on this initiative four years later, G. Hunt told me that it was a somewhat "naïve attempt" to define nano products. G. Hunt still argues for the flexibility of the definition, but also advocates an approach that would consider the particularities of each situation of use rather than choose a uniform size criterion. This is close to the property-based definitions discussed in the previous chapter (phone interview, G. Hunt, August 2011).

dissolution and hence faster assimilation)", and whether MNMs were "unstable under specific conditions (e.g. UV, friction)".

In both the BSI PAS and the early propositions of the CEN TC352 working group, labeling was to define what the nano products were, and circulate information about potential risks, uncertainty and uses. The future European market of nano products required both the definition of nano products through the labeling instrument, and the equipment of the actors expected to constitute the demand for nano products. As such, it was to be a "market device"[1], in that it was supposed to construct a market integrating risks, in which suppliers define their products so that well-informed citizens could buy products knowing their potential safety implications. "Well-informed consumers" were to be created through the labeling system:

All relevant information should be provided to enable consumers to make an informed choice between products before purchase, without opening any retail packaging.

This required a further multiplication of definitions, at the level of the practical use of labels:

It is recommended that labels on any of the following goods should include a statement (...) so that it is visible and legible prior to sale to consumers expecting to find it:

a) Containers of MNMs;

b) Products (or their packaging) containing or comprising MNMs;

c) Products (or their packaging) using nano-enabled effects;

d) Products that use the prefix "nano" in promotional or descriptive information

As the guidance proposed a flexible approach to the qualification of nano products, it also adopted a flexible approach about the consumer who was supposed to use future labels crafted according to the *guidance*. They were supposed to be individuals buying consumer goods, but also professionals. Indeed, the BSI PAS considered that...

... the purchaser should be equipped and staffed to take responsibility for subsequent labeling for identification and safety purposes, and maintenance of production control systems from the point of receipt onwards.

This implied further consideration about the possibility that nanomaterials enter a production chain at various points, and multiply even more the nature of consumers of nanomaterials:

[1] Callon et al., 2008

Nanomaterials may enter at one or more points into a more or less complex supply chain from primary manufacturers through to wholesale and retail distributors. In this situation, the upstream business should inform those downstream when they are in possession of relevant information, and those downstream have a reciprocal duty to ask for any such information, in so far as it is significant for purposeful labeling.

The guidance that the BSI PAS proposed, and which was re-used by the proposition made to CEN was meant to answer concerns of individual and professional users of the label. It was expected to help consumers identify uncertainties about potential risks, and offer ways for professionals to track their supply back in case some new results would happen. In the situation of uncertainty about the definition and risks of nanomaterials, this required flexibility about the content of the label according to the conditions of use, and the physico-chemical characteristics that were responsible for the properties of the products. Thus, the BSI PAS was an attempt to allow users of the label to be flexible about both the nano products and the "nano consumers", while using the approximate 100nm size limit as an overall umbrella for nano products.

The framing of the nano product market that the initial guidance proposed was linked to "basic principles" meant to be part of the "conceptual framework" of the device, and a response to the European Commission mandate to CEN: "precautionary principle", and "transparency". The former suggested that "actions should be taken even before risks are actually demonstrated" and thus was the basis of the objectives of the labels as an indication of uncertainty about risks. The latter implied that instruments of "traceability" were put in place. As I will discuss in the next paragraphs, both were controversial for the participants.

Discussing European precaution

The initial proposition was discussed at length among participants in the working group. The main demand of NGO participants was to enlarge considerably the scope of nano products "in order to apply the precautionary principle"[1]. NGOs' participants proposed to set a wider size limit, using the specific surface area criteria, with the explicit objective to include nanostructured materials (see chapter 3). Participants coming from the industry criticized the NGOs' propositions. But the opponents of the NGOs joined them in pushing for the solidification of a boundary, against the flexible "nano-ness" that the guidance suggested. They did this, as opposed to the NGO participants, by narrowing the scope of

[1] The argument was used by one of the civil society organizations present in the group. The position of the NGOs was related to me by a member of ANEC (Brussels, November 22, 2010).

nano products. For instance, “byproducts” were repeatedly targeted as too costly to include in the guidance.

The opposition was not just about the extension or the reduction of the scope of the project. More importantly, it was about the very possibility of defining nano products in the flexible manner the BSI PAS had proposed. For many participants in the working group, the situation of uncertainty regarding the definition of nano substances and products made it impossible for the labeling document to enter the flexible boundary work that the BIS PAS had proposed. Thus, the US participant stated that:

Government regulators continue to evaluate labeling for nano objects, but acknowledge that the science is currently limited and evolving, which would permit them to determine what labeling might be needed or permissible for products that use nanomaterials and, more fundamentally, what materials might be appropriate to consider "nano" in the first place. Accordingly, it may be inconsistent with the basic tenets of the appropriate focus for a consensus-based standards-setting body to undertake development of this document at this time, given the evolving state both of the science and of regulatory policy on labeling content for such products.[1]

Consequently, she considered that it was better to “stick to a scientific description”. The “science” she used was very much the same as the international science of ISO TC229: the description would be “scientific” in that it limited “nano” to “what it really is”, i.e. a “prefix denoting a size”. Accordingly, the US participant preferred to use “nano objects” rather than nanomaterials, i.e. objects merely defined according to their size. Contrary to the initial proposition that introduced a wide range of information through the labeling system, mostly related to potential “nano-enabled effects” (potentially related to risks), her critical comments used the argument of the ontological uncertainty to limit the scope of the future document. In this perspective, the label was not intended to provide information about “hazards” or “safe use”, but bland “scientific” information about the size of the objects being included in a product. Consequently, the intended user of the future label was, in this position, an individual consumer merely interested in the presence of nano-size objects, whatever consequences they might have for the products he or she was buying.

Defining the “nano-ness” of the product as “just a size” holds important implications. Chapter 4 made it clear that sticking to a size range was a way not to use a (toxicological) property-based definition. This was made explicit during the discussions about the labeling guidance, when proponents of the size definition complemented their positions by explaining that

[1] Comments submitted by the US participant to the guidance labeling project.

The prefix "nano-" is not intended to be an abbreviation of a performance property that is enhanced or generated by the presence of nano-objects. It is simply a prefix that should be used for the limited purpose of identifying the size or scale of a material under the SI (International System of units of measurement) *definition.*[1]

The size-based definition was a way not to transform the guidance labeling into a risk management device, by conveying information that was not related to the risks of products. It implied that any hint that the labeling device could be used for risk regulation was criticized. This meant caution not only about the definition of the nano-ness of products but also about the writing style. For instance, one of the initial sentences of the BSI PAS read:

"the potential risks associated with the use of MNMs in consumer products are not well understood"

This original sentence suggested that the labeling work was linked with the identification and circulation of information about the potential safety effects of nano substances. The sentence caused long discussions, and numerous propositions were made to replace it. The following statement (submitted by a JRC expert participating in the working group) is just one of many examples, from the series of commentaries sent in the fall of 2009 on the first version of the document:

"the sentence is too broad. There are certainly a number of MNMs for which the risk associated with their use in consumer products is well understood, and basically absent, certainly when taking into account that risk is a combination of hazard and exposure, the latter of which can in many cases be limited"

This participant then suggested to replace the sentence by:

"the potential risks associated with the use of MNMs in consumer products are not often, but not always well understood"

The project leader considered this sentence "too optimistic", and eventually used the expression "not fully understood". As we will see below, this was not enough to convince the participants to accept the text.

For the very justification for the flexible definitions of nano products and consumers was the "precautionary principle", which was mentioned as one of the principles of the document. Yet in

[1] Comments: 12

discussions about a future normative document crafted within the Vienna agreement, the precautionary principle was not an acceptable argument because of the "global relevance" that the document was expected to respect. The American delegate provided a 4-page long discussion paper on the "global relevance policy" that the initiative, conducted under the Vienna Agreement, should follow, and which had to be clarified throughout the process. In this document, she criticized the reference to the precautionary principle:

The precautionary principle as defined in this draft TS is not generally recognized in all countries. As such this fails the mandate from ISO Technical Management Board that to be included in an international standard there has to be "Global relevance".

This implied more than variations in the writing style. As a future international technical specification, the document needed to allow different interpretations at national levels. The criticism of the precautionary principle was also another version of the refusal of the ontological flexibility that the original made possible: contrary to the first version of the guidance, the critiques of the precautionary principle contended that the future TS should solidify one information (nano=size, independently of the properties), and one target: people-to-be-informed about the size of the components of the product they would buy. The NGO participants of course did not follow this criticism of the precautionary principle. Yet their use of it also led them to argue for the solidification of a size limit. Thus, the initial BSI PAS propositions and their critiques were built on a completely different basis. This also implied that the initial flexibility about the identity of the consumer was to be reduced.

Discussing European traceability

The other contested objective of the labeling mechanism dealt with its potential use as a communication device among industries, in addition to an information tool for individual consumers. The BSI PAS supposed that the labeling device could be used by both groups, yet in the discussion within CEN, delegates from the US, Italy and Japan constantly pushed for the limitation to the "information to the consumer", possibly only about the "nano" content of products – "nano" being understood as "a prefix", i.e. a mere size-related epithet, regardless of the properties it rendered possible. Limiting the scope of the document to the individual citizen was thus expected to limit the flexibility in the type of information that the BSI PAS had proposed:

The starting document for this work, PAS 130, was all-encompassing in the universe of products covered (…)

This situation would lead to many varying and in some instances, opposing interpretations with some choosing to label a product within a class, while others do not. The US suggestions limit the range of products (…). The focal point for the manufacturer who wishes to use the TS becomes, "is there a nano-object present?" and "will normal use lead to consumer contact with a nano-object?" For the consumer, the question is, "do I want to bring this into my household?"

The insistence on the limitation of the receiver of the label to the consumer of nano products[1] was tightly connected to a controversy about the principle of transparency, translated in the BIS PAS into a call for a more efficient "traceability" all along the development chain of nano products. Accordingly, the US delegate discussed "traceability" in the same document in which she had questioned the reference to the precautionary principle:

The concept of traceability is also used to refer to a widely-accepted risk management tool that enables products and their ingredients to be identified retrospectively at any stage in the life-cycle. This kind of traceability is normally applied to sensitive product sectors, such as food, drugs and medical devices, where traceability is used to conduct recalls in the event of product defects and to take corrective actions.

Indeed, traceability articulates the construction of industrial standards, concerned citizens, and regulations, by allowing consumers and regulators to track signals of alert[2]. As Franck Cochoy said, traceability developed "as much to answer private complaints as to answer a safety injunction voiced by the State regarding the protection of consumers-customers"[3]. The BSI PAS had proposed an approach that was both flexible about the definition of nano products, and strict about the use and circulation of labels, which were supposed to be used as traceability instruments. Hence the reluctance of the actors involved in the CEN guidance labeling project about the extension of the scope of the project to the circulation of information among companies. Limiting the consumer to an individual-to-be-informed-about-size was a way not to construct a traceability device that could pave the way for future regulation[4].

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[1] Limiting the receiver of the future label to the "general public" was also a request from NGOs, who contended that the objective of the labeling guidance was to be targeted to individual consumers.

[2] Torny, 1998

[3] Cochoy, 2002: 374, my translation.

[4] Interestingly, the oppositions between participants from industries and NGOs that were clearly visible about the focus on risks, or the extension of the scope of nano products were not present at this level. Both groups pushed for the document to be targeted to "consumers".

Writing the final document

The extent of controversies about some of the central points of the document, the vividness of the contributions and the confrontational tone of the exchanges within the project group was quite unusual in the standardization arena. Faced with concurrent propositions from delegations with opposed opinions, the leader of the project had to reach a consensual endpoint for the guidance document. The response that eventually appeared the most consensual was that of the US delegate, who proposed to consider "nano as a prefix", that is, as a mere size criteria regardless of the properties of the concerned material, and, in particular, of its health and safety issue. This was a condition for the labeling device to be "globally relevant", and have a chance to pass the balloting process. The final text sent for balloting proposed to label the following:

This guidance on format and content is applicable to the labelling of the following:

- *MNOs* (Manufactured Nano Objects)
- *PCMNOs* (Products Containing Manufactured Nano Objects), *except where the nano-objects are bound and could not be released under reasonable and foreseeable conditions of use or disposal.*
- *PCMNOs which are components of complex systems (e.g. a vehicle, mobile phone or game console), which could be expected to release MNOs under reasonable and foreseeable conditions of use or disposal.*
- *MNOs and PCMNOs in which there is a significant level of incidental NOs generated that might on reasonable grounds be expected to be released.*

As compared with the original BSI PAS, the year-long discussions do not seem to have brought much. Yet they did solidify particular choices at the expense of others. First, "by-products" were no longer mentioned, in favor of a "significant level of incidental NOs" (with no indication about the reason why a level would be "significant"). Second, the size criterion was clearly chosen as the most relevant, in the absence of another definition. The initial document proposed to label nanomaterials, in a way that could potentially expand according to the needs or expectations of label users. The final one stuck to "nano objects", defined, as in TC229, as a "material with one, two or three external dimensions in the nanoscale", and to "product containing manufactured nano-objects (PCMNO)", that is, "product in which MNOs are deliberately added, mixed, attached, embedded or suspended". Nano products that were supposed to be labeled were those that could release nano objects from the structure in which they were included. Hence a compromise between the alternate arrangement, limited to size, and the initial labeling scheme, which was considered too flexible for the actors involved. Accordingly, the document did not propose to introduce different types of labels (for instance related to properties, or particularities of the use of products) in order to stick, as the American delegate had argued, to "science", i.e. the

100nm size limit[1].

As a result of the constant refusal from the participants to expand the receivers of the labels to a wide range of potential consumers (be they industries or individuals), the limitation to the size criterion was accompanied by the restriction of the scope of the project to the individual consumer.

The principles that grounded the first document were eventually moved into a "wider conceptual framework" section "as an informative annex". Written by the US delegate, it explained that

to effectively respond to regulatory and market needs, as well as scientific and technological developments in various countries, the TS recognizes that the characteristics or requirements of a specific region may diverge and that different needs or interests exist in other countries or regions.

The "conceptual framework" drew a difference between the guidance document and the "additional general corporate responsibility and governance concepts", which were mentioned but not meant to determine the content of future labels. For instance, the conceptual framework distinguished "labels", which "provide one source of information that facilitates communication, by providing consumers with contact information for the producer and product identification information", and "supply chain communication", which was thus outside the scope of the guidance document, and "allows products and their ingredients to be identified one step up and one step down at any stage in the product development". The precautionary principle was still mentioned, yet it was "recognized that the TS (would) be usable in countries that do not subscribe to this concept".

The difficult construction of European nano products and consumers

The initial formulations of the British PAS, although they did propose boundaries to distinguish "nano" from "non nano", were flexible enough to potentially include a wide range of products, depending on the expectations of consumers and producers. In the meantime, they also paved the way for a property-based definition of nano products, while operationalizing the European principles of

[1] Truly enough, the final version of the document proposed to use "nano" to label MNOs, but it did consider "agglomerates and aggregates" (a central requirement for NGO members), and a modified version of the " nano-enabled effects" that were mentioned in the initial document: "It is recommended that the prefix "nano" should only be used in product labelling if either or both: 1) the product does contain MNOs, including their agglomerates or aggregates; 2) the product displays nanoscale phenomena according to definition". After a long discussion, "nanoscale phenomenon" was preferred to "nano-enabled effects". Indeed, nanoscale phenomenon could be related to the size criterion that was eventually chosen, since it was defined as an "effect attributable to nano-objects or nanoscale regions". If the phenomenon was "attributable to nano-objects", then the condition did not add anything to the definition of nano-object. If it was "attributable to nanoscale region", then the property was size again: meaning that a discontinuity in a property of the material should occur at the 100nm limit.

precaution and transparency. Yet as it was developed under the Vienna agreement, the CEN initiative needed to make room for international constraints and expectations. The refusal to accept the initial labeling – an attempt to introduce flexible definitions of both nano products and consumers – led to the promotion of a size-based label, directed toward a single, individual consumer. This resulted in a compromise in the final text, which grounded the approach on the size criterion and the individual consumer to be informed, while maintaining differentiation among products according to the possibilities for the release of nano objects. This compromise did not manage to clarify the objectives of the guidance document, which was proposed for voting at ISO TC229 and CEN 352, and rejected in both places. The members of the French delegation were critical: "the objectives were not clear"; "the project leader had proposed a ready-made document from the start instead of negotiating with the participant"; "he had not been able to take the viewpoints of the participants into account" and, consequently, "the consensus was weak" [1].

Writing international standard certainly requires particular leadership qualities and an ability to use the procedure to make one's propositions heard without imposing them on the other participants. However, my interest lies less in the detailed reasons for the rejection of the project, than in what it says about the making of nano products and the European zone. The failure of the project at both CEN and ISO (it could have been rejected by one, and continued by the other) was due to the impossibility of crafting an acceptable labeling device that would allow an ontological flexibility to be translated into a label, as well as the conflicting views of the scope of the European principles on which the document was based. The example of the CEN guidance labeling thus renders the porosity of the European zone visible. When it works under the Vienna Agreement CEN defines standards and norms that are supposed to be "globally relevant", while also being a vehicle for the Commission to enforce European general principles. The porosity of the European zone made it necessary that the guidance should construct "simple" nano products, not related to particular expectations and properties, for a no less simple public: a single consumer wishing to obtain information about the size of the components of the product he or she buys – regardless of the consequences of this size for specific properties. Needless to say, the information thereby conveyed (or which would have been so if the labeling guidance had been enforced) solidifies even more the elimination of property-based definitions.

The construction of flexible nano products is not necessarily bound to fail. The next section follows up on the construction of "flexible" nano products, using a French standardization project. Thus, it shifts the attention from the construction of international zones to that of a national position on the existence of nano products and consumers.

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[1] Quote from a meeting at AFNOR (Paris, March 2011). At the time of writing, the follow-up of the guidance labeling is being discussed.

Section 3: French responsible nano products

Beyond boundary-drawing

So far, the contested construction of definitions for nano products has appeared to be the product of both technical (im)possibilities and national positions. I have examined how international arenas are places where, through the very construction of standards, national delegations compete against each other, different publics of nanotechnology are constructed, and different problematizations of nanotechnology and its products are opposed. The technologies of democracy examined in the previous chapter and in the first two sections of this one attempt to settle boundaries between "nano" and "non nano" through negotiations among national delegations, industry and NGO representatives. Stabilizing these boundaries implies a close articulation between science policy instruments, technical constraints and instrumentations, the possibilities of legal transcription, and the expectations of industrialists and consumers. The approach intends to first "clarify" the definition, in order to mobilize, at a later stage, regulatory, scientific or market instruments. Yet it faces numerous difficulties. Characterization issues mean that definitions are crafted while the measurement instruments of the "nano properties" are not available. Hence definitions, while circulating in various arenas, can always be contested and re-opened. Nano products raise even more complicated issues than nano substances, since they imply that each separate component, and their size distribution should be considered.

This section describes a different process. It provides an example in which the construction of norms for nano products is less about drawing boundaries than exploring the ways of dealing with (ontological) uncertainty. This implies that nanotechnology's publics (and, specifically, consumers) are constructed in ways that do not solidify beforehand the identity of the social groups involved. By the same token, this section also illustrates the tight intertwining between the making of national science policy and that of positions to be advocated in international arenas.

Noticing that propositions for "nano-free" and "nano-inside" labels opposed each other, the French delegation at ISO TC229 envisioned, soon after the creation of the committee, an approach that would not differentiate "nano" from "non-nano". A member of the French nanotechnology commission at AFNOR thus explained, referring to a high-rank civil servant in charge of nanotechnology at the French ministry of economy ("Mrs. Roure"), who was an active participant in nanotechnology international arenas since the 2004 Alexandria meeting (cf. chapter 4):

Mrs. Roure holds an interesting position. We are stuck between the Asian "nano-inside" and the European "nano-free". She proposed that we develop a "safe and sustainable by design" label. In this case, we would answer consumers' requests. It would lead us to ask at an upstream stage about the precautions that have been taken.[1]

"Safe and sustainable by design" designates an inclusive approach for the integration of ethics and safety issues at the heart of the process of scientific research. It was…

… a way of including all the concerns in the very design of products, industrial processes, and the functioning of markets[2]

In her expectations, safety by design was not to be limited to the level of the laboratory, as American proponents of safety by design, which Roure had had contact with[3], proposed. The industrial landscape was to be transformed so that consumers and citizens would be able to identify benefits and uncertainties, voice concerns, and include them in the making of products and industrial processes. For her, standardization was to play a central role in order to produce a "safe by design" approach.

It is not surprising that the somewhat grandiloquent expectations of Roure came short of realization within ISO TC229[4]. "Safety by design" requires the introduction of property-based definitions of nano substances. Yet as seen in chapter 4, ISO TC229 could not stabilize any property-based practices of dealing with nano substances. It is through a project initiated in the fall of 2009 by the French nanotechnology commission at AFNOR, and, more specifically, by Arila P., member of the Direction Générale de la Santé (DGS) at the French ministry of Health, that the French refusal of the nano-inside / nano-free boundary was made explicit.

When she joined the ministry of Health in 2007 after having worked in a health public agency, Arila immediately became a member of the newly created nanotechnology inter-ministry group[5], which gathered a dozen people involved in nanotechnology-related activities in different ministries. She then focused on the exploration of new regulation for nanomaterials, became representative of France in the

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[1] Interview AFNOR, Saint-Denis, Octobre 2008.

[2] Interview, F. Roure, Paris, Octobre 2008.

[3] "Safety by Design" had been heralded by chemist Vicky Colvin as a way of integrating safety issues in the very making of nano objects (see (Kelty, 2009). This approach will be discussed at further length in chap.6. Having worked with Jean-Pierre Dupuy for the 2004 nanotechnology report released for the French administration, Roure knew about Vicky Colvin's safety by design, and considered it a way forward to deal with nanotechnology potential concerns.

[4] One could nonetheless argue that Roure's objectives were not foreign to projects aiming to define "good practices" for industries producing nanomaterials, as discussed within ISO, or put in place by company A*** (see chapter 4).

[5] In France, this group was a "*groupe interservice*". This means that it was an ad hoc formation with no long-term administrative existence.

REACH negotiations, one of the first members of the French nanotechnology commission and delegation to ISO and CEN meetings.

I talked to Arila in October 2009 in Brussels, as we were attending a meeting organized by the European Commission about the safety of nanomaterials. She explained to me that she wanted the AFNOR nanotechnology commission to develop a "nano-responsible standard" (*standard nano responsable*), which could provide "tools to manage uncertainty", while "proposing an approach open to all the concerned actors"[1]. Her discourse then echoed Roure's propositions by stressing that ISO's work on nanotechnology was "not enough to manage uncertainty". What she had in mind then was less to define the nano-ness of materials than to ensure that industrial actors, NGOs, and public bodies could take seriously the risk uncertainty of nano substances.

The project she initiated in the fall of 2009, with Benoît C., in charge of nanotechnology at AFNOR, and David Bertrand, the head of the French nanotechnology commission and a promoter of contained carbon nanotubes development (see chapter 4), aimed to help industries' decision-making in a context of uncertainty about the potential risks and benefits of nano substances and products. The initiative refused to define the discussions as an issue of nano/non-nano boundary in order not to solidify too quickly the definition of nano products, while also better informing the consumer. Defining the nano-ness of products too strictly was seen as a threat to all nanotechnology-based products:

It is essential that we avoid the pitfall of labels such as "with nanomaterials" or "without nanomaterials", with no other explanations about potential hazards. This would expose the French market to a rejection of nanotechnology similar to the one we saw for GMOs. *The risk is that the consumer might associate nanomaterials with hazard and exclude all products using nanomaterials (particularly in cosmetics and food)*[2].

At the initial stage of the project, little more was stabilized than the need to avoid both "nano-inside" and "non-nano" labels, and the overall importance of risk/benefit evaluation. In addition, the process of crafting the standard was meant to be inclusive. On the Brussels-Paris trip during which she began to tell me about the project she had in mind, Arila told me that it "was to be something that will include as many actors as possible". She went on: "I want Josée C. to be there", referring to a representative of *France Nature Environnement*, an NGO that had been active in the nanotechnology discussions in France, and mentioned trade unions and consumer associations, which she also wished to be involved in. Then during the subsequent meetings, the need to "include as many participants as possible" was repeatedly heard. "As many as possible", including myself as a researcher. I was invited by

[1] Unless otherwise specified, quotes in this section are excerpts from the notes I took in my interactions with the members of the nano-responsible standard project.
[2] Quote from a preparatory document.

Arila to participate in one of the early exploratory meetings, during which Benoît, David and herself discussed the project. It would start by a formal meeting, where the members of the French nanotechnology standardization commission and other people involved in the development of nanotechnology in France would be invited.

As both a State engineer and a sociologist, my participation was supposed to be of interest for them. Accordingly, I was involved in the steering committee of the project, and participated in the project throughout its development. This means that the empirical material used in the following pages is more ethnographic than that of the previous sections of this chapter. This also means that some of the initiatives of the actors involved in this project paralleled those undertaken in this very dissertation. This particular position of course raises issues for the type of sociological analysis and description that is then possible. The second section of chapter 3 also offered an illustration of the involvement of the analyst in the construction of standards and guidelines. In this former case, my interventions were mostly conflicting ones, pretty much similar to breaching experiments, through which I could make the internal constraints visible, and identify the permanent work needed to maintain boundaries that could make the international organization function. The mistakes I made while working at OECD WPN were opportunities to render visible principles of work that I had not identified beforehand. The situation of the nano-responsible standard is of a different kind. For once, there was a clear continuity in my participation in the project and my research: I made it clear from the start that I was interested in how it was possible to manage uncertainties about the existence of nano substances and products, which helped solidify this very phrase within the written and oral presentations of the project. I worked together with members of the team to describe existing normative tools (see below), participated in plenary meetings, and in the meetings of the leading group (*comité restreint*). I commented on the various versions of the document on which the approach was based. Yet once the main objectives of the project and the general process it proposed were defined, I seldom intervened and adopted a more external position.

Managing uncertainty

The initial meetings focused on nano substances and products, and their management in industrial processes and consumer uses were chosen as the entry point of the reflection. As one of the participants said during the first meeting:

That's the very objective of the project: we need to identify the ways in which companies can manage uncertainty, and, doing so, how they can take expectations of all their partners into account. I mean, partners: their customers, suppliers… and consumers' and environments' groups.

The situation of uncertainty indeed holds a practical meaning for industries, concerning both the relationships with suppliers and customers (What should I do if my suppliers sell a "nano product"? What are the expectations of consumers?), and internal strategy (How to decide to develop this product using a nano substance, which is not characterized and might have adverse effects?). Therefore, the standard was to be primarily a tool for industries involved in the production of nano substances and nano products, while at the same time a tool for concerned groups to gain information about industrial processes and consumer goods.

The first formal meeting of the project gathered representatives of industrial professional organizations and NGOs, civil servants, and external experts like myself. It was devoted to the exploration of the potential uncertainties that industrial actors faced when working with nano substances. In a presentation, I discussed the uncertainties about the existence of products and publics, and the political imagination that was needed in order to find ways in which the construction of publics and substances could be collectively undertaken[1]. At the end of the formal meeting, decisions were made to work on examples of nano substances used in consumer products. Carbon nanotubes and silver nanoparticles were selected, the first because David Bertrand was a member of the steering committee, the second because of their extended presence in consumer goods[2]. The two cases were supposed to provide examples: by following these nano substances as they travel from conception to mass production, are included in various matrixes, then are part of consumer goods, and eventually disposed of, the objective was to identify the questions that could arise, the problems that might emerge, the potential instruments of control, and the information to be provided suppliers and sellers.

Numerous meetings then followed. Arila was in charge of the project, and Benoît was responsible of the secretariat. The French ministry of Health funded the project through dedicated public money, and part of Arila's working time. The steering committee extended: two civil servants involved in nanotechnology regulation from the ministries of labor, and industry joined. A scholar paid by a consumer association to participate in ISO's meetings as a member of the French delegation was invited, and representatives of a federation of industries in paints and coatings and a manager in a French

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[1] A point I had made in (Laurent, 2010f). I do not want to overemphasize my role in this process, and, as it will appear in the following of the description, I was certainly a minor voice among the actors involved, especially the representatives of industrialists, who, as the project was growing, became more involved and more numerous. Yet I did help formalize the initial concerns of the project, which revolved around the notion of uncertainty, the need to experiment, and the importance of allowing new actors and issues to emerge.

[2] Silver nanoparticles had been discussed beforehand in a dialogue process named "Nanoforum", in which many of the same participants – including myself – had been involved (cf. chapter 7).

distribution company joined. The meetings of the leading group were meant to craft documents that were subsequently discussed in plenary meetings. The nano-responsible standard was thus an instrument expected to involve both public and private actors. It originated from a concern voiced in the public administration, but was to be developed by an association of private companies and to represent both the interests of consumers and those of industries[1]. Eventually, as it will appear in the following descriptions, it was to be a device from which the national position of France in international arenas could be crafted.

The specificity of nanotechnology

The initial works of the group consisted in reading and commenting on existing normative instruments, and reflecting on their potential applications to nano substances. In so doing, what the involved actors did and what I am presently relating conflate: all these actions relate to the clarification of the type of nano products and the type of consumer the project constructed.

When the nano-responsible project started, other instruments had been aimed to "deal with uncertainty". Practical-oriented risk management tools, such as the recent ISO 31000 standards on risk management, were discussed during the meetings of the nano-responsible standard project. ISO 31000 is based on the well-known dichotomy that separates the evaluation of hazards from the evaluation of exposure. Consider for instance the case of silver nanoparticles, which can flow around, to which the evaluation of hazards and exposure is intimately connected (see chapter 4). One should add the pervasive uncertainty about "which parameter is the relevant one" in the evaluation of risks – an intrinsic difficulty since the processes of innovation in the development of nano substances are precisely about constructing materials with emerging properties, new characteristics, and new functionalities. Consequently, the participants concluded that the separations on which ISO 31000 was built made this standard not usable in the case of nano substances[2]. Participants considered that the existing normative or regulatory tools forced them to "wait till the definitions (we)re there", that "they (we)re based on existing substances, on well-defined objects", whereas the nano-responsible project aimed to focus on "all the uncertainties about nanotechnology, including the definitions of nanomaterials". Thus, the

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[1] In undertaking its non-profit activities, AFNOR claims to "constantly gauge the interests of any and all socioeconomic stakeholders concerned that business activity is conducted in adherence to law" (http://www.afnor.org/en/group/about-afnor/about-us, accessed April 11, 2011).

[2] See (Jasanoff, 1987). The addition of the "communication and dialogue" requirement raised other issues. It had been specifically proposed in the case of nanotechnology by a well-known scholar specialized in risk perception studies, and Roco himself, who developed an approach for "nanotechnology risk governance" (Renn and Roco, 2006b). This idea was to add, at every stage of a process that strongly resembled the ISO 31000 process, communication and evaluation of concerns of civil society. See (Laurent, 2010a: 84-89) for a discussion of these devices, and the separations on which they are based.

ontological uncertainty of nano products was conceived less as a problem to be overcome by stabilizing criteria of definition than as a situation to work with. It forced participants to consider that the connection between the treatment of potential risks, the assessment of potential uses, and the consequences for the industrial and consumer practices all along the trajectory of substances required a specific instrument.

Commenting on "safety data sheets" (the vehicle through which companies had to provide information within the REACH regulation), some participants stated that they:

do not consider specific applications. They don't say a word on the fact that nano silver can be used in toothpaste, in cosmetics, in textiles... And of course the types of use modify the uncertainties. One can decide to accept some uses and refuse others. That's why the tool will be useful if it is circulated along the production and distribution chain.

This quote is interesting, since it makes it clear that the nano-responsible project was attempting to extend the category of the "users" of the norm. "Users" could be producers buying nano substances from a supplier, which would later be incorporated within a product, distribution companies buying products to sell, or "final consumers" purchasing consumer goods. Thus, the future standard was expected to make producers provide information according to the expectations of users, while also helping the former make decisions about the development of nano substances. Hence the interest of members of the distribution sector for the future nano-responsible norm. For instance, the senior manager of a major French distribution company explained during one of the project meetings:

I am very interested in this tool. I need it for my customers. I need to know what I am buying from suppliers, what the decisions that had been taken upstream are. It is extremely important for us. And if there is an issue for a product, I also want to be able to take it away from the shelves.

Throughout the exploration of the existing tools, the project was targeted toward the crafting of a device for internal decision-making, as companies needed to decide what to produce, what to distribute, what to sell, and how to control it, and an instrument through which sellers and buyers could gain information throughout the value chain about the "nano" characteristics of the substances and products. Therefore, the construction of a "nano" supply and a "nano" demand was an objective of the project, which could participate in the organization of a market for nano products in a way that was more complex than the construction of a nano/non-nano boundary.

Crafting a normative document

After the initial meetings, the project took the form of a writing exercise, during which concerned producers and users explained how their substances were produced or used, and participants, describing the circulations of the substances, attempted to list the questions to ask in order to describe potential risks, expected benefits, and ways of dealing with uncertainty. The case of A***, and its containment choice, was considered in the case of carbon nanotube. Participants talked about other cases, in which producers could experiment with various types of solid matrix in which nanotubes could be dispersed, and which would be altered under specific conditions of use. As expected (see chapter 4, section 1), the case of nanosilver was much more difficult. It was studied as part of the experience of various participants in the project, for instance representatives of professional organizations in paint and coatings. In this case, the trajectories of the nano substances were much more diverse, as the very type of substances varies, their integration of products could take various forms, and the type of use covered a wide range of applications.

The project members used these examples to construct tables in which the circulation of nano substances was detailed (from "design" to "waste"). The format of the nano-responsible standard was eventually that of a list of questions related to each of a product life cycle (design, production, transformation, use, waste). Quantified risk/benefit evaluation was thus eliminated. The value of the document was eventually not in a transferable tool that could be unproblematically applied to all situations. Instead, it was interesting in so far as it would be able to circulate along the value chain, while being at the same time an instrument through which companies could make their industrial choices explicit. A user of the document would then interrogate each step of the production process he/she uses, and his/her methods of coping with potential risks (e.g. containment, customers' information, substitution in favor of a better-known substance). He/she would be incited to "circulate information about her practices", "explain the reasons why he/she develops his/her products and under what conditions", and "possibly choose a substitute rather than the nano form of a materials".

From the two examples considered in detail, participants constructed a list of questions related to the characterization, use, and re-treatment of substances, such as the following:

- *What are the main physical and chemical characteristics of the substance? Is there available information about its size? About size distribution? Shape? Specific surface area?*
- *Is the release of nanoparticles in the atmosphere possible during the production process? What are the concerned materials? Are there available risk studies?*
- *In what ways are release, dissemination and exposition to nanoparticles possible during the product lifecycle?*

Other questions would then suggest other initiatives for the user of the document to undertake. For instance, the document comprised questions related to the type of matrix the nano substances were supposed to be included in. At the distribution stage, questions were asked about the type of transportation, and storage. For each stage, the document suggested techniques to be introduced in the industrial practice (e.g. containment, labeling of information related to a particular use). In this process, the existence of nano substances and products remained entirely flexible. The problem of existence could be avoided in some cases (as when containment was possible). It was to be dealt with by considering particular situations of use, and the parameters that were known or suspected to have effects on final properties. It could also be managed by referring to existing cases.

Initially meant to ensure risk/benefit evaluations[1], the device eventually provided guidance for the description of "problematic situations"[2], where uncertainties were managed and the interests of a wide range of actors made explicit all along the trajectory of substances and products. The problem was not to define the existence of nano products in a way that would have drawn a boundary between "nano" and "non-nano", but to consider a variety of methods for the characterization of substances, and to manage a situation in which the potential uncertainties of nano substances and products were multiple, while expectations not easily identifiable. The nano-responsible project considered multiple potential trajectories, and, consequently, multiple ontologies – potentially as many as there are trajectories of nano substances and products from design to production, distribution and use. There is at this point a parallel between the tool considered as a description device intervening with the actors of nanotechnology, and the objectives of this very dissertation. This alignment is not fortuitous: it was an outcome of my participation in the process as much as it was a condition for my active involvement in it. It is not enough, however, to account for the problematization of nanotechnology that the nano-responsible standard proposed. Indeed, the tool was not considered solely as a description/intervention device, but was also a vehicle that enacted the French national position on nanotechnology policy – an objective in which I had no part. I will get to this later point after having discussed an important component of the project, namely its objective to integrate the future externalities of nano products production processes.

[1] I had voiced my concerns about this form of analysis, and made the point that the project needed to explore in what ways "risks" and "benefits" could be evaluated rather than stick to this as an already made tool.

[2] The reference to Dewey's expression is not unintended. I will get back to the pragmatist interpretation of this tool in chapter 7.

A "living document": integrating future externalities

The document was not a rigid instrument, with questions and propositions stabilized once and for all. As one of the participants put it:

talking about this means extending the list of questions, doing quite a lot of work in exploring the possibilities of interrogations from a company. Then the thing is that the list has no reasons to be stable… it would have to be a living document, something we are able to extend as we know more about nanomaterials.

At the time of writing, how to operationalize the "living document" remains to be seen. At any case, it was meant to include as much the evolution in production processes as that of the "interested parties", namely those who want to participate in the process, who have issues with production processes, or who need tools to use supplies they buy from producers of nano substances. Consider the following statements, voiced by participants in the project:

"if problems suddenly appear, I want to be able to withdraw the concerned products from my shelves. Hence, I need to know what type of nano substances have been included in the products I am buying." (distributor)

"I want to control what my customers do with the nanotubes I produce. If they are proven safe, then I can change that later. But for the moment, I don't want my nanotubes to be included in airborne devices, I don't want them to flow freely around." (industrial company)

"We want to be able to monitor what is going on within industries (…), what the producers know and what they don't know…" (NGO)

"You can't deny the fact that there will be other actors at some points. There are local groups who might be interested, who might want to be involved. So the document has to be made open enough so that at some point, these people could see what's happening in the production plant in their town" (NGO)

Thus, the participants in the project considered that the future standard should make it possible to accommodate the evolving nature of its "publics", be they consumers, stakeholders, producers, distributors. At this point, one can clearly identify the joint dynamics of techno-economic development and the production of social groups. As Michel Callon described, when markets extend, they produce overflowing, and thus concerned groups – either because of their exclusion (e.g. rare disease) or because they are affected by the implications of technological development (e.g. they live in the vicinity of a polluting plant)[1]. The dynamics of innovation in nanotechnology development is precisely about

[1] Callon, 2007b.

constructing new substances, developing new uses, and, consequently, making the social "proliferate"[1]. Accordingly, the type of framing (and the subsequent overflowing) that the nano-responsible project proposed is quite specific. It is supposed to be able to include potential concerned groups as they emerge, and potential new technical characteristics as they are identified. While the CEN labeling project eventually solidified into a labeling device for an individual consumer to be informed about "scientific data", the nano-responsible initiative was targeted at a multiplicity of publics, who were supposed to evolve as substances were circulating. Consequently, the construction of the nano market is also, in this example, that of substances and products (supply), industrial processes, of social groups (whether customers – demands- or concerned groups). In this case, the standard is not just the passive terrain of negotiations among parties with identifiable stakes. It is also a process through which a whole market is shaped, which has no reason to stop once the standard is written and the instrument solidified, since its very circulation with nano substances and products should make room for technical and social evolutions.

A component of the French national position

The nano-responsible standard had to be transferable in order to be useable. The first way of doing that was to craft a list of questions general enough to be relevant for most users, yet with sufficient examples and details to be useful and provide elements related to a wide range of industrial situations. It implied particular writing strategies (e.g. using annexes as places to provide a complement of information). The second was to propose international standardization bodies to work on this proposition, and make the French proposition an international standard, more widely recognized than just an AFNOR document. In this process, the initiative was constructed as a part of a national strategy. That the national approach was conceived as a need for French actors to manage uncertainties was as much about the importance of public involvement and the precautionary principle as about ensuring the continuous growth of nanotechnology development. But the two were not contradictory for the participants. On the contrary, they were the two sides of the same coin: that of the French "responsible" development of nanotechnology, which was to be presented and pushed forward within international arenas.

The participants in the nano-responsible project were also closely involved in international discussions about nanotechnology. As a representative of France for the REACH negotiations, Arila P. had constantly pushed for the circulation of information, and the extension of existing regulatory tools.

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[1] See (Strathern, 1999) on the "proliferation of the social" through the mediation of non-humans.

For instance, she had argued for the extension of the use of Safety Data Sheets (SDS) to information about products for various "publics", including corporate users and regulatory agencies:

We insisted on (…) the identification of nanomaterials, with their characteristics, in the SDS that is provided to the downstream user. Now it is only mandatory for substances that are proven to be hazardous. We argue for the extension of SDS to substances for which there is uncertainty. (…) Then there is awareness of the specific properties of nanomaterials, and companies will think about the matrix in which they will incorporate it.[1]

For Arila and the French delegation to the ISO committee, the criterion of health, safety and environment was to be the basis of any standardization activity in nanotechnology. This concern for the toxicological aspects of nano substances and products led the members of the French delegation to push for more complex definitions than the sole size criterion. As seen in chapter 4, it led the control-banding project at ISO TC229. At OECD, the French participants regularly tried to overcome the boundaries that the international organization was painfully trying to solidify. Recall that those who tried to question the separations between WPMN and WPN during the WPMN plenary meeting described in chapter 2 were the members of the French delegation[2]. The French position regarding the regulation of nanotechnology contended that risks were to be taken into account, and innovative devices were to be experimented with.

The national dimension of the nano-responsible project appeared even more evident during a meeting at AFNOR in November 2010, when the French nanotechnology standardization committee discussed the future of the French involvement within the Comité Européen de Normalisation (CEN, cf. section 2). In the fall of 2010, the British Standardization Institute (BSI) announced that it relinquished the secretariat of TC352. Consequently, national delegations were invited to apply for the secretariat and presidency of TC352. Benoît C. pushed for the application of France, through AFNOR, which was eventually agreed upon by the participants in the French delegation. France was not the only one: Germany and the Netherlands applied, while the Czech Republic joined the French application. The French application, the "rationale behind it" (*la logique qu'il y a derrière*), and the differences with other countries (particularly Germany), were discussed during the November meeting. For the members of the French delegation, CEN was an important arena to position the country, since it was considered

[1] Interview Arila, Paris, November 2008.

[2] Consider, for another instance, the following excerpt of my fieldwork notebook, as I was returning in June 2009 from an OECD WPN workshop in Portugal with Françoise Roure, the head of the French delegation:
"F Roure is annoyed by the meeting on "international cooperation". Presentations and discussions focused on consensual themes: "we need to collaborate", "we manage to set up a network of labs"… (…) Françoise insisted many times on collaboration being also about risk management and, as she says, "global evaluation of benefits". Each time, Jacqueline (from the OECD WNP secretariat) told her that "the WPMN is here for that", and R*** (the American delegate) immediately "got back on the topic". She only managed to include "the importance of international cooperation for risk management" in the final report."

to offer more opportunities than ISO for the nano-responsible project to be received. As a member of the French delegation said during the meeting:

The project will fit better within CEN. Just look at the principles we're putting forward: precaution and transparency. It clearly falls within the mandate of CEN[1].

But the proximity with CEN was not limited to the level of moral principles. It was also a matter of how expectations were crafted, institutional structures constructed, and technical instruments mobilized. During the November meeting, participants discussed the two mandates, that of CEN TC352 and ISO TC229. One of them contrasted CEN and ISO in these terms:

The CEN mandate is directed toward upstream toxicology and ecotoxicology. The characterization of nanomaterials is expected to be done according to their potential risks. At ISO, the process is that of an analytical characterization. As for toxicology, they are slowly moving forward, with the exception of control-banding.

This is precisely what chapter 4 described at length: the "analytical characterization" done at ISO refers to the "science-based process" through which international consensus can be reached. By contrast, CEN, where the European principles of "precaution" and "traceability" were heralded, could appear as a more favorable place to propose approaches that were meant to define nanomaterials according to their toxicological properties[2].

CEN could appear as a site where alternatives approaches could be proposed, and national strategies could be made visible. As for the French committee, it applied for the secretariat of CEN TC352 with in mind the desire to push for the nano-responsible project. In this process, the German delegation (through the *Deutsches Institut für Normung*, DNI) was seen as the adversary. "Germans want to take over CEN" was a sentence that I repeatedly heard throughout the project meetings. The German position was described in previous examples (see chapter 4). As much as the French one, the German delegation defined its position within international arenas in conjunction with their national science policy. For members of the AFNOR nanotechnology commission, "Germany (had) definite ideas". Thus, David Bertrand explained that

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[1] Notes, AFNOR meeting Nov. 2, 2010. Quotes in this paragraph are excerpts from notes I took during this meeting.

[2] This was all the more visible as the second mandate of CEN insisted on the European specificity, and the need to harness CEN in order to produce ways for Europe to deal with the "expectations and concerns" of consumers, and complement ISO's work on nanotechnology. The previous section described negotiations around the European specificity.

The Germans want to control decisions and funding. They are well-positioned at the DG Research and DG Entreprises. They control CEFIC (the European Chemical Industry Council). *They have a clear strategy. They develop nano for business.*

Whether the Germans had indeed “definite ideas” or not, CEN was a scene where national pride was to be defended, where the national nanotechnology policy was presented, and which contributed to its solidification. This is what Bertrand explained:

At this time, the French strategy does not exist. (…) We need all the actors to be involved, we need a consistent strategy. And I think getting the CEN presidency should be part of this strategy.

As described by David Bertrand, the German position within CEN was constructed around industry and research. As he reminded everyone during the November meeting, “the head of the German delegation is a researcher, the deputy is an industrialist, and they have all the professional organizations behind”. Whether or not the German delegation wanted to develop “nano for business”, the fact that it was seen as an adversary is telling: CEN was a place to construct national positions, where the (supposed or real) German industry-research complex united for the sake of industrial development would confront a French position crafted according to a “responsible” construction of substances and publics that would ensure that “HSE impacts” are examined and “questions of usefulness” were raised.

Stabilizing the French position

While I insist on the links between the making of the nano-responsible standard and the construction of the French position in international arenas, I also do not want to imply that the French position was uniform and stable[1]. On the contrary, the nano-responsible project, and, later, the French application to CEN, caused tensions and ambiguities.

Administration and industries

The support for the nano-responsible project took various forms within the French administration. The ministry of health was actively (and financially) supporting the project: meetings

[1] Symmetrically, I did not attempt to describe in more details the German positions. Although all the French actors I talked too insisted on the “consistency” and the “strength” of the German strategy, an exploration of the dynamics within the German delegation would probably show ambivalence and uncertainty.

were held at the General Direction of Health (DGS), and the leader of the project was a civil servant from DGS. Other ministries could be more or less involved in the project, but overall agreed to make uncertainty the focus of the project[1]. Yet the construction of the instrument as both a decision-making tool for companies and a device through which a market for nano products could be produced was not easily accepted. Some industrial sectors, such as the food industry, were never represented in the working group. But even for those who were, the support was ambivalent. As the project grew bigger, it became more and more evident that it would come to fruition, and more and more industrial partners joined. It was clear that they had interest in participating in it in order to be able to voice their expectations. The ambivalence of their support was visible during meetings, as some participants from the industry repeatedly voiced a concern about the need to limit the scope to internal decision-making within companies – something other actors, most notably distributors, constantly opposed. The strong links of the project with the administration were another topic of concern[2]. For some members of the project committee, this involvement threatened to pave the way for future (constraining) regulation, and, as such, was hardly acceptable. Thus, David Bertrand told me about a representative from a professional organization:

She often phones to tell me that this project is not acceptable, that we need to stop it (...) She said this working group was a scandal (...) What she considers as scandalous is that it is an initiative of the public administration... She is afraid of not being able to control the process, and to see it imposing more and more constraints on industries. Well, we do change industrial practices with this project.[3]

Oppositions were visible each time the process tried to formalize and solidified a frame that would draw boundaries, not necessarily between nano and non nano, but within those who would comply with the standard and those who would not. This is precisely the role of certification, a process through which companies can make their compliance to a standard visible, and which, in this case, would have allowed customers to differentiate between "responsible" and "non-responsible" nano products. The question of certification was sensitive, and elicited many discussions, including at very early stages of the project, where no version of the document actually existed. Hence, some participants explained that "the whole interest (was) to introduce certificates with the standard. Otherwise there is no way for the consumer and the regulator to know who the virtuous companies are". Others were

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[1] Actors from DGS recall in interviews that they had to "to convince the ministry of industry" of the need to manage the uncertainty of nano substances and products. They also considered that they failed to involve the ministry of agriculture and the food industry.

[2] The implication of public bodies in the construction of norms is not uncommon (cf. for instance water management). Their involvement in a large technological domain still to be defined, however, was considered an innovation by the participants.

[3] Interview with David Bertrand, Paris, May 2010.

clearly skeptical about the interest of certification and threatened to leave the group if it was enforced. This discussion is important. It is a sign that the solidification of a tool meant to absorb externalities is not an easy task, since when accomplished (through, for instance, certification), it is bound to isolate a "responsible nano market" from other markets (with other characteristics, less safe products, less informed consumers, etc.), and create nano products, consumers and regulations. Industrialists were then ambivalent about their potential strategic choices, as they navigated between an objective of developing "responsible" nano products integrating externalities, and attempts to benefit from a situation of regulatory fuzziness.

The industrial participants in the project were indeed reluctant to accept constraining initiatives. Thus, the French government proposed in 2010 to introduce a mandatory declaration for producers of "substances in nanoparticulate state" (*substances à l'état nanoparticulaire*)[1], defined as:

Engineered substances characterized by one or more external dimension, or internal structure, in the 1-100nm size range, including under aggregates or agglomerate forms potentially bigger than 100nm but conserving properties typical of the nanoscale.

The draft decree asked for the declaration of substances in nanoparticulate state, and of materials that used mixtures in which "substances at the nanoparticulate state were included but not linked" (that is, "potentially extracted or rejected in normal conditions of use"). At the time of writing, this proposition is still being discussed. It has attracted many criticisms, especially from the industrialists, who contended that operationalizing the definition was not technically feasible, because of the lack of standardized measurement instruments. They also criticized the proposed threshold for the declaration[2], which would include, for them, far too many objects in the scope of nano products. Solidifying boundaries to define nano substances and products in too strict a manner was far less acceptable than an instrument such as the nano-responsible standard that was targeted toward the actual making of nano products.

Civil society organizations

Albeit far less numerous than industry representatives, consumer groups and civil society organizations were present in the process – as Arila had wished from the start. A member of France Nature Environment, two people from a major national consumer association in France, and

[1] This followed a proposition originated from the "Grenelle de l'Environnement", a national consultation process about environmental regulation, launched by Nicolas Sarkozy after his election in 2007.
[2] In the draft decree: "500g for declarations before May 1st, 2013", "100g before May 1st 2014", "10g for later declarations".

representatives of Vivagora[1] (a civil society organization advocating the democratization of technical choices) participated in the work of the commission, and considered it an important site for them to defend their position about the regulation of nano substances and products. Whereas some participants from the industries were trying to limit the scope of the standard to that of internal decision-making, other participants from NGOs and civil society groups tried to extend it. They repeatedly voiced concern about the need to propose an encompassing tool, which would be addressed to consumers rather than just companies. Consider the following quotes, excerpts from notes I took during meetings or conversations with actors considering themselves as representatives of "civil society":

"It should not just be a tool for industries. It should also provide information for consumers, and for those who would want to question industrial processes" (representative of a consumer group)

"For applications that really do not add much for society, industries should abstain. I am still wondering whether we will be able to ensure that." (phone conversation with a member of Vivagora)

"It is important to ensure the opening of discussions to civil society, to make it visible outside the industrial production, considering that industrial production is a social affair. (representative of France Nature Environnement)

As following the approach that developed the nano-responsible standard implied not sticking to ready-made demands (e.g. a label for silver nano products), but exploring the ways in which information should be conveyed, the way the project evolved caused the involved civil society organizations to question their positions. The process thus implied forms of social mobilization that were not linked to a solidified stake (e.g. the existence of nano silver) but which needed to evolve with problems that were constructed during the course of the construction of the norm, and, later, when the standard would be used[2]. It was indeed "safety by design" – "design" of the whole industrial chain, from conception in laboratories and R&D units to industrial processes, distribution and consumer uses. The project aimed to produce consumers and products, supply and demand, participating NGOs and responsible industrialists.

That such involvement was performed for the sole benefits of industrialists, who could then develop products targeted to better-known markets in more efficient conditions of circulation, was a concern for some participants from civil society organizations. The NGO participants were wary about the possibility for the tool to ensure that products were *not* developed. This explains why many of them pushed for the risk/benefit analysis: this was conceived as a way to introduce limitations and decisions

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[1] We encountered Vivagora in chapter 3. I will get back to the case of this organization in chapter 7.

[2] An example of social mobilization consistent with such an approach will be described in chapter 7. One can see the differences with the "scientific understanding of the public" described in chapter 2.

not to develop products for which the expected risks outnumbered the potential benefits. Accordingly, NGO participants in the nano-responsible standard project were concerned about the possibility of questioning the very basis of nanotechnology programs. Consider for instance the following quote, a transcription I wrote out of a conversation with a member of Vivagora, who was talking about the nano-responsible project:

> *All these questions about standardization and industrial practices... Why are we doing this? I know, this is important, we need to work on the definition of products, and examine what characteristics are important... But still, there is a fundamental question, which is the objective of the development of these products.*

The project was indeed not attempting to question the principles of the construction of national programs of support for nanotechnology. Truly enough, the nano-responsible project did not attempt to bear on the continuous growth of research funding. In addition, it could not hope to raise systemic issues, e.g. the problem of a general exposure of the population to nano substances due to their prevalence in industrial process. These were not the objectives of the nano-responsible project. For the NGOs involved, it meant that the participation in the project rendered necessary to multiply their forms of engagement and the sites where they could voice these concerns. This also incites the analyst to consider various empirical sites where the problematization of nanotechnology is undertaken, and various forms of distance to the actors he or she studies. This argument for the multiplication and variety of distances of intervention for the social scientist and the actors engaged in nanotechnology will be further explored in chapter 7.

Internalizing future externalities. Experimental constructions

The nano-responsible standard offers an example in which nano users and consumers, nano products, and responsible nano companies are constructed, within a process that aims to internalize potential overflowings, and, consequently, attempts not to define in too rigid a manner the existence of nano substances, products, and concerned groups. Thereby, this tool proposes to integrate within the functioning of markets the regulation of risks, the ontological flexibility of substances, the variable identities of concerned citizens, and ethical considerations (such as European principles of transparency and precaution). This example is perhaps the best illustration of the dissolution of the boundary between "nanotechnology" and exterior "contexts". The nano-responsible standard was conceived for its proponents as a tool through which industrial development could absorb externalities – including its critiques. This example illustrates the modalities of an inclusion of the potential risks and social concerns linked to technological innovation in the operations of profit-making.

One can see the difference between this example of "safety by design" at the level of industrial processes and the final result of the CEN labeling guidance, which attempted to solidify a size-based definition of nano products without accounting for social expectations and technical explorations. That the technology of democracy thereby produced is to be developed at the European level made it an interesting topic for future research: the way it will be transformed into a European device, potentially open to international expectations and critique, will offer other examples of trials for the attempts to problematize nanotechnology's products and consumers as flexible categories.

International, European and French nanomaterials. A geography of problematizations.

The public management of nano substances and products leads international and national actors to craft definitions of "nano-ness", and thereby define the problem of nano products. There are international, European and French nanomaterials, defined differently and problematizing nano substances and products in different ways. International ISO nanomaterials are defined with the 100nm size limit. The "science-based" process through which nano products can then be defined carefully separates the definition process from that of regulation-making. Consequently, the international nanomaterials cannot be related to properties potentially connected to toxicological effects. In Europe, the various definitions of nanomaterials that are explored are meant to be "policy-based", that is, operational for regulation-making. This consensual point does not mark the end of the discussions. For once it is accepted, oppositions occur among European institutions (European Parliament and European Commission), European expert bodies (SCENIHR and JRC), and, eventually, among stakeholders (industry, NGOs, member states) arguing over the future definition of nanomaterials introduced by the European Commission, and based on the 100nm size limit and a size distribution. The boundaries of the European zone are at stake in some places, particularly the *Comité Européen de Normalisation*, where standards are crafted for European and, in some cases, international use. The guidance labeling project for products containing nanomaterials, based on "European values" and supposed to be "of international relevance" provides a telling illustration of the investment needed to stabilize the (porous) European zone. Eventually, the nano-responsible standard developed as part of the French strategy for nanotechnology was crafted in such a way that it did not attempt to draw a boundary between "nano" and "non nano". It was meant to integrate future technical and social concerns in a device that could both create a market of nano products, and help industries in the production, use, and circulation of actual nano products. That it co-exists with other propositions that were more constraining (e.g. the substances in nanoparticulate state of the French government) is revealing of a situation that is still in an experimental state. Accordingly, the French actors are attempting to solidify a national position that can then be defended in international arenas.

Problematizing nano products implies that material existences are defined, processes of collective decisions about them are enacted, and identities of producers and consumers are performed, or, as in the French nano-responsible norm, left open for future constructions. The table below (table 2) is a synthesis of the ways of dealing with the ontological uncertainty of nano products. Each of these approaches relies on organizational, material and cognitive infrastructures through which roles are distributed among public and private actors, oppositions among them are organized, and the collective problem of nano products is defined. In short, they are technologies of democracy.

The CEN labeling guidance is not shown on this table. It would hold a particular position. It aimed to introduce flexible and open definitions of nano products in order to inform consumers about potential risks. It was supposed to respond to European concerns for policy-based definitions and for the protection of consumers in front of uncertain risks, but it also needed to make room for the expectations of international participants, who pushed for "science-based" criteria.

	ISO	Europe	France
Objectives of the definition work	International common language	Regulation-making	Managing uncertainty
How to define nano products	Defining "science-based" criteria	Defining "policy-based" criteria	Flexible and open definition
Forms of decision-making	International negotiation	Negotiation among stakeholders	Collective exploration
Users of the definition of nano products	Consumers and policy-makers to inform on sizes	Consumers to protect and inform	Involved companies, Interested consumers

Table 2. Three ways of dealing with the ontological uncertainty of nano products

In all these examples, the ontological work goes hand in hand with the making of democratic orders, economic markets, and geographic zones. Spatial boundaries are discussed; national positions are solidified as they need to be fought for on European or international scenes; they confront each other and can make their way more or less efficiently in international arenas. Therefore, geographic formations defined by common problematizations of nano products result from the process of standards writing. They are not rigid zones lying passively next to each other, but dynamic constructions on trials with nanotechnology. They are the outcomes of the stabilization processes we encountered throughout this chapter.

These processes imply that some propositions fail and alternatives are excluded. Property-based definitions of nano products were not accepted at ISO. SCENIHR's sophisticated relational definitions meant to include future nano products were not endorsed by the Commission. The flexible approach for the definition of nano products and consumers that the guidance labeling had proposed failed to be accepted by CEN and ISO. The stabilization of international, European and national democratic orders resulted in the elimination of many problematizations of nano products. The previous descriptions render more complex simple explanations that would resort to the rhetorical force of arguments, or the power of stakeholders' interests. The outcomes of the negotiation processes in international, European and French arenas are determined by a wide range of factors related to organizational and technical constraints. Throughout the examples developed in this chapter, the dynamics of influences and negotiations in national and international arenas does not appear as an abstract fight between ready-made national positions. Rather, it is in the very process of writing guidelines and standards that options are re-opened or closed down, reconfigurations of existing collective choices occur, or are eliminated. The very process of standard writing thus appears as a locus for democratic action, in the sense that it makes explicit the problematization of nanotechnology that the concerned device enacts, and renders visible the infrastructure needed to stabilize national and international industrial policies on nanotechnology.

An important distinction we encountered in the controversies about the definitions of nano products separates the description of existing nano products from the attempt to encompass the future developments of nanotechnology in the scope of nano products. This was a concern of SCENIHR, which argued for the integration of Mihail Roco's next generations of nanomaterials into the definition of nanomaterials. The French nano-responsible standard made the future developments of nanotechnology a central focus: the instrument was expected to participate in the responsible development of future nano products. These two examples directly connected the problem of nano products with that of the responsible future of nanotechnology. The next chapter pursues this question further, by interrogating the problematization of the "responsible futures" of nanotechnology.

CHAPITRE 6 : CONSTRUIRE DES FUTURS RESPONSABLES POUR LES NANOTECHNOLOGIES

La construction des objets des nanotechnologies n'est pas séparable de celle des programmes de développement du domaine. Le dernier exemple du chapitre précédent a montré comment la définition du caractère « nano » des objets peut intégrer des développements futurs. Ce chapitre analyse la définition de futurs « responsables » pour les nanotechnologies et les formes démocratiques qu'elle constitue. Il se penche ainsi sur la problématisation du « développement responsable » des nanotechnologies aux Etats-Unis et en Europe. Ceci amène à s'intéresser à diverses expertises techniques, notamment l'expertise en sciences sociales et en éthique. Il s'agit donc de mettre au jour des rôles attribués à l'éthique et les ordres démocratiques qui sont ainsi stabilisés.

La première section du chapitre se penche sur la problématisation des futurs des nanotechnologies en termes « d'implications ». Le terme est utilisé aux Etats-Unis par les concepteurs des programmes de développement des nanotechnologies eux-mêmes. Pour eux, il importe de mobiliser des compétences expertes capables de s'assurer que ces implications n'empêchent pas le développement des nanotechnologies. Mais les expertises connues, et en particulier celle de la bioéthique, se heurtent à des difficultés : les versions libérales comme conservatrices de la bioéthique sont fondées sur l'examen des « faits scientifiques » grâce à la mobilisation d'un système de valeurs connues par l'éthicien. Ce pré requis empêche la bioéthique d'intervenir dans le développement des nanotechnologies, et ne peut proposer qu'une paraphrase de l'impératif de responsabilité. En réaction, des chercheurs insistent sur la nécessaire imbrication de la pratique scientifique et des instruments de la responsabilité, dans une situation où les objets, les programmes, les enjeux et les publics restent à définir. Une traduction possible de cette approche prend la forme de l'expérimentation de sciences sociales, qui doit démontrer à petite échelle la possibilité de renouveler l'évaluation des nanotechnologies grâce à la remise en cause de la dichotomie entre faits et valeurs.

L'accent mis aux Etats-Unis sur le développement responsable des futurs des nanotechnologies trouve un écho au sein des institutions européennes, où la définition des programmes de développement des nanotechnologies est simultanément une réflexion sur l'identité européenne et ses valeurs. La construction de la politique scientifique européenne sur les nanotechnologies apparaît ainsi comme une entreprise morale, se fixant des objectifs compatibles avec une stratégie définissant l'identité européenne (et fondée sur l'innovation, le développement durable ou la solidarité) et opérationnalisée par des instruments censé faire exister en pratique les principes moraux à la base de la construction européenne. La seconde section du chapitre examine ainsi la fabrication d'une série de dispositif (avis éthique, code de conduite, revue éthique des projets européens, projets de recherche en sciences sociales) dont l'objectif est d'assurer la « responsabilité » du développement des nanotechnologies. Définir et faire jouer les principes européens ne sont jamais des actions acquises à l'avance, mais sont rediscutées alors qu'experts, industriels, associations et états membres s'interrogent sur la possibilité de contraindre le développement des nanomatériaux ou d'interdire certains domaines d'application (comme l'amélioration des performances humaines). La différence très nette de positionnement entre la Commission Européenne et le Parlement Européen met en évidence l'instabilité de la définition et de l'usage des principes.

Chapter 6. Making responsible futures for nanotechnology

Responsible nanotechnology futures

Nanotechnology programs were defined as plans for the future from their inceptions. The American nanotechnology policy reports, particularly those concerned with the "convergence" of nanotechnology with biotechnology and information science, made great use of a deterministic language. One of them opened with the affirmation that

We stand at the threshold of a new renaissance in science and technology, based on a comprehensive understanding of the structure and behavior of matter from the nanoscale up the most complex system yet discovered, the human brain.[1]

Promised was a world where "people may possess entirely new capabilities for relations with each other, with machines, and with the institutions of civilization"[2]. Announcing a "new renaissance" questions the functioning of democracy: what roles are citizens expected to play in the making of this bright future? How determinist is the vision of the future presented? What are the possibilities for public action to shape the future of nanotechnology? These questions received an answer in the American nanotechnology programs through the notion of "responsible development", which was heralded as a central principle for innovation in nanotechnology. As defined by the director of the National Nanotechnology Initiative, responsible development refers to all the operations undertaken to mitigate the potential risks of nanotechnology and maximize their benefits, while informing the public about both risks and benefits[3].

But the analysis cannot stop with the acknowledgment that the construction of futures is supposed to be responsible. The "responsible development" of nanotechnology forces us to question the production of "responsibility", both at an individual and collective level. How to make sure that scientists, policy-makers, industrialists, activists and citizens act responsibly? These questions are asked by the proponents of nanotechnology themselves. This chapter considers empirical sites where the production of "responsible futures" of nanotechnology is discussed, and more or less formally

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[1] Roco and Bainbridge, 2003: 1

[2] Roco and Bainbridge, 2003: 22

[3] See (Roco, 2004) for a presentation of the "National Nanotechnology Initiative after three years". Responsible development refers to the activities undertaken in order to "provide R&D support for knowledge development, identify possible risks for health, environment, and human dignity, and inform the public with a balanced approach about the benefits and potential unexpected consequences." (Roco, 2004: 8). This definition of responsibility can be contradictory with others, which will be described in this chapter. See also (Roco, 2005).

operationalized in science policy instruments. It analyzes the devices that define responsible futures for nanotechnology, and pose them as problems for the democratic organization.

We already encountered the theme of "responsible innovation" in the previous chapters, as companies want to develop carbon nanotubes while containing their risks, definitions of nano substances and products are expected to deal with potential risks, and industrial norms are crafted in order to develop products in a responsible manner. I pursue these explorations in this chapter, by looking at empirical sites where the future of nanotechnology is discussed, in order to be operationalized in a responsible way in science policy programs. Thereby, I describe technologies of democracy meant to define the collective organization through which "responsible" nanotechnology can be constructed.

Producing responsible futures of nanotechnology requires the mobilization of various forms of thinking and expertise. It can be framed as a question of ethics, that is, a question about "what should be done" about nanotechnology, at the individual level of the scientist or the collective level of public choices. Problematizing the futures of nanotechnology as a question of ethics was done at first by the advocates of "transhumanism", who contend that humans need to use technological progress to "enhance" themselves. Thinkers inspired by transhumanism have had strong interest in nanotechnology, and have inspired the American "Converging Technologies for Improving Human Performances" report[1]. The Pennsylvania-based *Institute for Ethics and Emerging Technologies* is one of the leading sites of transhumanist thinking, where the ways in which humanity could benefit from nanotechnology to "improve itself" are explored. Some of the transhumanist thinkers are concerned about the need for "appropriate information" in order for each individual to decide whether or not he or she would want to be "enhanced"[2]. Others argue for a "democratic transhumanism", which would ensure that every type of being, be they enhanced or disabled, straight or cross-gendered, human or animal, could live according to his or her personal choices[3].

Transhumanist thinkers are not the only ones reflecting on the ethics of nanotechnology and the ways in which the "responsible development" of the field could be conducted. As nanotechnology programs called for research in the "societal implications of nanotechnology" (in the U.S.) and in "nanotechnology Ethical Legal and Societal Aspects (ELSA)" (in Europe), philosophers and social scientists participate in projects reflecting on the construction of the future of nanotechnology in responsible and ethical ways. They are often critical of the transhumanist perspective. Alfred Nordmann, one of the members of the first research project in nanotechnology in the U.S., and later coordinator of a report commissioned by the European Commission on the future of converging

[1] William Bainbridge, co-instigator of the NNI, is a fellow of the Institute. See (Schummer, 2007) for a description of the links between transhumanism and nanotechnology programs in nanotechnology programs.
[2] Bostrom, 2003
[3] Hughes, 2004

technologies in Europe[1] thus recalled during an interview that he was extremely dissatisfied with finding himself in a university conference packed with transhumanist thinkers[2], whereas he had expected the event to be devoted to the "serious examination" of nanotechnology ethical issues[3]. This anecdote makes it clear that the definition of the legitimate expertise to be mobilized in order to ensure a responsible production of nanotechnology's futures may be controversial. It is, for a part, a matter of scholarly discussion (who is entitled to speak in academic circles about nanotechnology's responsible futures?) but also of administrative expertise (who is the decision-maker supposed to ask for advice related to the making of responsible futures for nanotechnology?).

So if "ethics" is often a response to the concern for the making of responsible futures of nanotechnology, the mobilization of "ethics" is a starting point, rather than the outcome, of the analysis of the problematization of nanotechnology's futures. What counts as "ethics" may differ. This chapter will indeed contrast various forms of "ethics" of nanotechnology, some of them meant to mobilize existing expertise in ethics, such as bioethics, others meant to transform the reflection on the potential "implications" or "societal aspects" of technological development. But the analysis of the production of the futures of nanotechnology cannot be limited to the landscape of various forms of ethical argumentation, or, for that matter, of any other forms of normative scholarly reflection on the future of nanotechnology[4]. What is at stake is the democratic construction that the expertise about the responsible future of nanotechnology enacts. First, any expertise in ethics defines individual and collective modes of action. For instance, democratic transhumanism supposes that information is provided to every citizen, and that every one of them has equal access to technological development. Second, as science policy officials call social scientists, philosophers and other scholars to work on the societal implications of nanotechnology, the relationships between the production of knowledge in ethics - or other social sciences interested in the responsible development of nanotechnology - and policy-making (whether it relates to the allocation of research funding, regulation, or other domains of policy activity) might take different forms[5], and needs to be interrogated. This implies not to limit the analysis to that of discourses and arguments, but to account for the ways in which expertise in ethics and

[1] Cf. (Nordmann, 2004). I will get back to this report in the second section of this chapter.
[2] Interview with A. Nordmann, Washington, October 29, 2009. Nordmann also talked about the "so-called center for responsible nanotechnology", as he mentioned the Center for Responsible Nanotechnology, a think tank exploring the "implications of molecular manufacturing", and advised by Erik Drexler.
[3] He developed this critique in his academic work (Nordmann, 2007).
[4] See an example in (Ferrari, 2010). I attempted to draw such a landscape in (Laurent, 2010a: 105-146). This chapter remobilizes part of this latter piece of work.
[5] For instance, (Kelly, 2003) is a discussion of two forms of relationships between ethics committees and the science policy scene: one that highlights the possibility of a consensus through the rational examination of scientific practices, and another that makes visible oppositions based on conflicting values.

social science is mobilized as a component of science policy[1]. Examples in Europe and the U.S. will demonstrate that in some cases, ethical advice adopts the modality of an expertise that needs to be displayed as objective and independent of political decision-making (US), while in others, it is part of a moral space on which science policy is grounded (Europe). Consequently, I will describe different arrangements between nanotechnology objects, futures, concerns and publics enacted by the technologies of democracy expected to produce responsibility.

In the following, I focus on sites where the making of responsible nanotechnology futures is problematized. I will consider academic and policy activities of ethicists and social scientists, and the involvement of policy-makers and public officials defining nanotechnology programs "in a responsible way". The first section of this chapter considers examples in the United States. It focuses on the works of proponents of a "nanoethics", modeled on bioethics, and the involvement of critics of bioethics who proposed a "real-time technology assessment" in order to collectively construct nanotechnology. The second section follows the concerns for the "responsible development" of nanotechnology from the United States to Europe. The making of a European responsible nanotechnology policy in Europe also involves the mobilization of ethics, but as a component of a European-wide space in which common values and principles need to be stabilized.

[1] While the literature of the ethics of nanotechnology has been rapidly developing, the analysis of ethics as a form of expertise is more rarely undertaken. See (Ferrari, 2010) for a general discourse analysis of nanotechnology ethics, which does not focus on the production of ethics knowledge as a public expertise though.

Section 1: An American expertise about the making of responsible futures

The proponents of the American nanotechnology programs did not define the problem of the responsibility of nanotechnology's futures in connection with the making of science policy instruments that indeed constructed the future. Rather, nanotechnology was to be made responsible through the study of its "social implications". Their examination was considered a necessary condition for the success of the National Nanotechnology Initiative:

Research on societal implications will boost the NNI's success and help us to take advantage of the new technology sooner, better, and with greater confidence.[1]

"Research on societal implications" was expected to mitigate the potential health risks of nano substances and products, and deal with social and ethical issues, including the potential "nanodivide" (i.e. the unequal repartition of nanotechnology "benefits" across the world), the "implications for civil liberties" of the decrease in size of electronic devices, the philosophical questions about human nature raised by the use of nanotechnology and converging technologies for "human enhancement", and potential "military uses"[2]. Thus, making a responsible future for nanotechnology appeared, following the concern for the societal implications of nanotechnology as called for by the NNI, as a problem of mobilizing the right expertise, which could be based on

sober, technically competent research on the interactions between nanotechnology and society.[3]

Such a "technically competent research" would

help mute speculative hype and dispel some of the unfounded fears that sometimes accompany dramatic advances in scientific understanding[4].

Thus, the objective of the "societal implications" research seemed to be that of the correct representation of nanotechnology-related public concerns in order to correctly manage them, and avoid false representations of nanotechnology. The situation is more complicated though. For during the

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[1] Roco and Bainbridge, 2001: 2

[2] These issues and concerns stemmed from initial works about the "societal implications of nanotechnology" led by the National Nanotechnology Initiative (Roco and Bainbridge, 2001; 2005).

[3] Roco and Bainbridge, 2001: v

[4] *Ibid.*

exploration of the "societal implications" of nanotechnology in the workshops organized by the NNI, some participants considered that "responsible development" required a collective, reflexive and deliberative construction of nanotechnology's futures[1]. One can thus contrast a "representationist" approach with a "constructionist" one, which contends that the future of nanotechnology will be responsible if collectively constructed through participatory instruments[2].

The 21th Century Nanotechnology Research and Development Act of 2003, which defined the federal program for nanotechnology, eventually integrated concerns for the "social and ethical implications" of nanotechnology in a formulation that left room for both approaches. The discussions at Congress on nanotechnology's ethical issues occurred during a series of hearings at the Senate and the House in 2003, organized in preparation of the Nanotechnology Act[3]. During these hearings, the invited scientists called for an appropriate examination of the implications of nanotechnology, and spoke of the need to "inform" and "educate" the public about nanotechnology. Political scientist Langdon Winner displaced the question of the representation of nanotechnology and its implications, and argued that deliberative mechanisms should be mobilized in order for nanotechnology to be constructed with the public.

The Nanotechnology Act eventually called for the "identification" of nanotechnology's "implications" and also asked for "public input" to be the included in federal nanotechnology programs. Thus, it called for social scientists and publics to be involved in nanotechnology programs, without providing details about the channels through which such an involvement was expected to occur. The remainder of this section describes some of the works that originated from this concern for "integration" in the making of nanotechnology's futures. In particular, I am interested in the kind of expertise that is proposed to policy-makers in order to ensure that the futures of nanotechnology are produced in responsible ways.

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[1] Cf. (Fisher and Mahajan, 2006a).

[2] I introduced this distinction when comparing two reports released in France in 2007, one written by the National Committee of Ethics, and the other written by the ethics committee of CNRS (National Center for Scientific Research) (Laurent, 2010a: 111-116). Discussing the interventions of an American public bioethics committee on human embryo research, Susan Kelly makes a similar distinction, between a model centered on consensus building based on values mobilized by ethicists, and another one in which policy alternatives are negotiated with scientists (Kelly, 2003).

[3] A more detailed examination of these debates is in (Laurent, 2010a: 116-120).

The failure of dualist ethics

<u>*Using "human dignity for the evaluation of nanotechnology?*</u>

In 2005, the President's Council of Advisors on Science and Technology (PCAST) commissioned the President's Council on Bioethics (PCB) to explore the ethical issues of nanotechnology and the way of dealing with them within the NNI. PCB organized a public hearing session devoted to nanotechnology in September 2007, during which two physicists, a toxicologist and a UNESCO ethicist testified. PCB has previously released a skeptical opinion on "human enhancement", using the concept of "human dignity" as a value to be mobilized in order to evaluate technological development[1]. PCB tried to use "human dignity" to evaluate the ethical concerns of nanotechnology. This proved difficult, as the following excerpt from the report PCB released after the hearings explained:

During the sessions on nanotechnology, some Council members began exploring how nanotechnologies might affect human dignity, but in the process they encountered a revealing difficulty. The nanotechnologies that potentially might harm human dignity (i.e., nanotechnologies that would radically affect fundamental aspects of human life and might alter human nature) currently do not exist. With the scientists and engineers responsible for creating them arguing over whether or not they will ever exist, it seems premature to assess the impact of these specific nanotechnologies[2].

The very reason for PCAST to commission PCB – reflecting on the futures of nanotechnology- was the cause of the impossibility for the council to provide an opinion. As the technologies that could be problematic "did not exist", then "human dignity" could not be used to evaluate them. PCB considered separate "nanotechnologies" rather than a global science policy program. It thus had to wait for them to be stabilized enough in order to perform any ethical analysis based on human dignity. The impossibility for PCB to intervene in the making of nanotechnology's futures is characteristic of an approach that separates the facts of science and technology (that is, the technical characteristics of the "nanotechnologies") from the values of the ethicist. In this case, the values are based on "human dignity". They can be qualified as conservative since they were used by PCB, created by President Bush in 2001 and headed till 2005 by Leon Kass, a known critic of biotechnological innovation, to ground opinions that limit the practices of technological innovation, particularly in the life sciences[3].

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[1] President's Council on Bioethics, 2003. On the concept of human dignity as it is used by PCB, see President's Council on Bioethics, 2005.

[2] Crowe, Sam, "Understanding the Ethical Implications of Nanotechnology: Highlights of a Limited Inquiry By the President's Council on Bioethics", January 2008.

[3] This has caused internal dissensions within PCB as well (Jasanoff, 2007: 194-196).

This framing of ethics is not the only possible one. During the PCB nanotechnology hearings, other constructions of the role of ethics, and, consequently, of the role of the council for the making of nanotechnology's futures were heard. In particular, UNESCO ethicist Henk ten Have insisted on the need to introduce mechanisms for dialogue between scientists, humanists and citizens. For Ten Have, ethics was tightly involved with other social actors in the construction of institutions that could exercise an "ethical vigilance" on emerging technologies. This, however, was not considered part of PCB's role, as one of the members of the council stated:

Now, many of the other problems you mentioned, Dr. ten Have, seem to me to be extremely important, but I view them more as issues in politics or issues in general prudence, things that should be done, for instance, to re-insert science in the political community, for instance, to regenerate trust. But, again, I'm not... maybe I'm blind to this. I don't see the specific ethical issue that would require reflection[1].

Ten Have's suggestion indeed led not to wait for facts to be solidified enough in order to mobilize values, but proposed that ethics should intervene in the collective construction of nanotechnology itself (which then comprised science policy programs as well as material objects). This differed from the human dignity approach of PCB. That Ten Have provided no concrete example of infrastructure able to enact such a "constructionist ethics" did not help convincing the members of the council to abandon the human dignity approach.

In developing the concept of human dignity, PCB had been criticized for its conservative position. Scientists had expressed concerns about the use of scientific data in the Council reports that were opposed to stem cell research[2], and members of PCB had voiced internal critique[3]. Accordingly, PCB was criticized by advocates of transhumanism, for whom nanotechnology was an opportunity for human development, on the condition that one did not introduce (as it was the case within the "human dignity" framework) boundaries between "human" and "non-human", "male" and "female", or "human" and "animal"[4]. But in the case of nanotechnology, the PCB "conservative ethics" could not manage to translate into the ban on a given technological object or practice: the ontological uncertainty of nanotechnology substances and products (cf. chapter 4 and 5) prevented the Council from using "scientific facts" stable enough to exercise the value of human dignity. The following section will show that "liberal ethics", which would insist on personal choices rather than human dignity, and of which

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[1] PCB transcripts: Sept. 7, 2007.
[2] "2 of Bush's science advisers say their board distorted facts. Report criticized for ignoring stem cell research", Gareth Cook, Boston Globe, Saturday, March 6, 2004.
[3] Jasanoff, 2007: 194-196
[4] "George W. Bush is getting brain-jacked", James Hughes, March 2004 (http://ieet.org/index.php/IEET/more/1421/, accessed August 30, 2010).

many PCB members had been long-term critics[1], was no more successful in acting on the futures of nanotechnology.

<u>*Mobilizing bioethics*</u>

In a paper published in 2003, three bioethicists, among whom philosopher Peter Singer, explained that one should "mind the gap" between nanotechnology development and ethics reflection[2]. This paper was then often cited, and mobilized to argue for the early engagement of ethics in nanotechnology development. The National Science Foundation (NSF) funded several projects in ethics, in order to ensure that the "gap" was indeed "minded". Among them, a group of authors gathered within the "Nanoethics Group", a loose association of researchers coming from bioethics, computer ethics and engineering ethics, received several grants from NSF in order to work on the ethics of nanotechnology[3]. Some of them, like Patrick Lin and Fritz Allhof who co-edited several volumes entitled *Nanoethics*, became prolific authors in the field of nanotechnology ethics. For the researchers of the Nanoethics Group, bioethics was the most convenient framework for any ethical analysis of nanotechnology:

Nanoethics, if it becomes a separate field, would be better understood on the model of bioethics. (…) Familiar issues in bioethics include whether euthanasia is justified, how stem cells should be used, how to fairly distribute scarce organs for transplant, and whether animals should be used in research. Similarly, nanoethics would consider ethical implications of activities and results of nanotechnology and nanoscience. Issues in nanoethics would include how to safeguard privacy in a world with nanosnooping devices, to what extent the manipulation of human beings should be permitted, and how to minimize the risk of runaway nanobots.[4]

For the members of the Nanoethics Group, bioethics could provide an institutionalized form of argumentation, an expertise with known professionals and existing instruments for the management of technology. Such an expertise in ethics was to be based on universal principles able to objectify decision-making processes, hence its name "principlism". Defined in the late 1970s and later solidified by the bioethics profession, these principles are the following: autonomy, beneficence, non maleficience, and

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[1] Evans, 2002: 62-63
[2] Mnyusiwalla, Daar et Singer, 2003
[3] Projects funded by NSF are: "nanotechnology and human enhancement", Award Number : 0621021, PI : James H. Moor ; "ethical issues in nanotechnology and human enhancement", Award Number : 0620694, PI : Fritz Allhoff, Co-PI : John Weckert
[4] Moor and Weckert, 2004: 305

justice[1]. For nanotechnology, "autonomy" implied that informed consent was to be ensured when using nano substances and products in medical practices or consumer goods; "beneficence" and "non maleficence" led to call for risk/benefit analysis; "justice" made it necessary to address the so-called "nanodivide", which describes a hypothetical situation in which the expected benefits of nanotechnology are not equally distributed[2]. As in bioethics argumentation, the use of principles about nanotechnology meant that compromises and trade-offs among principles were to be made. Here, the role of the ethicist was to balance among them – for example, "health risks" vs. the "autonomy" of individual choices – and to discuss situations where the trade off was particularly difficult. For instance, the ethicist would defend human enhancement in the name of autonomy, as long it does not harm others, and would interrogate the case of children, for whom "informed consent" appears trickier[3]. He would then refine his analysis by setting limits (Moore suggested in an interview "using a simple, majority age rule"[4]) or use additional philosophical principles[5]. This mode of argumentation can travel harmlessly across technological domains (from biotechnology to nanotechnology), since it is based on the separation between the technology and the values to apply to it. It could satisfy the expectation of NNI as it is indeed a matter of "professionals" who can provide an expertise at-a-distance, based on the objectification of both scientific domains (by scientists) and values (by ethicists).

Developing nanoethics

For all their inspiration in bioethics, the members of the Nanoethics Group also argued for the novelty of "nanoethics". They were incited to do so by an article published in 2004 (that is, shortly after the NanoAct has passed), which blamed the ethicists of nanotechnology for crafting a non-existent "nanoethics" (as it was argued) for their own financial and research interests[6]. The director of the Nanoethics Group, Patrick Lin, felt compelled to answer, and explained that there was indeed a need

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[1] Evans accounts for the ways in which the bioethics mode of argumentation managed to make its way into federal science policy, and eventually became the dominant ethics expertise (Evans, 2002). The bioethics principles derived from the 1979 Belmont report, which developed a framework for the protection of medical subjects (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979, *Ethical principles and guidelines for the protection of human subjects of research*).

[2] The authors of the "mind the gap" paper published numerous papers about nanotechnology ethics, in which they mobilized the principle of bioethics in order to analyze the potential "nano-divide" between developed and developing countries (see Salamanca-Buentello et al., 2005; Singer et al., 2005). The same group of authors holds the very same position about biotechnology (Daar et al., 2007). In all cases, the position does not question technological development itself in order to apply "ethical norms" on it (in this case, the condition of justice).

[3] Phone interview with James Moor, February 23, 2010.

[4] *Ibid.*

[5] The notion of "primary goods" as defined by John Rawls was thus used by a member of the Nanoethics Group, in order to deal with situations where "informed consent" is complex to use (e.g. future generations being modified by a genetic intervention on germ-line cells) (Allhof, 2008).

[6] Keiper, 2004

for nanoethics, the specificity of which lied in the "close relationships" and "constant interactions" between science and ethics[1], as most of nanotechnology was still to be developed. Accordingly, he considered that:

Nanoethics is not something one can complete satisfactorily either first or last but something that needs be done continually as the technology develops and as its potential consequences become better understood. Ethics is dynamic in that the factual component on which it relies has to be continually updated. (…) New technology often creates novel situations for which no ethical policy exists or seems immediately obvious. In the face of policy vacuums we need to consider how to formulate new and appropriate ethical policies given the new facts[2]

Albeit used as an argument for the specificity of nanoethics, the idea of the "permanent catching up" in a situation of "policy vacuum" was hardly new. The same group of people had worked on "computer ethics", for which James Moor had identified the same type of "policy vacuum" [3]. For Moor, as computer science led to changes in many domains of human activity because of the "information malleability", so did nanotechnology because of the "material malleability" it entailed[4]. Patrick Lin wrote about "space ethics" as he was beginning to work on nanotechnology, and identified there another "technological leap"[5]. His colleagues at the NanoEthics Group had developed the same kind of argumentation in biotechnology[6]. While the ethicists of the Nanoethics Group argued for the novelty of the field (they had had to invent a new name for it), they were also able to make their methods travel from one technological domain to another, from biotechnology to computer ethics, from space exploration to nanotechnology, since the logic of their ethical reflection was the mobilization of an expertise in ethics that was independent of the questions it was applied to. Accordingly, their ethical reflection was not concerned with the material construction of nanotechnology substances and products, but was expected to intervene as soon as these objects would be available – which means that nanoethics was condemned from the start to permanently "catch up" with scientific development while permanently lagging behind.

<u>*Writing as an objective nanoethicist*</u>

Critics of bioethics have argued that the bioethics argumentation discusses the "means" while leaving the "ends" of technological development intact, thereby leading to the actual development of

[1] Lin, 2007a; see also Lin, 2007b. (Allhof, 2007) is another response and defense of nanoethics.
[2] Lin, 2007a
[3] Moor, 2001
[4] Moor, 2005
[5] Lin 2006
[6] E.g. on germ-line cells genetic engineering (Allhof, 2008).

technology whatever the ethical advice might be[1]. Members of the nanoethics group indeed define themselves as "fairly liberal", and see their positions as opposed to those of the President's Council on Bioethics[2] - the place, as seen above, where a "conservative bioethics" was defended. Yet nanoethicists could not simply defend a liberal ethics limited to the defense of individual choices. As an expert group being funded to work on these issues in the context of the NNI, which expected "sober professionals" to be involved, it was important to demonstrate the objectivity of the expertise on the societal implications of nanotechnology.

Grounding the discussion on rigid boundaries between nanotechnology and principles to apply on it was a way of doing so. Then, safety issues could be dealt with through the beneficence and non-maleficence principles, which led to allocating the question of risks to technical experts, thereby removing it from the scope of ethical analysis. This ignores the possibility for collective discussions about the very existence of nano substances and products, as seen in the previous chapters, and simultaneously allows the ethicist to maintain a distance to the object of his/her study and claim that he/she is indeed holding a neutral position in the debate. For other concerns like the future developments of nanotechnology, the position was more complex to hold. Take for instance human enhancement. Even if the ethicist does not enter the problem of the construction of human enhancement's objects (e.g. brain implants or nanodevices to be used within the body), he/she is asked to evaluate whether or not the domain is morally acceptable. Thus, the Nanoethics Group wrote a report on the topic for NSF in 2009[3]. In this report, the authors were careful not to take sides. "Pro" and "anti" enhancement positions – clearly demarcated as transhumanist thinkers were opposing the President's Council on Bioethics – were presented. The authors could then discriminate what they perceived as the excesses of both sides. Hence, the libertarian argument put forward by the "pros" was criticized, according to a bioethics-like method of argumentation that contends that no principle (in that case autonomy) should be considered as more important than the others in all situations:

Current arguments need to be more compelling and philosophically rigorous, if the pro-enhancement side is to be successful[4].

On the other hand, the exercise of neutral expertise led to the refusal of "metaphysical" arguments, such as critiques based on the threat that scientists would be "playing God" if using nanotechnology for human enhancement. These arguments, so the human enhancement report argued,

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[1] Evans, 2006
[2] The expression was used during an interview with Moore, referring to his own position and that of his colleagues.
[3] Allhof et al., 2009
[4] Lin and Allhoff, 2006: 51

"tend to emphasize common notions of human dignity and the good life"[1]. But the nanoethicists considered that "human dignity" was an unreliable concept, since the definition of the "good life" might evolve with nanotechnology[2]. Eventually, the members of the Nanoethics Group could conclude their ethical examination of human enhancement by stating that the principles of bioethics needed to be safeguarded, in order for future beneficiaries of human enhancement technologies to be autonomous enough to use them, without risking harming others.

The careful exercise of objectivity production through ethical argumentation implies maintaining boundaries throughout the writing process, so that the objectivity of expert advice is not threatened by a perceived shift in favor of one side rather than another. This has been successful in bioethics[3]. Bioethics could rely on a professional community heard by policy makers, and was integrated in scientific research and medical practice through instruments such as the institutional review board. The case of nanotechnology appeared more complicated for the "bioethics-inspired" ethicists. They managed to stabilize the form of ethical argumentation by arguing for risk/benefit analysis, the equal distribution of benefits across the world, and the diffusion of appropriate information for the general public and interested stakeholders. In short, they could at best reproduce the common themes of responsible development of nanotechnology as they were outlined in the NNI reports, without discussing the construction of material substances and products and the production of futures in science policy instruments.

The failure of conservative and liberal ethics for the making of nanotechnology's futures

The problematization of nanotechnology's futures that the American ethicists proposed automatically excluded them from any active role. A necessary condition for the intervention of PCB members and nanoethicists was the actual development of technologies for an ethical evaluation based on values ("human dignity" for the former, the principles of bioethics for the latter) to be performed. As for the technologies that did exist (like some of the nano substances and products we encountered in the previous chapters), both sides called for risk-benefit evaluations – operations that are highly contested and linked to the very existence of substances and products (as seen in the two previous chapters), but which were not interrogated by the American ethicists.

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[1] Lin and Allhoff, 2006: 30

[2] Note that the four principles of bioethics were not considered to be subjected to evolutions.

[3] The story has been told by John Evans, and Sheila Jasanoff. Evans insists on the shift from a debate on "substantive questions" to discussions on the ways in which bioethics principles can be applied, while never questioning the logic of technological development (Evans, 2002; 2006). Jasanoff situates the concern for the objectivity of ethics in a wider American debate opposing the dynamics of opposition of stakeholders in legal settings, and constant calls for "sound science" (the previous chapter provided other illustrations of this dynamics). She shows that the growing influence of ethical expertise has moved technological issues away from public debate (Jasanoff, 2005b: chap.7; Jasanoff, 2011).

Nanoethics and the PCB ethics were strongly criticized by Jean-Pierre Dupuy, a French, Stanford-based philosopher. Dupuy considered that ethicists did not grasp nanotechnology's central philosophical problem. For him, this problem was not related to technological objects or scientific facts, but to a "metaphysical program" planning long-term developments. Dupuy considered that the metaphysical program was not visible in the mundane substances and products that were already present in industry production lines and on store shelves, but in the futuristic literature that had made its way into nanotechnology programs[1]. One of its major topics consists in "captur(ing) (...) the self-organizing properties of living organisms in order to harness them to human ends". Dupuy illustrated this by a recurring example:

In November 2003, scientists in Israel built transistors out of carbon nanotubes using DNA as a template. A Technion Israel scientist said, "What we've done is to bring biology to self-assemble an electronic device in a test tube [...] The DNA serves as a scaffold, a template that will determine where the carbon nanotubes will sit. That's the beauty of using biology."[2]

Thus, using "nature as a template" was for Dupuy the basis of nanotechnology's metaphysical program. "Molecular machines" were symbols of a will to control nature and harness living and non-living matter in order to exploit physical or chemical properties. That they did not always correspond to what nanoscientists "really do" does not matter: their development was, for Dupuy, the underlying driving forces of nanotechnology programs. Consequently, Dupuy rejected nanoethics in favor of a "catastrophism" consisting in "setting our eyes on the worst-case scenario and seeing to it that it never sees the light of day"[3]. The objective of catastrophism was then to perform an "on-going normative assessment", meaning that metaphysical programs should be discussed collectively, in order to envision the "worst possible case", and implement the appropriate actions to avoid it.

Drawn in broad terms in a single paper, the "on-going normative assessment" was not explored further by Dupuy. One can indeed wonder what the role of the ethicist could be in this "future ethics" (in Dupuy's own terns)[4]. But at this stage in the analysis of the problematization of nanotechnology's futures, such a proposition is of interest since it offers a critique of the conservative and liberal ethics of

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[1] The "metaphysical program", in Dupuy's account, remains mostly at the level of discourse. Yet one could track it back to science policy instruments (e.g. the example of the use of Kurzweil's graphs in an evalution of the NNI report released in 2002, Laurent, 2010a: 41-42). Considered as such, the proximity with the approach undertaken in the dissertation and the description of the metaphysical program needs to be interrogated. As it will be described in chapter 7, the difference mainly lies in the fact that the methods followed by the dissertation do not rely on a distance from its objects that is defined beforehand.

[2] This example is used in (Dupuy, 2007) and (Grinbaum and Dupuy, 2004).

[3] Grinbaum and Dupuy, 2004: 9

[4] Dupuy considered his job done once he had described the threat of nanotechnology's metaphysical program. He did not then consider it necessary to pursue his research further in this field (personal communication).

nanotechnology based on the separation between the examination of metaphysical programs and the mobilization of values in order to define the "worst possible case". Dupuy's arguments also suggest making the future an object for collective discussion. This latter point echoes ten Have's propositions in front of the PCB. It will be further illustrated through the example of social science projects funded by the NNI to explore the societal implications of nanotechnology.

Making experimental nanotechnology futures

The critique of the bioethics-inspired nanoethics led Dupuy to argue for a critical distance from which the analyst could identify an underlying metaphysical program. Others considered on the contrary that, far from being too close to the nanotechnology programs, the nanoethicists were not close enough, and could not account for nanotechnology as a scientific program in the making since they were deemed to wait for "facts" in order to apply ethical principles on them. In the remainder of this section, I describe some attempts, by American philosophers and social scientists, to define the problem of nanotechnology's responsible futures in terms that do not rely on the fact/value dichotomy.

<u>*Characterization of nano substances and products*</u>

In discussions within the American science policy institutions, sociologists and political scientists argued that nanotechnology required innovation in the governance of science. In a 2004 conference held by the National Academy of Science (NAS), philosopher George Khushf proposed an approach to the study of nanotechnology based on the refusal of bioethics. A former engineer and never a member of the bioethics profession[1], Khushf did not consider that the problem of the making of nanotechnology's futures was to identify the ethical issues of nanotechnology "facts", as soon as they were available. Rather, he considered that "science and ethics could not be related in a two step process"[2]. As opposed to Dupuy, for whom the role of the philosopher consisted in identifying the "metaphysical program" of convergence, Khushf was less interested in a global program that would lie "behind" science policy initiatives, than in scientific practices and the actual constructions of new material entities. For Khushf, scientists needed to consider that "ethical issues were part and parcel of their research", and, consequently, of the making of material entities. He then proposed a "situated

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[1] Phone interview with Khushf (May 2009).
[2] Khushf, 2004. See also (Khushf, 2007).

ethical reflection"[1]. The "integration" of scientific research and ethics was the main objective to pursue, in order for ethics to contribute with science to the construction of new nano substances and products.

Khushf later developed his nanotechnology ethics, by promoting an approach through which the ethicist would undertake dialogue processes with scientists, and would be integrated into laboratory practice in order to describe research practices. Ethics could then help make scientific practice explicit, and thereby demonstrate how the processes through which new objects were created occurred[2]. Khushf named this approach "characterization", which he understood as more than a simple description. Characterization was expected to participate in the definition of the expectations related to scientific projects, and the ways, including the technical ones, to meet them. Consequently,

Characterization in this context is formative and constructive, not an act that can be done once and for all. It is an ongoing process that must attend the development of the science.[3]

In Khushf's view, ethics was no more the matter of a professional constituency mastering a discipline (as bioethicists master a form of argumentation based on principles, or conservative ethicists master the human dignity argument), but of a research collective, whose works were "ethical" in the sense that they would open room for discussions.

Khushf's propositions were included in various administrative reports after the NAS workshop[4]. But they remained only a minority component of a much more diverse nanotechnology policy literature that, under the general theme of the responsible development of nanotechnology, allowed Khushf's and the nanoethicists' arguments to be simultaneously acceptable[5]. Some isolated experiences along Khushf's lines of thought were conducted after these initial developments. Thus, Khushf mentioned during an interview a study undertaken by Christopher Kelty, an American anthropologist, which he considered a good illustration of what his "characterization" approach could be. Kelty had been interested in the

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[1] *Ibid.*

[2] Hence, Khushf has been working on research focusing on the construction of living cells (Khushf, 2009).

[3] Khushf, 2004

[4] In some cases, one can identify the process through which elements of Khufsh's positions make their ways into policy documents. The following except appears in the 2006 review of the NNI:
"In general, when the social impacts of a new technology are considered, ethics and fundamental research and development are treated as separate. Such an approach keeps facts and values separate, posits risks and benefits that are measurable and scalable, and assumes that uncertainty can be understood and managed scientifically. But because nanotechnology is a potentially disruptive emerging technology, addressing its impacts on society will require a different approach." (National Research Council, 2006, *A matter of size. Triennal review of the National Nanotechnology Initiative* (hereafter NRC, 2006): 88)
These words are themselves quoted from Khushf's contribution to the responsible development workshop, and are consistent with his refusal of the fact/value distinction.

[5] For example, the excerpt below is followed by: "responsibility lies with all the stakeholders to make well-informed decisions that will lead to both realizing the benefits and mitigating the risks of nanotechnology" (NRC, 2006: 92). Any liberal ethicist could endorse this.

work of the Center for Biological and Environmental Nanotechnology (CBEN) at Rice University[1]. CBEN does research on nanomaterials and their environmental applications, such as water treatment. One of the researchers at CBEN is Vicky Colvin, whose work on fullerenes is widely recognized, and who played a major role in the definition of the federal nanotechnology policy. Testifying before Congress, Colvin advocated the inclusion of the "impacts" of nanotechnology in the federal programs so that the risks of nanotechnology might not become risks *for* nanotechnology. Rather than analyzing the risks of fullerenes once their potential use had been defined, Colvin's approach consisted in characterizing the toxicity of the substance as a function of its structure. As other properties of fullerenes were linked to their nanometric scale, their toxicity might play interesting roles, such as the destruction of tumor cells. As the other properties of nano substances, it needed to be controlled. In CBEN research projects, toxicity thus became, according to Kelty, a fundamental property of the material, as much as its surface area, its atomic mass or its density. As such, it was yet another parameter on which to play in order to design nano substances with interesting functions. The "implications" of nanotechnology were then integrated within the very practices of scientific research, and within the material itself. Vicky Colvin labeled the approach "safety by design", as the design of the material then comprises its toxicological properties.

"Safety by design" echoes the attempts to propose property-based definitions of nano substances described in chapters 4 and 5. In this perspective, there is no difference any more in the work about "safety" and the work about "ethics". Safety by design deals with the construction of nano substances and products, and thereby performs an ontological work in the laboratory. Here, ethics is not separated from scientific practice. Health risks are ethical issues, in so far as they imply the identification of the substances' properties, i.e. their "characterization", both in Khushf's and in the physical sense. In this perspective, molecular machines are not metaphors that need to be checked according to their closeness to reality, nor symbols of contestable metaphysical programs, but objects being constructed in laboratories. Human enhancement uses objects such as nanotube brain implants, which can be constructed in different ways. The issue at stake here is no longer to separate "principles of action" (e.g. bioethics principles, or human dignity) from the content of the action, but to open up the construction of all the aspects of scientific practice and technical developments, be they decisions to take in the laboratory, characteristics of technical systems, modes of collaborations among disciplines and actors, expected usefulness or future distributions of applications.

[1] See (Kelty, 2009).

A constructionist ethics

Khushf proposed a constructionist ethics grounded on the participation of the ethicists in the construction of physical and chemicals objects, and of public concerns. In this perspective, the ethicist and the scientist participate together in the definition of the "ethical questions" associated with nanotechnology research (e.g. the possibilities of future applications to other domains, or the appropriation of knowledge by private actors). By the same token, futuristic discourses (such as the science-fiction literature that inspires nanotechnology policy programs) are treated differently in Khushf's account than in Dupuy's. They are not something to put at a distance in order to consider them as representative of a hidden metaphysical program, but elements to be considered as long as they are connected to actual practices in the laboratory, and participate in the construction of research objects.

Unsurprisingly, ethicists engaged with the Nanoethics group did not align with Khushf's positions. He was not contacted to be in the editorial board of the newly created *NanoEthics* journal by John Weckert, himself a member of the Nanoethics group[1]. Indeed, one of the contributors of an edited volume devoted to nanoethics and directed by Patrick Lin and colleagues explained that one "could see a danger with Khushf's way of viewing ethical values" [2]. This commentator, Arthur Zucker, explained that it would be better for ethicists to keep "adding to the store of knowledge" (by which he meant knowledge in ethics) "external to the science". For Khushf the production of knowledge is a simultaneous concern of ethics and science. But for Zucker:

Nanoscience may discover things we didn't know about ourselves but it is easier and less unsettling to the public to keep a prima facie dichotomy between what we discover and what we value[3].

For fear that it might prevent from objecting values to the progress of scientific development, Zucker refused Khushf's move beyond the science/ethics dichotomy, and by the same token, the shift away from the problematization of nanotechnology's futures issue in terms of the opposition between the liberal and the conservative ethics. This refusal is far from incidental. Some of Khushf's colleagues said that he is "fascinated by auto-replicative nanomachines"[4]. True or not, the anecdote is telling. Khushf's position does not imply agreeing on the call for a rational examination of the "facts" of nanotechnology before mobilizing "values", but participating in the solidification of composite assemblages – molecular machines, human enhancement devices, "safe by design" nanomaterials. Such a

[1] Nordman told me this anecdote during an interview (28 octobre 2009, Washington)
[2] Zucker, 2008: 68
[3] Zucker, 2008: 70
[4] Interview with A. Nordman, Washington, October 29, 2009.

move renders the establishment of an objectifying distance difficult, precisely because of the refusal of any dichotomies. Consequently, it also fits well with current evolutions that nanotechnology brings to scientific practice. Research on nanomaterials means in some cases that "material science" and "toxicology" can no longer be distinguished as the two work together to explore the potentiality of materials[1]. In others, it implies that physicists work on biological material in order to harness the properties of natural molecules[2]. Hence, Khushf's proposition is a component of a science world where no a priori boundary among disciplines holds a stable quality, and where, by the same token, no possibility exists for external critique.

Khushf's proposition did not fit easily with the at-a-distance expertise in ethics that American nanotechnology policy called for. Indeed, Khushf "does not get any hearing" according to a European ethicist, who complained in an interview that his fellow American ethicists did not consider Khushf as much as he deserved. The challenge that Khushf's propositions face in order to get heard in the American ethics landscape is linked to the difficulty, in this constructionist version of ethics, of demonstrating the quality of the expertise in ethics for policy advice. Khushf did not attempt to do that. The last American example I want to consider is also anti-dualist, but nonetheless attempted to demonstrate the value of an external expertise about nanotechnology's implications.

<u>*An experimental ethics*</u>

Khushf's position refuses to separate, as nanoethicists do, the "facts" of nanotechnology from the "values" known by ethicists. It considers that the responsible development of nanotechnology requires a collective production of futures that would involve natural and social scientists. Such an anti-dualist approach was also undertaken by scholars coming from Science and Technology Studies (STS), who ambitioned to develop a new methodology for technology assessment that would be adapted to nanotechnology. Thus, David Guston and Daniel Sarewitz proposed in the early 2000s to develop "real-time technology assessment" (RTTA), which would aim to

> *integrate social science and policy research natural science and engineering investigation from the outset*[3].

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[1] For instance, the director of the nanotechnology initiative at the U.S. National Toxicology Program explained during an interview that "toxicology was entering a new realm of practices" with nanotechnology, in that "work was material science as much as it was toxicology" (Phone interview with Nigel Walker, November 12, 2009). Colvin's "safe by design" approach follows this approach.

[2] A well-known example is the use of ATPase as a "nanocopter". Futurist Ray Kurzweil presented as such the work of Carlo Montemagno (Kurzweil and Grossman, 2004: 2).

[3] Guston and Sarewitz, 2002: 2

Guston and Sarewitz pursued the STS analysis of the coproduction of science and society, and took inspiration from European methodologies for technology assessment, such as Constructive or Participatory Technology Assessment (CTA and PTA)[1]. Like CTA, RTTA was meant to integrate technology assessment into the making of technologies. Like PTA, it hoped to involve stakeholders and publics in the reflexive and deliberative construction of technology. Guston and Sarewitz were careful to differentiate their approach from existing methodologies. They argued that RTTA was about the production of new knowledge rather than the experimentation about new technologies, that it would develop tools for the analysis of the evolution of public values and concerns, and that it sought to integrate retrospective case studies with prospective explorations[2].

Guston and Sarewitz used nanotechnology as a domain where RTTA could (and should) be implemented. When speaking at one of the National Nanotechnology Initiative (NNI) workshops devoted to the societal implications of nanotechnology, Daniel Sarewitz and Michael Crow, president of Arizona State University, argued for the connection between "R&D inputs and desired societal outcomes" [3]. This would require an "analysis of the past and current responses to transforming technologies", "dialogue among scientists, technologists, policy-makers and the public"[4], and eventually:

the creation of a dedicated intellectual, analytical, and institutional capability focused on understanding the dynamics of science-society interface and feeding back into the evolving nanotechnology enterprise[5].

RTTA was further institutionalized when the Center for Nanotechnology in Society (CNS) was created at Arizona State University, under a grant of the National Science Foundation established after the Nanotechnology Act. Directed by Guston and hosted by the Consortium for Science Policy and Outcomes directed by Sarewitz, CNS received the biggest award granted by NSF for social science research in nanotechnology, and became by far the main project within the NNI in the social and ethical implications part of the program[6]. The "anticipatory governance" that CNS is experimenting is supposed to be the next step of STS[7], through which social scientific research and policy-making would be finally reunited. Yet the position is different from Khushf's. As I will describe in the remainder of

[1] Schot and Rip, 1997
[2] Guston and Sarewitz, 2002: 6
[3] Crow and Sarewitz, 2001: 65
[4] Crow and Sarewitz, 2001: 66
[5] Crow and Sarewitz, 2001: 65
[6] CNS-ASU is not the only NNI funded project expected to ensure that the "implications" of nanotechnology are adequately dealt with. It is the main component of a set of initiatives through which, according to their promoters and to the director of NNI himself, "nanotechnology is becoming a model for addressing the societal implications and governance issues of emerging technologies generally" (Roco et al., 2011: 406).
[7] A chapter entitled "anticipatory governance" was written in the 2008 STS handbook by RTTA scholars, in which the connection of STS research and practice with policy-making was envisioned as the next step for the field (Barben et al., 2008)

this section, the "experiment" is not that of the characterization of laboratory objects, but a social scientific experiment.

"Policy relevance" against ELSI

Guston and Sarewitz presented RTTA as a step forward after previous attempts to link social science and scientific research, and thereby ensure that scientific and technological development was conducted in responsible ways. One of these previous attempts was the "Ethical, Legal and Social Implications" (ELSI) program of the Human Genome Project (HGP), which, according to Guston and Sarewitz "had not been well-integrated into either the science process or the R&D process"[1]. It is worth discussing the ELSI program of the HGP, since it sheds light on the objectives of RTTA as operationalized in the Center for Nanotechnology in Society.

The Human Genome Project allocated 3% of its funding to the study of "Ethical, Legal and Social Implications" (ELSI) of genetic research. The ELSI program, famously backed by DNA discoverer Jim Watson at the launch of the HGP project[2], led to the examination of ethical issues connected to human genome. Projects were funded to study the "ethical implications" of human genome research, about the organization of research, and the construction of science policy. As its first director, Eric Juengst, put it, the ELSI research was meant to address

the virtuous genome scientist's professional ethical question: "What should I know in order to conduct my (otherwise valuable) work in a socially responsible way?[3]

For all the enthusiasm of its initiators, the ELSI program was heavily criticized. A source of tension was the conflicting demands it was submitted to. The ELSI program was expected to ensure its objectivity (i.e. that it was not captured by political interest). Juengst, a bioethicist directly involved in the expansion of principlism as a tool for the objectivity of ethics advice[4], was concerned with the production of independent knowledge. Juengst insisted on the quality and intellectual independence of the ELSI research, as he responded to critics who asked:

how "objective" can ELSI grantees be about any issue that bears on genome research, when their funding is provided by the genome research community on the assumption that genome research is a good to be protected?[5]

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[1] Guston and Sarewitz, 2002: 3
[2] The story has been told by many authors (among whom, Jasanoff, 2005b)
[3] Juengst, 1996: 68
[4] Evans, 2002: 24, 162.
[5] Juengst, 1996: 70

But the problem of objectivity was deeper than that of the source of funding. For the ELSI program was also asked to be "politically relevant", as a report from Congress stated[1]. This meant that it was supposed to provide advice that could be directly translated into policy-making. These competing expectations resulted in a complex institutional history, during which the program faced multiple changes of status, in order for the institutional body not to be absorbed by alleged political interests[2]. Critics of ELSI were the basis for the creation of the National Bioethics Advisory Commission[3], which institutionalized the principles of bioethics, as instruments for the functioning of the expertise of the advisory committee[4]. This evolution occurred very much to the dissatisfaction of Eric Juengst, for whom the role of ELSI was to generate knowledge and a community of specialists able to use it, with no formalized process of connection between the production of objective knowledge and that of policy-making[5].

The dynamics at play here is remarkably similar to that of the expertise of federal bodies for scientific and technical issues. As Sheila Jasanoff has argued, the production of scientific advice in the U.S. administrative circles has had to deal with concerns about the objectivity and neutrality of the expertise: the federal agencies that were the most explicit in separating the "policy" role from the "scientist" ones were those that faced destabilizations and accusations of producing an expertise that was over-politicized[6]. Such a tension was clearly at play in the case of the former Office of Technology Assessment (OTA), expected at the time of its inception in the 1970s to provide both "independent and "policy-relevant" advice. This eventually caused its elimination in a later period marked by severe cuts in the federal budget, as it proved unable to demonstrate the link between its expertise and law making, precisely because of the institutional construction of its neutrality[7].

Thus, the American expertise on the societal implications of science and technology is based on two dualisms. Not only are social norms and moral values to be separated from scientific facts in order to mobilize an ethical expertise independent of the question being examined (as seen in the case of the Nanoethics group), but the ethical expertise also needs to be separated from decision-making processes.

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[1] US Congress, House of Representatives, 1992, *Designing Genetic Information Policy: the Need for an Independent Policy Review of the Ethical, Legal, and Social Implications of the Human Genome Project*, Committee on Government Operations, US House of Representatives.

[2] One of the critics of the program became its head and turned the working group into an advisory commission (McCain, 2002).

[3] McCain, 2002: 132; US Congress, 1992, *Designing Genetic Information Policy. The need for an independent policy review of the ELSI of the Human Genome Project*, Committee on Government Operations, US House of Representatives.

[4] Evans, 2006

[5] Juengst, 1991; 1994; 1996.

[6] See Jasanoff, 1992; 1990. Chapter 4 provided other examples, related to the management of potential risks of nano substances and products.

[7] Bimber, 1993

Bioethics functions on both separations (whether under its "liberal" – cf. the members of the Nanoethics group - or "conservative" versions, as advocated by PCB). Khushf refused the first dichotomy and did not explore the second. Proponents of RTTA have been challenging the first dichotomy, in ways very similar to Khushf. In basing their reflections on a critique of HGP's ELSI program, they attempted to rethink the second through specific social scientific instruments.

The main critique that RTTA scholars addressed to the HGP ELSI program was indeed that it had "no policy relevance". For instance, Daniel Sarewitz and one of his colleagues from CNS wrote about the failure of the ELSI program to "link ELSI research to policy decision processes"[1]. The "no policy relevance" argument is debatable. At the very least, it is vigorously opposed by Eric Juengst[2]. Yet albeit its (probable) simplification, it was mobilized by CNS scholars as a useful counter example to make their objectives explicit. Rather than developing research projects that would analyze the societal implication of nanotechnology for the sake of it, they would develop a technology assessment that could be fed into nanotechnology policy-making. Thereby, they would pave the way for a new Office of Technology Assessment, which could avoid the fate of the first OTA thanks to the combination of "policy-relevance" and "quality research".

The way to do so was, for the proponents of RTTA, to refuse the fact/value dichotomy. Therefore, it could argue that it would intervene in the very making of nanotechnology objects, concerns, publics and futures, and thereby ensure the "relevance" of their approach. But they also needed to demonstrate the quality of RTTA research, and its ability to provide expertise for the making of science policy. This could be done by making CNS a (social) scientific demonstration. On a small-scale environment, researchers would experiment with RTTA, and eventually demonstrate that a new office of technology assessment based on RTTA would be viable. The space of the demonstration was then an isolated space, which could be, in some instances, an actual scientific laboratory, and, in others, a totally different locus. In any case, it was supposed to contribute to policy-making by demonstrating the value of RTTA on the scale of the social scientific experiment.

Several instruments were put in place in order to do so. I already described one of them in chapter 3. The *National Citizen Technology Forum*, a multi-site citizen conference organized in 2008 on the topic of converging technologies and human enhancement, was conceived as a demonstration of the value of the consensus conference format for the engagement of the American public in discussions about future technologies and as a social scientific instrument through which deliberation dynamics could be studied. I comment below on two other initiatives meant to operationalize RTTA: the

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[1] Bennett and Sarewitz used (Cook-Deegan, 1994). See also (Fisher, 2005) for a critique of the HGP ELSI program by a proponent of RTTA.

[2] Juengst, 1996

integration of social scientists in nanotechnology laboratories, and the making of scenarios about the potential developments of nanotechnology[1].

Embedding human and social scientists in the laboratory

Some of the CNS researchers have been involved in a project that intends to "embed" humanists and social scientists in a scientific laboratory. The project was based on the experience of a researcher, Erik Fisher, who had had an early experience as an "embedded humanist" at the Thermal and Nanotechnology Laboratory of the university of Colorado between 2003 and 2006[2]. There, Fisher participated in various laboratory projects, talking with scientists and asking questions about their practices. He was interested among others in a project consisting in carbon nanotube synthesis in silica tubes ("tubes in tubes"). Applications for this project were being explored at that time; people mentioned for instance industrial applications for heat transfer. Following this project, Fisher had repeated discussions with the person in charge of the available technical options. For instance, as the project leader was about to use the usual catalyst, Fisher asked whether another one would be possible. The following discussion led them to consider the possibility of an iron nanoparticle solution, which would be eventually both more efficient for the synthesis of nanotubes, and less risky in terms of its toxicological impacts. Thus, Fisher argued that the embedded humanist contributed to rendering visible for the scientists themselves the micro-decisions that are taken during the mundane course of research, and that the scientists' activity might be made "reflexive", in the sense that the everyday practices of scientific activity could be denaturalized thanks to the presence of the humanist, and potentially open to interrogation and reconfiguration. Eventually, Fisher expected the intervention of the humanist to transform the very outcomes of scientific process – a result of the "embeddedness" that the silica story was meant to be a demonstration of. The "embedded humanist" thus hoped to perform a "midstream modulation" of nanotechnology research[3]. Its "midstream" quality was defined as such:

Viewed this way, the midstream corresponds to the implementation stage of a large, distributed, and dynamic decision process. For simplicity, upstream decisions may be characterized as determining what research to authorize, midstream decisions as determining how to implement R&D agendas, and downstream decisions as determining whether to adopt developed technologies[4].

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[1] RTTA has fostered other initiatives. I describe here two of the most characteristic of an otherwise much more diverse program. See for an introduction (Barben et al., 2008).

[2] (Fisher, 2007). I have had repeated and fruitful discussions with Erik Fisher over the past few years, and participated in some meetings about his project. I thank him for his support, and for his openness to my external look at his project.

[3] See (Fisher and Mahajan, 2006b), for a general presentation of the midstream modulation project.

[4] Fischer et al., 2006: 490-91

Through the metaphor of the "stream", the embedded humanism initiative could be inscribed in the whole RTTA project alongside "upstream public engagement" (conducted through NCTF) and downstream "societal implications research"[1].

The work of the "embedded humanist" is meant to render nanotechnology problematic – i.e. as an entity of individual reflection for the scientist, and collective discussion with the humanist. As such, it is close to Khushf's approach, both descriptive and prescriptive. It also implies a transformation of roles: that of the humanist as well as that of the scientist. The former does not hold "values" or "principles" which he could mobilize to study the "implications" of scientific research. His own anthropological description contributes to the scientific project. The latter is led to denaturalize and question his everyday practices[2].

In 2009, Fisher received funding from NSF for a project devoted to "socio-technical integration research" (STIR). STIR, still ongoing at the time of writing, has taken the notion of embedded humanism to another scale. It coordinates about a dozen graduate students "embedded" in nanotechnology laboratories in ten different countries, who are asked to contribute to the project with "narratives of embeddedness", in which the "modulation" of scientific research can be made explicit, in the guise of Fisher's early experiments[3]. The number of embedded humanists is higher than Fisher's initial attempts, but the logic is the same: the objective is to describe and act on actual nanotechnology research practices in a selected number of laboratories, and ultimately to demonstrate the value of midstream modulation by gathering empirical cases where embedded human and social scientists transform research outcomes[4].

Scenario writing

Another instrument used at CNS has been scenario writing. Scenarios were conceived by the leaders of the scenario project at CNS as the basis of a work of collective reflection that aimed to explore what the future of nanotechnology could be, and make it a topic of pluralist deliberation. As Cynthia Selin, a member of CNS and leader of scenario projects put it,

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[1] Fisher et al., 2006: 493

[2] See (Fisher and Miller, 2009), for a presentation of this particular objective.

[3] I had the opportunity to participate in research meetings of the group of people involved in Fisher's embeddedness project.

[4] In his PhD work, François Thoreau is currently examining STIR as an experiment in social sciences, in which a stable protocol is put to test in a number of laboratories in order to demonstrate its value through the circulation of "stories of engagement" produced by "embedded human and social scientists". His work discusses the modalities of the "imperative of reflexivity" that such a project brings to bear on scientists.

the question that immediately arises from this mandate is: how to study and encourage deliberation of implications of something that has yet to occur? That is, nanotechnology is largely about potential and future deliverables, promising to be revolutionary. But given the inchoate form of it, there are no completely reliable and grounded ways to talk about implications. This situation poses challenges for the social scientists who have been summoned to go into the lab, talk to policy makers and engage the public about nanotechnology. They must confront the future.[1]

Scenarios were conceived as an answer to these challenges. They were developed and discussed through the *Nanofutures* project, in three phases[2]: writing, vetting, and deliberation. CNS members wrote the initial scenarios. They chose to focus on themes that had been discussed in the NNI works on the societal implications of nanotechnology, and that were present in the scientific, as well as in the science-fiction and popular literature[3]. The scenarios comprised the following examples:

- *"Living with a brain chip": a brain chip delivers information inside the brain during the sleep of the user.*
- *"Automated sewer surveillance": a sequence technology is used to analyze DNA fragments in used waters, thereby permitting a control of populations.*
- *"Disease detector": a device measures the protein rates and detects abnormal levels even before the appearance of illness symptoms.*

When I visited CNS for a few months in 2007, the project was just starting. Initial scenarios had been written and illustrated, so that they could be presented as comics. NSF reviewed the activity of the center during my stay at ASU: one of the issues the evaluation raised was that of the plausibility of the scenarios. As Selin explained to me at that time, the NSF reviewer "wanted to know that (the scenarios) did not come out of nowhere"[4]. Accordingly, she devoted much time and energy to solidify a process that could ensure the "plausibility" of the scenarios, and, therefore, the validity of the method she was developing. Scenarios, for her, were useful tools: she had to demonstrate both their quality and their usefulness for the participants in the projects she was leading, and for funders interested in the policy-relevance of RTTA.

The demonstration of the quality of the scenario could be ensured through vetting processes. The second phase of *Nanofutures* was entirely devoted to the review of the scenarios by ASU scientists

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[1] Selin, 2009
[2] (Selin, 2009). *Nanofutures* was also discussed by CNS researchers in (Barben et al., 2008).
[3] Ira Bennett, a member of CNS involved in the making of these scenarios, described the process and commented on an example in (Bennett, 2008).
[4] Unless otherwise specified, quotes in this paragraph are excerpts from my fieldwork notebook.

gathered in focus groups, and asked to contribute with keywords that could be used in a later bibliometric analysis. Scenarios were modified accordingly. For instance:

> *Many of the vetting sessions resulted in nominal changes to wording or slight changes in the technology. The scene about ultra fast sequencing technology used to analyze the DNA in harvested waste water was approved with a quick "yes, that is exactly how it would work" by a senior scientist and his lab. Another scene that describes a cranial chip with a data feed that puts information into the brain was modified from a single brain chip to a network of chips due to the lack of knowledge about where memory functions in the brain. In this case, uncertainty was figured into the technical description through the choice of a more robust technological pathway. One scene was removed from the project due to the vetting session.*[1]

The scenarios were then discussed in the third phase of the project (still ongoing at the time of writing). They were posted on the Internet for online commenting and discussed by the panel members of the National Citizens' Technology Forum on converging technologies (cf. chapter 3). They were sent to scientists, industry groups and NGOs representatives, who were asked to participate in online discussions. In another project led by Selin, collective discussion was part of the development of scenarios[2]. CNS members proposed an initial description of a nanotechnology-based products developed at the ASU Institute for Biodesign – a device able to measure biomarkers and thus able to provide personal analysis of health and potential illness, even before the apparition of symptoms. The potential use and development of this device were then discussed during a workshop by bioethicists, sociologists, political scientists, journalists, and physicists. Eventually four scenarios were produced, which proposed four different versions of the technology and its use through narratives involving the device (e.g. a young man uncertain about whether and how to use an illness tracking device that had supposedly become widely available at little cost).

In these projects, the scenario was conceived as a way not to accept the dichotomy between "reality" and "science-fiction" in order to make issues related to nanotechnology development explicit. The previous example, for instance, led participants in the workshop to interrogate the types of market and social relationships an illness tracking device might construct, should it become widespread. But for CNS members, scenarios were not only tools meant to stimulate a collective identification of the "societal implications" of nanotechnology. They were also expected to "intervene on futures". They had "the potential to reorient attention and modify action", as scientists and other participants reflected on the potential development of nano products. Reorientation and modification could only occur for the limited numbers of participants in the scenario projects organized at CNS. But RTTA scholars could

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[1] Selin, 2009

[2] Selin told me about this project in personal discussions. She presented it in (Selin, 2009).

then use these attempts to write papers, where, by interviewing participants and accounting for the gradual construction of scenario, they could demonstrate the value of scenario-making for the exploration of nanotechnology's societal implications and the modulation of participants' opinions and practices. In that sense, the mobilization of scenarios did not follow the approach undertaken by the nanoethicists, based on the correct representations of nanotechnology's facts. Neither did it operationalize a collective construction of nanotechnology programs. Here, the scenario was a basis for a collective reflection in the isolated setting of the social scientific laboratory, which could then demonstrate to academic colleagues and policy-makers the interest of scenario writing for the making of nanotechnology's responsible futures.

Expertise for American responsible futures of nanotechnology

The objectivity of the expertise on the societal implications of technology is an important issue in the U.S. discussions about the making of responsible futures of nanotechnology, and a long-term concern of the American science policy. To the concern about the objectivity of ethical advice is added the question of its "policy relevance", which renders problematic the link between the production of knowledge in ethics or social science and policy-making, and makes the distance to the object being examined by philosophers or social scientists a vivid issue. Bioethicists have managed to negotiate it, and nanoethicists have tried to replicate its modes of action and argumentation on nanotechnology. Their recognition as professionals cannot hide the fact that they have not been able to orientate the direction of federal nanotechnology programs, but have mainly reproduced its general objective of responsible development. The traditional opponents of these liberal ethicists, the conservative ethicists at the President's Council for Bioethics, were no more successful in intervening in nanotechnology, for the very same reason. Also based on values to be mobilized on stable technological objects, the human dignity approach was bound to wait for the nanotechnology objects to materialize. Isolated voices in the American debate are either those, like Dupuy, who based their critique on its exteriority to the whole metaphysical program of nanotechnology[1], or those, like Khushf, who want to abolish this exteriority altogether.

As they refuse the separation between risk and ethical issues, and question the link between (social) scientific expertise and public decision-making, Khushf's ethics and CNS' real-time technology assessment shift the discussion away from the opposition between liberal and conservative ethics. Both attempt to get rid of the distinction between "ethics" or "social science" and "science", between

[1] Dupuy's arguments echo those of the theologians in the 1970s and 1980s who criticized biotechnology with a "playing God" argument, and refused the liberal ethics that bioethics introduced (Evans, 2002).

"principles" and "research projects". CNS is the closest operationalization of Khushf's propositions, which remain a minority voice in the American ethics landscape. But in providing mechanisms for RTTA, it restores the boundary on which an expertise can be based: that of the scientific experiment. While sympathetic to the questioning of the fact/value dichotomy that RTTA proposes, and to the objective of "democratizing science"[1], Khushf has doubts about the value of the CNS experiment. He explained in an interview that he was "skeptical of the possibility to translate the small scale experiment into actual product making"[2]. The dichotomy that CNS is based upon – a necessary one to get heard and demonstrate the value of RTTA for American policy-makers – indeed contradicts Khushf's refusal of separations between science and ethics, between social science and research practices.

Going from the small scale and demarcated experiment to the visible results expected to enlighten policy-making requires that the promoters of the experiment perform demonstrations. Displaying the outcomes of CNS's experiment to funders is an important aspect of RTTA. In the same fashion as the proponents of "informal science education" who would go to Congress to make sure that their approach is included in the nanotechnology bills (cf. chapter 2), so the RTTA advocates organize meetings in front of the Congress' nanotechnology caucus, are attentive to presenting the results of their work to policy-makers, and display their experimental results in numerous professional nanotechnology conferences[3].

The expertise about the societal implications of nanotechnology in the American science policy landscape clearly echoes positions such as those of the Woodrow Wilson Center and more generally the basis of legitimate expertise in the American policy-making system (cf. chap. 4), in grounding its intervention on an exterior position able to ensure its objectivity. This objectivity can be based on the principles of bioethics, which nanotechnology rendered more complex to apply, thereby offering opportunities for other approaches based less on the representation of the future than on its actual construction - in the case of RTTA, in a laboratory setting. Turning to the European case, the next section will illustrate another approach, in which the concern for responsible futures of nanotechnology is integrated in the construction of nanotechnology policy programs. In this latter case, the constructionist approach extends to the entire European technological development program.

Shifting the analysis from the U.S. to Europe is not an arbitrary decision motivated by the sole hope to contrast different democratic constructions. It is necessary to account for the processes that made responsible nanotechnology a public issue. We saw that the European Constructive Technology Assessment influenced RTTA, and that the European controversies about GMOs were used as

[1] Guston, 2004
[2] Phone interview with G. Khushf (May 22, 2009).
[3] The example of Dave Guston, director of CNS, is telling. Over the past few years, I have seen him presenting the results of CNS research in numerous conferences and public events. At the time of writing, whether the experiment successfully demonstrates the feasibility of a new, RTTA based, office of technology assessment, remains to be seen. But so far, NSF has constantly renewed CNS grants since the center's inception.

arguments in the U.S. to target the publics of nanotechnology (cf. chapter 2). In turn, European ethicists and philosophers made the concerns for the responsible development of nanotechnology travel from the U.S. to Europe. Alfred Nordmann, one of the early initiators of research projects in the ethics of nanotechnology moved back to Europe in 2004 and authored a report for the European Commission, which was supposed to define the European approach to "responsible nanotechnology". At the same time, Jean-Pierre Dupuy was trying back in France to initiate a collective reflection about nanotechnology. He wrote a report for the French administration with Françoise Roure, who then became the head of the French delegations in international arenas discussing nanotechnology[1]. The next section starts from the early reflections about the construction of responsible nanotechnology in Europe, and then explores the instruments of the making of European "responsible nanotechnology programs".

[1] Dupuy and Roure, 2004

Section 2. European values for responsible nanotechnology futures

European responsible nanotechnology programs

European strategy for nanotechnology

While the U.S. was crafting a federal initiative for public support of nanotechnology research, the European institutions were launching initiatives in order not to be left behind (so the argument went). The 2004 Communication of the European Commission that presented the "European strategy for nanotechnology" made it clear that

> *one of the crucial differences between the EU and our main competitors is that the landscape of European R&D in nanotechnology risks becoming relatively fragmented with a disparate range of rapidly evolving programmes and funding sources.*[1]

In order to deal with fragmentation[2], "integration" was heralded as a key concept. The objective was to make the Union a "knowledge-based economy", as defined by the Lisbon strategy of 2000, and to use nanotechnology in order to shift "from a resource-intensive to a knowledge-intensive industry"[3]. Integration covered that of the European member states' national initiatives within the European research space, and that of the "societal dimension" at the core of nanotechnology policy.

This meant that particular areas of nanotechnology research were to be pushed forward, such as applications of nanotechnology for environmental (e.g. nanomaterials for water treatment, nanomaterials for construction allowing energy savings) and health (e.g. nanovector for drug delivery, nanoparticules as tracking devices inside the body) purposes[4]. The "integration" objectives, however,

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[1] Communication of the European Commission, 2004, "European strategy for nanotechnology": 8.

[2] The "fragmentation" argument was advanced by the person in charge of nanotechnology at the DG research (Hullmann, 2006a).

[3] The consequences of the Lisbonne strategy for the practice and governance of public research have been described by Isabelle Bruno, who analyzes management methods inspired by New Public Management as governmental technologies aiming to transform public researchers into "entrepreneur researchers" (Bruno, 2011). This section will show that the integration of the "ELSA" of nanotechnology into European science policy is not contradictory with the overall economic objective of European innovation policy described by Bruno, but that it is less an inescapable technology of power than a vehicle for the fragile stabilization of an original (and contested) political formation.

[4] "Decision No 1513/2002/EC of the European Parliament and of the Council of 27 June 2002 concerning the 6th framework programme of the European Community for research, technological development and demonstration activities, contributing to the creation of the European Research Area and to innovation (2002 to 2006)"; "Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the 7th Framework Programme (…) (2007-2013)".

meant more than targeting application sectors for nanotechnology research. It also involved the mobilization of science policy instruments expected to coordinate the work of the different member states, and making operational the "European values" and "European principles"[1] that were expected to be at the heart of the Lisbon strategy. This section describes several of the science policy instruments through which these European values and principles are supposed to bear on nanotechnology. Thereby, it analyzes the ways in which European actors attempt to make responsible nanotechnology futures. Although the concerns for the social and ethical issues of nanotechnology circulated from the US to Europe, they were differently dealt with within the European institutions than in the U.S.. It will appear that "European ethics" is an integrated component of the construction of a European moral space, based on "European principles" which are manufactured and operationalized in science policy instruments.

Speaking of a "European ethics" raises many problems. One of them relates to the modalities of the application of the subsidiarity principle, which, since the 1992 Maastricht Treaty, only devolves competences not falling into the exclusive competencies of the Union when the actions of the member states are insufficient to reach the desired objectives. Ethics is not an exclusive competency of the Union. But the task of implementing shared European values requires coordination at the Union level. How to ensure both the application of the subsidiarity principle and the enactment of the European values is a problem that is addressed by European officials in ways that I will describe through the description of the instruments meant to make European nanotechnology programs responsible. This will offer empirical illustrations of the contested application of the subsidiarity principle[2].

European ethics and its implications for the making of the European political space have sparked critical comments. MariaChiara Tallacchini, for instance, recently wrote that, because of European ethics…

Citizens are (…) disempowered twice: because ethics is conceived of as an expert knowledge and because it belongs to the governments of Member States. And in both cases, the alleged justification is that these mechanisms better represent European citizens.[3]

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[1] One could discuss the analytical differences of "principles" and "values". As they are used in almost interchangeable ways in the European institutions, I do not address this terminology issue.

[2] This means that this section differs from the discussions of the subsidiarity principle grounded in political philosophy (Van Kersbergen and Verbeek, 1994). The perspective adopted here is closer to the studies of the application of the subsidiarity principle in particular domains of policy-making (e.g. (Golub, 1996) about environmental law), although many of them are interested in deciphering how to apply the principle (by, for instance, asking whether or not the Union is an appropriate level of intervention for the domain at stake). The principle is for me an entry point in the study of the construction of the European political space, and not a guiding rule for the evaluation of European regulation.

[3] Tallacchinni, 2009: 294

I am much willing to follow Tallacchini in her interest for the democratic constructions that ethics enacts: at stake with ethics is indeed democratic order and citizen representation. But whether and in what ways "citizens are disempowered" in the case of nanotechnology remains to be seen. As I will describe, the making of responsible nanotechnology futures in European institutions constructs various (and controversial) channels of "empowerment", while the European expertise in ethics does not follow the organization of its American counterpart.

Responding to the American nanotechnology programs

As scholars moved from the U.S. to Europe and the NNI and NBIC reports caught the attention of E.U. officials, concerns for the responsible development of nanotechnology attracted interest in Europe. Thus, the *Converging Technologies for the European Knowledge Society* (CTEKS) report, to which Alfred Nordmann was a rapporteur and which was commissioned by the D.G. Research of the European Commission, was conceived as "a European response to the American NBIC program". Nordmann recalled the influence of a European civil servant at the D.G. Research:

One of the first readers of the NBIC report was Mike Rogers, at the time program officer at the Foresight Unit of the Directorate General Research of the European Commission. (…) Rogers suggests two ways in which the Commission ought to go beyond the U.S. report. The first way is to place a greater emphasis on the social sciences and humanities and take a more comprehensive approach to the cognitive sciences. The second way is to integrate this convergence within European values to allow for the acceptance of the emerging technologies.[1]

Being a former secretary of the European Group on Ethics in science and new technology (EGE), Mike Roger had been accustomed to working with "European values". More than that, the whole process of defining a European approach to converging technologies and nanotechnology can be read as attempts to define "European values" and integrate them in responsible science policy-making.

Hence, the perspective outlined in the CTEKS report proposed to develop converging technologies for "European values" such as solidarity, sustainable development and the mutual production of social expectations and technological development. This "integrated approach" made nanotechnology a case for the development of European democracy. As nanotechnology's objects were still to be crafted, and science policy programs to be defined, so the development of nanotechnology was an opportunity to "invite and empower" "European societies". Accordingly, the CTEKS report offered a skeptical account on converging technologies, and proposed no less than "a new social contract between science and society" supposed to answer a series of "challenges", such as the "development of local

[1] Nordman, 2009: 287, emphasis added

solutions that foster natural and cultural diversity", the "promotion of sustainable development, environmental awareness, precautionary approaches", and the "empowerment (of) citizens and consumers to understand, use and control CTs and to maintain a sense of ownership"[1]. This European take on converging technologies argued for the mutual construction of science and society, both as an empirical reality, and as an objective for the making of European science policy[2]. The report suggested the use of a series of instruments, including a "European design specifications for converging technologies", an international "code of good conduct", the mobilization of the European Group on Ethics, and "foresight tools" that included "vision assessment" and "deliberations about the visions that underpin the development of CT" [3].

The CTEKS report conceived the European nanotechnology policy as a "collective experiment" within the shared development of converging technologies. Thereby, the report linked the European nanotechnology policy to the more general approach to E.U. research policy, that of the Lisbon strategy, and that of the European Research Area, which was expected to be "deeply rooted in European society" and which

should experiment with new ways of involving society at large in the definition, implementation and evaluation of research agendas and of promoting responsible scientific and technological progress, within a framework of common basic ethical principles and on the basis of agreed practices that can inspire the rest of the world.[4]

Hence, the early formulations of the European nanotechnology policy introduced values and principles that would have to be integrated in the making of nanotechnology policy. The *Action Plan* that defined the main directions of the European nanotechnology policy followed up on this approach. It echoed some of the recommendations of the CTEKS report in calling the EGE to "carry out an ethical analysis of nanomedicine", which was expected to "identify the primary ethical concerns and enable future ethical reviews of proposed N&N"[5]. The *Action Plan* suggested to "embodying common shared principles for R&D in nanotechnology in a voluntary framework (for example, a "code of good

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[1] Nordman, 2004: 54
[2] (Nordman, 2009). The approach was explicitly based on Science and Technology Studies (STS), as Nordman restated during an interview (Washington, November 2009). In the CTEKS report and in Nordman's other publications, numerous references were made to the *Taking European Knowledge Society Seriously* report (Felt and Wynne, 2007), written for the D.G. Research by a group of STS scholars.
[3] Nordman, 2004: recommendation 9
[4] European Commission, 2007, *The European Research Area: New Perspectives. Inventing our future together*, Green Paper, COM(2007)161: 10.
[5] European Commission, Research DG, *An action Plan for Europe* (2005-2010): 9

conduct")"[1]. The later (6th and 7th) Framework Programmes proposed to operationalize these principles in defining goals such as "the environment as a whole: energy efficiency and sustainable energy production and the emergence of sustainable products", and "applications in the health-care field and development of nano-analytical tools"[2].

Thus, the making of European programs for nanotechnology was expected to be based on European values and principles that would define scientific practices in the laboratory, research objectives, and management methods for public concerns. They associated economic ("competitiveness"), social ("solidarity"), environmental ("sustainability"), and ethical ("self-fulfilling") objectives. The remainder of this section focuses on sites where the European values and their operationalization in nanotechnology policy instruments were discussed, thereby enacting the "responsibility" of nanotechnology research and development. As I will argue, the boundary between "general" principles and "substantive" policy-making is central in these processes: the operationalization of the subsidiarity principle relies on the stability of this boundary.

European principles for the operationalization of the subsidiarity principle

European principles for a European expertise in ethics

Following the suggestions of the CTEKS report and of the Action Plan, the European Commission asked the European Group on Ethics (EGE) to work on nanomedicine in 2007. Founded in 1997, the EGE had released about twenty opinions before being asked to work on nanomedicine. It defined nanomedicine as such:

The field of 'Nanomedicine' is the science and technology of diagnosing, treating and preventing disease and traumatic injury, of relieving pain, and of preserving and improving human health, using molecular tools and molecular knowledge of the human body.[3]

Defining 'nanomedicine' proved to be a major issue for the members of the working group, who had been used to dealing with well-defined issues, and not a "global, enabling technology"[1] that gathered

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[1] European Commission, 2004, *Communication. Toward a European strategy for nanotechnology*, COM/2004/0338: art 5. The suggestion of a code of conduct was intended in the Action Plan as a tool for international collaboration ("to bring the EU together with countries that are active in nanotechnology research and share the commitment to its responsible development").

[2] European Commission, FP7 Cooperation Work Program 2010. Theme 4: Nanosciences, Nanotechnologies, Materials and New Production Technologies, European Commission C(2009) 5893 of 29 July 2009: 8

[3] EGE opinion on medicine: 53.

not only brain implants, drug delivery devices, and imaging devices based on nanoparticles programs, but also roadmaps, allocations of funding, expectations of future development, and concerns about potential risks. Therefore, the EGE considered a wide range of "ethical" issues of nanotechnology - from safety to informed consent, questions of justice and matters of regulation adaptation – which were related to "nanomedicine" in that they referred to applications of nanotechnology in the health sector. Eventually, EGE did not differentiate "risks" from "ethics". Rather, "ethics" covered the topics that could be labeled as a "public problem" of nanotechnology[2].

At the EGE, the discussion revolved around the "principles" according to which nanotechnology programs were supposed to be crafted. They were linked to the legal "ethical framework" (as defined in the Oviedo convention[3], and the European Charter of Fundamental Rights) and the "European values" that the member states were to consider. When mobilizing European principles, the EGE adopted a perspective outlined in a document it had released in 2000, and which presented a "European approach to ethics"[4]. The 2000 report, written as the committee had been compelled to make its positions clear regarding European funding for stem cell research, had defined principles that should be applied in European ethics. Some of them were inherited from bioethics[5]. The others were "human dignity", "individual freedom", "principle of solidarity", "freedom of research", and "principle of proportionality"[6]. Among them, "safety", "responsibility" and "transparency" were deemed "Europe specific".

In a context where ethics does not fall into the competences of the European Commission, these principles allows the committee (and through it, the Commission) not to interfere in the prerogatives of the member states, while defining common values. As such, mobilizing principles is a means to operationalize the subsidiarity principle. In the nanomedicine opinion, "pluralism" was indeed considered as one of the "characteristics of the European society", which was

> *mirroring the richness of its traditions and adding the need for mutual respect and tolerance. Respect for different philosophical, moral or legal approaches and for diverse cultures is implicit in the ethical dimension of building a democratic Europe. This is relevant also for the moral controversies prompted by nanomedicine.*[7]

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[1] Phone interview with Anne Cambon-Thomsen, member of the EGE, April 21, 2010.

[2] In the final opinion, concerns were sorted in different but "interrelated" categories ("safety", "bioethical questions", and "social ethics").

[3] The Oviedo convention defined in 1997 general principles for bioethics research.

[4] European Group on Ethics, 2000, *General report on the activities of the European Group on Ethics in Science and New Technologies to the European Commission, 1998-2000*, Brussels, EGE

[5] cf. section 1 of this chapter: informed consent, beneficience and non maleficience, justice, autonomy.

[6] EGE, 2000: 11

[7] Nanomedicine Opinion: 44

For all its apparent political correctness, such unspecific language has important consequences. The "respect for diverse cultures" implies that the construction of a "democratic Europe" cannot be based on the solidification of rules that would contradict member states' "philosophical, moral or legal approaches". This is a variation on the subsidiarity principle, which uses "principles" as a basis to build a common European space while letting member states define their own regulatory approaches to ethics issues. Hence, the "plurality" argument conveys the impossibility for the ethical European principles to constrain member states (for instance by banning products or topics of research).

The boundary between "principles" and "national sovereign decisions" is not always easy to maintain, and nanotechnology proved a difficult case. Thus, the operationalization of the "safety" principle meant for the EGE that some products could be prevented from entering the European market. For instance, the "safety" principle opened the possibility for the adaptation of existing regulation, particularly for cosmetic products[1]. Human enhancement was another topic for which the concern for "pluralism" did not prevent the EGE from adopting the language of the ban. The nanomedicine opinion concluded that the projects devoted to transhumanism funding were not to be given priority over others, and that, at any rate, the distinction between "medical and non-medical use" should be made clearer by European research in ethics[2]. Hence, the concern for the European general values and the importance of the subsidiarity principle did not translate in an expertise that would have tried, as the Nanoethics Group did (see the previous section), to balance the pros and cons, and maintain an objective position overlooking the discussions where stakes were opposed. Rather, EGE was led to define domains of technological activity that it considered outside the scope of the European values.

As the boundary between the principles supposes to leave decisions to the member states and the content of the issue at stake is not clearly drawn, the approach of the EGE is much more dynamic than that of American bioethics, for which the four basic principles are independent of the question being examined – a condition, as seen above, for its construction as an objective expert knowledge. European ethics is indeed based on principles, general enough not to hint at constraining regulation, but it also paves the way for an ontological work necessary if one is to ban certain areas of research (e.g. human enhancement) or regulate certain objects (e.g. nano substances). This is important since the EGE is directly involved in the making of research policy instruments. Since the renewal of its mandate in

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[1] Nanomedicine opinion: 55

[2] The opinion proposed to create a European network on ethics (nanomedicine opinion: 62). When considering human enhancement, the EGE referred to a previous opinion it had released on ICT implants, in which it proposed that the "enhancement of physical and mental capabilities" (a topic which is central in discussions about nanotechnology) should be limited to a few well-defined cases, such as the "improvement of health prospects", for instance to "enhance the immune system to be resistant to HIV", and banned a few objectives, including "changing the identity, memory, self-perception and perception of others", or "coercion towards others who do not use such a device" (ICT implants opinion: 33-34).

2005[1], the EGE has been closely linked to the European Commission. The Bureau of European Policy Advisers is in charge of the organization of the work of the EGE and its secretariat[2], the head of which is widely known as "attentive to follow-up on how the opinions are taken into account"[3]. EGE is asked by the European legislation to "establish close links with the Commission departments involved in the topic the Group is working on"[4]. The regulation defining the 7th Framework Program stated that the "opinions of the European Group on Ethics in Science and New Technologies are and will be taken into account"[5]. Hence, EGE opinions are expected to be translated into the European research policy instruments[6]. For that matter, nanotechnology was yet another issue on which the European ethics needed to define both the European principles and how they should be applied – that is, how the boundary between the principles and the content of the issue at stake was to be drawn.

The remainder of the section will focus on the intervention of other European institutions. At this stage, the case of the EGE warns us against two simplistic understandings of European ethics. The first is a critical account that blames European ethics for getting into substantive questions while it should stick to "general principles" in order to follow the subsidiarity principle[7]. It contends that the EGE is not "genuinely independent" of the Commission[8] and thus pushes for tacit regulation by advocating for the ban of new technologies. It then argues that the EGE should rely on general principles that allow the market to adequately function (e.g. "transparency"), without attempting to exercise "normative power" (which would fall outside the scope of its competences). The second, equally critical albeit in a symmetrical way, directly opposes the alleged shallow and general approach that European ethics would pursue, and which would ultimately solidify a logic of technology development based on market rules. By sticking too much to the definition of general "European principles", the EGE would take too small a part in the discussion about "ends", and refuse constraining regulatory evolutions[9].

The EGE opinion on nanomedicine can arguably be subjected to the two criticisms. It opens the path for normative constraints at the European level (e.g. limiting the funding for human enhancement

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[1] Commission Decision of 11 May 2005 on the renewal of the mandate of the European Group on Ethics in Science and New Technologies (2005/383/EC), OJ L127/17
[2] Commission Decision, 11 May 2005, art 4(2)
[3] Phone interview with Anne Cambon-Thomsen, member of the EGE, April 21, 2010.
[4] Commission Decision, 11 May 2005,art 4(2)
[5] Regulation (EC) No 1906/2006 of the European Parliament and of the Council of 18 December 2006 laying down the rules for the participation of research centres and universities in actions under the Seventh Framework Programme and for the dissemination of research results (2007-2013), Article 30.
[6] In previous cases, the requirements of the EGE were included, after negotiations with the Commission to ensure that the principle of subsidiarity was applied. For instance, the 5th Framework Program banned research on embryonic stem cell research, for cells produced within the E.U. (Jasanoff, 2005b).
[7] Plomer, 2008
[8] Plomer, 2008: 846
[9] Talacchinni, 2006; 2009

research, regulating nano substances) without defining explicitly new regulations[1]. Yet the two critical positions fail to account for the specificity of the work of the EGE, as part of the European moral system, where principles and the boundaries between them and the contents of the issues at stake are permanently worked upon, and where crafting nanotechnology policy defines the European principles. Accordingly, the questions raised by EGE in the making of the European responsible futures for nanotechnology were to be re-explored, throughout the use of other science policy instruments.

<u>Operationalizing the European principles at the D.G. Research: a "code of conduct" for nanotechnology</u>

Other bodies of the Commission are in charge of ethics – mostly the "governance and ethics" unit of the DG Research's Science, Economy and Society directorate - and were involved in the operationalization of European principles within nanotechnology policy. One of the instruments to do so was a "Code of Conduct" (CoC), which was proposed in the *Action Plan* as a device meant to ensure the responsible development of nanotechnology. An official at the Governance and Ethics unit of the DG Research and promoter of the CoC explained that such a code would be an instrument to "apply the precautionary principle" "against the backdrop of a set of basic and widely shared principles of governance and ethics"[2]. The governance and ethics unit saw the CoC as an instrument that could "achieve Governance goals whereas legislation c(ould) not"[3].

The writing of the CoC followed a process through which comments were requested about a "consultation document", in order for the CoC to reflect the expectations of the "interested stakeholders"[4]. The consultation paper was based on a series of "core European principles". "Precaution", "inclusiveness" and "integrity" were mentioned, and complemented by "better and constant vigilance", "realizing societal benefits" through "societal debate", "credibility and trust" through "open and transparent public dialogue", and "protection of fundamental rights". The consultation paper mostly proposed that the CoC should ask its compliers to follow these principles, and raised the following questions:

- *The Code of Conduct will bring added-value in the EU nano landscape. Do you agree with this statement?*

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[1] This is precisely what the Commission took out of the EGE opinion. See for instance in the "Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee regulatory aspects of nanomaterials" (SEC(2008) 2036. I will come back to this position, and its opposition with that of the European Parliament.

[2] von Schomberg, 2009: 5

[3] The later intervention of the European Parliament in cosmetic and novel food European legislation would prove him wrong (see below).

[4] (von Schomberg, 2009). The process is common within the European institutions, as a member of the Governance and Ethics unit explained in an email correspondance (see European Commission, 2001, *European Governance. A white paper*, Brussels, COM(2001) 428).

- *Do you think that the proposed scope of the Code of Conduct is sufficient?*
- *Do you think that the set of principles suggested in the consultation paper is sufficient to ensure a safe and sound nanosciences and nanotechnologies development in Europe? Would you suggest different principles?*
- *Do you believe that there are fields of nanosciences and nanotechnologies where research should not be conducted?*
- *How do you suggest sustaining interest once the Code of Conduct is adopted? What could be the follow-up?*
- *Would you/your company/organisation be willing to follow the Code of Conduct?*[1]

Thus, the consultation process was an opportunity to negotiate again what the European principles should be, how they should play out on nanotechnology issues, and how they should translate in the definition of acceptable domains of European research. Participants in the consultation were self-selected, according to an on-line consultation process. They reacted to the proposed code with interest, but appeared divided about the principles[2]. Actors coming from industry tended to ask for more principles to be included, to the extent that some of them suggested that the future code should be applied to every technological domain. For instance, one of the commentators stated that

Principles could be expanded to Sustainable Development, Transparency, Openness, Security, Safety, Quality of Science, Responsibility, and Anticipation.[3]

In the industrialists' perspective, adding general principles was a way not to get into the specificity of nanotechnology. This would have been the domain of European regulation. Rather, the role of the CoC (and, more generally, of European ethics) was for them to define general, European-wide principles, broad enough so that various types of national regulatory frameworks (e.g. granting legal existence to nanomaterials, in one way or another, or not) would fit in.

Commentators from NGOs adopted an opposite perspective. While subscribing to the principles suggested by the consultation document and proposing others (such as "responsibility" and "meaning", which were eventually included in the code), they were concerned about the existence of nanotechnology in European regulation. They considered that the CoC should "consider nanoproducts as new products", and that "existing regulation should be revised and specific new ones created"[4]. For the NGOs, nanotechnology objects were to be made existing in regulation, and boundaries were to be established between technical domains considered as acceptable, and those – like "military research",

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[1] Towards a European code of conduct for nanoscience and nanotechnology, consultation document: 6
[2] European Commission, 2008, *Analysis of the consultation results*
[3] *Ibid*: 2
[4] *Ibid*: 3

"enhancement", "nano food and feed"[1] – that were not. For them, the role of the European institutions was to define new entities in legal terms. In this perspective, the CoC could be a vehicle to craft definitions for nanotechnology entities, and introduce restrictions targeted to them (e.g. funding restrictions for human enhancement project, or containment conditions for the manipulation of nano substances).

Thus, the discussions about the making of the code led commentators either to advocate for principles independent of nanotechnology, or to call for actions specifically targeted to nanotechnology objects and domains. At stake here was the same issue EGE had to cope with: using European principles implied the negotiation of the boundary between universal European values and the specificity of the issue being discussed. Eventually, the code mixed "principles" with "substantive" statements. The code used seven "principles": "meaning", "sustainability", "precaution", "inclusiveness", "excellence", "innovation", "accountability". It introduced "prohibition, restrictions or limitations":

> *4.1.15 N&N* (Nanoscience & Nanotechnology) *research funding bodies should not fund research in areas which could involve the violation of fundamental rights or fundamental ethical principles, at either the research or development stages (e.g. artificial viruses with pathogenic potentials).*
>
> *4.1.16 N&N research organisations should not undertake research aiming for non-therapeutic enhancement of human beings leading to addiction or solely for the illicit enhancement of the performance of the human body.*
>
> *4.1.17 As long as risk assessment studies on long-term safety is not available, research involving deliberate intrusion of nano-objects into the human body, their inclusion in food (especially in food for babies), feed, toys, cosmetics and other products that may lead to exposure to humans and the environment, should be avoided.*[2]

Like the opinion of the EGE, the code attempted to negotiate "principles" – including the subsidiarity principle – and the content of the nanotechnology issue[3]. A laboratory following the CoC would not only apply the principle of "inclusiveness" and "accountability" by communicating about its research, it would also refuse to undertake "deliberate intrusion of nano-objects into the human body", and would not develop brain implants or nanodevices for drug delivery if meant to propose "non-therapeutic human enhancement (…) leading to addiction or solely for the illicit enhancement of the performance of the human body".

The CoC could not rely on a stable infrastructure that could have defined "nano-objects" in an unambiguous manner (see chapter 4). Similarly, the boundaries between "licit" and "illicit"

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[1] *Ibid.*: 4-5

[2] European Code of Conduct: 9

[3] This is a difference with the other few attempts at crafting "codes" for nanotechnology research. For instance, a British think tank, the "responsible nanoforum", produced a "responsible nanocode", aimed to be "principles-based code", these principles being those of responsible innovation ("transparency", or "dialogue"), and therefore consensual, and already included in nanotechnology policy. See the discussion in (Laurent, 2010a: 217-218).

enhancement were not clarified. The unspecific language of the CoC was criticized by some commentators, who were skeptical about the practical significance of the prohibitions advanced by the CoC[1]. Yet the Code also negotiated the application of the European principles to nanotechnology by allowing the subsidiarity principle to take place. It delegated to project coordinators and scientists the reflection on both the appropriate domains of research in nanotechnology, and the practical details of research practice, without introducing mandatory actions or constraining requirements[2].

The CoC eventually became one of the main components of the European approach to the ethics of nanotechnology, regularly presented by DG Research officials such as René von Schomberg, as the most visible attempt to define a "European approach to ethics", which would both "promote dialogue" while "not imposing some forms of ethics rather than others"[3]. As repeatedly advocated by its promoters at the governance and ethics unit, the CoC was expected to be used

as an instrument to encourage dialogue at all governance levels among policy makers, researchers, industry, ethics committees, civil society organisations and society at large with a view to increasing understanding and involvement by the general public in the development of new technologies.[4]

For a part, "encouraging dialogue" was the product of the very process that produced the code[5]. The code was also expected to be taken up at a wider level. Together with the Council, the European Commission recommended that member states

be guided by the general principles and guidelines for actions to be taken, set out in the Code of Conduct for Responsible Nanosciences and Nanotechnologies Research (..), as they formulate, adopt and implement their strategies for developing sustainable nanosciences and nanotechnologies (…) research. [6]

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[1] e.g. Donald Bruce's presentations at a workshop organized in May 2008 in Brussels by the DG Research about the code of conduct.

[2] Commenting on the European CoC, famous nanotechnologist Richard Jones wrote that "there's a danger that codes of ethics focus too much on the individual scientist" (Jones, 2009). Commentators in the first revision process also had issue with the accountability principle. Thus, the president of ISO TC229 suggested to "*replacing 'accountability' by 'responsibility': 'researchers should take into due regard as far as possible the social, environmental and human health impacts that their N&N research may impose on present and future generation.* " (*Analysis of results from the Public Consultation*: 15).

[3] These are René von Schomberg's words during an academic conference (Darmstadt, September 28, 2010, quotes from my fieldwork notebook). In the 2008-2010 period of time, I heard von Schomberg at least five times in academic conferences or European Commission public events, advocating the code as a central instrument in the making of the European nanotechnology policy.

[4] "Commission recommendation on a code of conduct for responsible nanosciences and nanotechnologies research & Council conclusions on Responsible nanosciences and nanotechnologies research 2009": 11-12

[5] It was followed by regular revisions, again based on stakeholders' comments.

[6] "Commission recommendation on a code of conduct for responsible nanosciences and nanotechnologies research & Council conclusions on responsible nanosciences and nanotechnologies research 2009": 3

Hence, the CoC was mobilized in the construction of a shared European space, in which scientists, industrialists and NGOs were expected to participate in discussions about nanotechnology development. At the European level, the CoC, as the EGE's opinions, was connected to the conduct of European research projects. The next sub-section focuses on the production of responsible nanotechnology in these project.

European research projects for responsible nanotechnology

Managing responsible European research projects in nanotechnology

Projects requiring European funding have to pass an "ethics review", which, since the FP5, is a vehicle meant to introduce constraints on the European research project. For instance, the ban on human embryonic stem cell research in FP6 (recommended by the EGE) was enforced through the ethics review process. While no coordinator has seen his or her project rejected because of the ethics review, some of them are asked to provide more detailed examinations of the ethical issues raised by their research, and to eventually adapt their methods and objectives[1]. Ethics review are performed by expert panels, and coordinated by officials at the "governance and ethics" unit at the D.G. Research. They are based on the legal European requirements (e.g. directive on data protection, clinical trials, or animal rights), general principles as defined in texts such as the Oviedo convention, and national legislations.

According to members of the governance and ethics unit, the system of the ethics review could easily accommodate nanotechnology. Members of the ethics review team would "treat nanotechnology like any other technologies"[2], which means that they could operationalize the subsidiarity principle at the level of nanotechnology research projects. This does not mean that they could apply the same rules they had used before for other technological domains. Indeed, a member of the ethics review described some of the specificities of nanotechnology as such:

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[1] The guide for applicants to the Framework Program thus asks:
"Does your proposed work raise ethics issues? Clearly indicate any potential ethical, safety or regulatory aspects of the proposed research and the way these will be dealt with prior and during the implementation of the proposed project. A preliminary ethics control will take place during the scientific evaluation and, if needed, an ethics screening and/or review will take place for those proposals raising ethics issues. Proposals may be rejected on ethical grounds if such issues are not dealt with satisfactorily." (FP guidelines, 2008: 15)
According to an interviewee, the rules are more constraining than in France (Phone interview with Anne Cambon-Thomsen).
[2] Phone interview with Dorian Karatzas, head of the Ethics Review sector, April 22, 2009

The difference is that the types of instruments – machines but also research protocols, the methodology that is designed – are different than other types of research. For instance, the size of the particles, the setting of the laboratory where the research might be done, the dual use of the applications.[1]

In the absence of regulation and considering the permanent concern for the subsidiarity principle, dealing with these specificities implies that the ethical review process may mostly make suggestions to project investigators, according to the advice of the members of the expert panels. For instance, all project leaders are advised to use the code of conduct, while some of them already mention it in the ethics annex of the project proposal. In addition, project leaders might use the opinions of the national ethics commission. If the project satisfies national ethical requirements, it "has good chance to pass the ethical review"[2]. Problems may then arise in cases where issues not dealt with by national committees are identified by the expert panels. This is precisely the case with nanotechnology, as a member of the governance and ethics unit (M) explains:

M: *If there is another concern, the experts are telling us. Because of the uncertainty surrounding, for instance, the use of nanomaterials. What is the effect on the scientists themselves? Is there stricter safety regulation needed, at the level of the lab? There, we rely on the safety regulation that exists in member states.*

BL: *But in the case of nanomaterials, there is no specific regulation?*

M: *Right, to the best of my knowledge, there is none. So they refer to the general rules for safety and, hem, common sense. They refer to the precautionary approach. They suggest appropriate safety procedures, like the limitation of exposure.*[3]

Thus, the case of nanomaterials illustrates how the principle of subsidiarity is operationalized at the level of the ethical review process. When no European or national legislation exists, but experts nonetheless identify a concern as regards European principles (e.g. "safety" or "transparency"), then the ethical review process leads researchers to adopt concrete actions (in the example considered here "safety procedures" and "limitation of exposure"). In this process, the EGE opinion and the CoC point, for both reviewers and applicants, to domains for which specific actions are needed (e.g. nanomaterials and the need for protective measures, brain implants and the need for informed consent). Thus, ethics reviews participate in the construction of the European nanotechnology research area. They make it clear that the European principles are indeed shared at the level of research projects, without pushing

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[1] *Ibid.*

[2] *Ibid.* The problem of "committee shopping" that follows from this commission has been identified by the EC and some commentators (Tschudin, 2001). This is indeed part of the fractured construction of a European moral space (see below).

[3] Phone interview with Dorian Karatzas, head of sector Ethics Review, April 22, 2009

for more stringent regulation. In doing so, they are tools to advance the "integrated" character of nanotechnology policy.

But some aspects of nanotechnology proved more complex to advise the project leaders on. In some cases, experts from the ethics review panels would point to the potential implications of nanotechnology, or research leaders themselves would raise issues about the potential implications of their work, when dealing, for instance, with brain implants offering potential control of the individual, or safety risks impossible to evaluate in a case of uncertainty about the characteristics of nano substances (cf. chapter 4). The "ethics and governance" unit introduced a new institutional approach to deal with such uncertain cases, which intended to "complement the ethical analysis" by requiring the set up of an "ethics board" within the project being funded[1]. The ethics board is expected to "discuss at every step of the project with the scientists" and "produce contributions as part of the annual or periodic reporting of the project". In these exploratory cases, rather than rely on "philosopher using abstract principles", ethics in the European projects is meant to be an opportunity to "produce knowledge", that is, knowledge about the "ethical implications" of the technology being developed, and, eventually, about the "principles that should guide further European research".

The ethics board is more and more a "contractual obligation" in situations where the existence of objects (nano substances and objects) is controversial. It is often associated with "special training courses to take place for especially young researchers coming in". Again, the device is meant to deal with a situation where "abstract principles" are not enough. For example, *Nano2Life*, the European network devoted to nanobiotechnology research funded as part of FP6 (cf. chapter 1), comprised an ethics board, which was composed of eight members, scientists, philosophers, social scientists, and religious leaders. According to one of its members, *Nano2Life*'s ethics board "provided a European ethical 'think tank' for research in biology at the nanoscale"[2], while the coordinator of *Nano2life*, a French physician at CEA, considered that it was "the only place where knowledge about the ethics' part of nanotechnology research could be seriously dealt with"[3]. The objectives of the board comprised the "evaluation of general and prospective ethical and social questions raised by nanobiotech Research & Development projects", the "monitoring of projects initiated by the network", the information of researchers and students about ethical issues, and the "dialogue with the public to identify ethical concerns of the European citizens". For instance nano brain implants were examined within *Nano2Life* as part of an evaluation of "human enhancement technology". Examining the "ethical, legal and social aspects of Brain-Implants using nanoscale materials and techniques", the members of *Nano2Life* ethics board re-mobilized bioethics reasoning, in advocating for informed consent, and pushing for the limitation of

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[1] Phone interview with Dorian Karatzas, head of sector Ethics Review, April 22, 2009. All quotes in this paragraph are excerpts from this interview.
[2] Bruce, 2006
[3] Interview with Patrick Boisseaux, coordinator of Nano2Life (Grenoble, January 2007)

safety risks. In doing so, their propositions were the same as those of the American nanoethicists (see the previous section). But they also interrogated the meaning of these principles when applied to nanotechnology. For instance, they questioned the meaning of informed consent in the case of brain implants, where the technology might transform the will of individuals. Contrary to their American colleagues, they made explicit the issues that the principle of safety faced, as the identity of the nano substances and products was uncertain, as was the boundary between "accepted" and "non accepted enhancement".

The main outcome of the ethics board is to advocate for more research, more examination, and more ethical analysis. But rather than an ethical argumentation based on a set of stable principles independent of the issue on which they are applied, the ethics proposed by *Nano2Life* pushed for the "integration of ethics" in the conduct of project. Such integration had various aspects. First, it implied the continuous transformation of research projects into ethical issues through the publications of papers and reports such as those the *Nano2Life* ethics board produced, and, consequently, continuous discussions about the European principles. Second, the integration also implied that the European scientists were trained to identify the ethical issues. This had a very practical dimension for scientists, through the mechanism of the ethical review process, which could be used as a tool to check whether scientists would use the code of conduct, acknowledge the EGE opinion, implement safety measures in laboratories, and define the long-term objectives of their project in terms that would be consistent with European principles. Hence, a research project ambitioning to develop the "non therapeutic enhancement of people" (e.g. brain implants meant to stimulate the cognitive capacities) would have no chance to pass the ethical review process as such. It would have to add an ethics board in order to "monitor the project", raise ethical issues as they arise, and organize training in ethics for scientists.

Whether the material "brain implants" developed in the projects would be different because of the integrated European ethics is then another question. The "early identification of issues" that the ethics board device is expected to ensure is explicitly connected to the "flexibility" it offers: rather than solidifying constraining choices in regulatory texts (which would, for instance, ban certain types of brain implants, or require additional risk assessment procedures for nano substances), the integration of ethics in research projects is a way to "explore", "dialogue", "identify long-term issues" without introducing mandatory requirements. As members of *Nano2Life* ethics board explain:

Researchers working with these new technologies have the obligation to thoroughly consider such issues and consequences before they start and while they carry out their projects. To discuss possible ethical implications with ELSA experts early on in a project may relieve the pressure for regulatory bodies to be proactive in response to the high speed of the development, because normally regulations are based on long-term learning and experience. (…) This *will help to prevent ethically, socially and legally non-acceptable developments for the benefits of patients – and also the success of the European health economy.*[1]

In a context where "regulations are not the only answer" and where "too much regulation can even be ethically unacceptable, because it might make research too expensive"[2], the integration of ethical thinking in research projects can thus appear as a way not to introduce legal requirements, not to create new entities subject to stricter regulatory control, or ban from the European research area (as "brain implants" or "drug delivery devices" might be), but to make sure minimal safety measures are taken, information is provided to patients, scientists are trained in ethics, and dialogues are undertaken with the general public. In so doing, the integration of ethics in research projects can operationalize European principles without hindering scientific development, and thereby solidify the "integrated European research space" for yet another technological domain without enlarging the set of regulatory texts.

<u>*Integrating (lay) ethics in European nanotechnology policy*</u>

The *Nano2Life* ethics board was but one (early) component of the integration of ethics in nanotechnology research. Many of the members of the *Nano2Life* ethics board were later involved in other projects, such as *Nanobio Raise*, which "aimed to combine science communication with ethics research in nanobiotechnology"[3]. Contrary to *Nano2Life*, *Nanobio Raise* was not a project in physics and biology, but a social scientific one, part of the many ELSA (Ethical Legal and Social Aspects) projects in nanotechnology funded by the 6th Framework Program. As *Nano2Life*'s ethics board, *Nanobio Raise* was expected to "clarify the ethical issues and public concerns"[4] regarding nanotechnology, and ensure the integration of ethics in nanotechnology research. Part of the integration objective was to be conducted through training classes meant to ensure "dialogue" between scientists and "nanoethicists". Thus, the project manager of *Nanobio Raise* organized "intensive courses" meant to

provide the participants with knowledge of the relevant ethical, legal and social aspects of nanotechnology; skills to communicate effectively with interlocutors outside the peer community including the media and lay audiences; and a broad understanding of 'horizontal' issues involved in public awareness and perceptions of nanobiotechnology[5].

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[1] Berger and al., 2008: 248
[2] Berger and al., 2008: 248
[3] Schuurbiers, 2010: 98
[4] Bennett and Schuurbiers, 2005: 766
[5] Schuurbiers et al., 2009: 201

For example, participants would be told about the range of nanotechnology applications, the potential safety issues of nanoparticles, the long-term question of transhumanism, or the results of the few nanotechnology-focused risk perception studies. These courses were not meant to be mere lectures during which scientists would have been taught by ethicists knowledgeable about nanotechnology "implications". Rather, they were components of an undertaking expected to ensure "improved nanoethical deliberation" tied to actual laboratory practices[1].

Insisting on the "dialogue" between nanoscientists and nanoethicists, and advocating for the integration of ethics at the heart of scientific research echoed the "embedded humanism" approach that the anti-bioethics American ethicists advocated. The coordinator of *Nanobio Raise* was also conducting fieldwork in a Dutch laboratory as part of Erik Fisher's embedded humanism project, and the only U.S. ethicists who participated in the *Nano2Life* workshops devoted to the examination of nanobiotechnology's ethical issues was G. Khushf. But the multiple connections between the American and European integrated ethics should not hide their dissimilarities. As detailed in the previous section, the American integrated ethics of nanotechnology had to ensure the objectivity of its position by constructing a social scientific, small scale experiment through which it was possible to demonstrate the validity of "real-time technology assessment" and which attempted to intervene in the construction of material objects (cf. the "safety by design approach"). In Europe, the integration was not meant to separate the expert work of social science from that of policy-making. Neither was it directed to the construction of material objects. Rather, ELSA projects in Europe were expected to ensure an exploration of the ethical issues of nanotechnology, provide recommendations to the European Commission, in a way that would not bypass the principle of subsidiarity, but could however contribute to the construction of the European nanotechnology policy. This is presented as follows by the D.G. Research:

European activities for ELSA and governance of nanotechnology cannot substitute activities of the European Member States, since ELSA is culturally shaped and governance is often subject to regional or national authorities. However, the importance of the role of European projects should not be neglected: They aim to facilitate cooperation between stakeholders in different Member States, to create a critical mass for topics of European concern, to identify national or cultural differences between regions and Member States or to play the role of a pathfinder for new developments.[2]

[1] *Ibid.*: 200
[2] Hullmann, 2008: 10

Identifying "topics of European concern", and "paths for new development" could be performed by the *Nano2Life* ethics board. It was also an objective of *Nanobio-Raise*, which was meant to contribute to the Technology Platforms on nanomedicine, and the future 7th Framework Programs[1], through the identification of "public concerns". This was done through the organization of focus groups which gathered about 150 "ordinary citizens" divided in 7 groups in the UK and the Netherlands, based on the "Democs" card game (see chapter 2). Coordinated by Donald Bruce, the director of the Society, Religion and Technology Project of the Church of Scotland, the objective of this "work package" was:

To obtain a qualitative survey, through focused discussions with small groups of lay people, of various public attitudes towards nanobiotechnology, and variations in opinions in the north, south, east and west of Europe.[2]

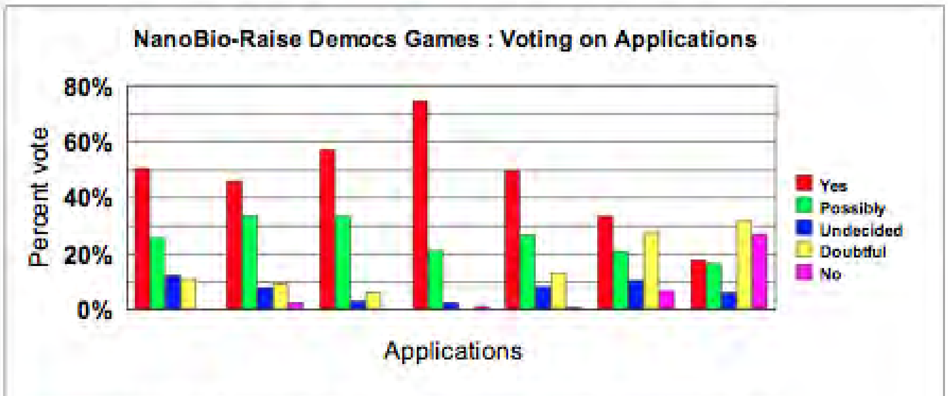
As described in chapter 2, the Democs game represents nanotechnology as a topic about which typified actors could discuss arguments. For its promoters, the "deliberation" part of *Nanobio-Raise* was meant to introduce "a novel form of lay participation in the format of a card game", which transformed nanotechnology into a topic for public discussion. The importance of the initiative was explicitly connected to the value of the participation of "lay publics" in the "governance of nanotechnology": conducting group discussion in a "deliberative format" was supposed to ensure, as Donald Bruce said during a nanotechnology conference, that "lay publics can have a say"[3]. For the *Nanobio Raise* project, this was directly connected to an affirmation of the need to go beyond the deficit model, which contends that publics would oppose scientific development because of a lack of understanding. As readers of the critics of the deficit model[4], *Nanobio Raise* participants ambitioned no less than making the European public speak. Participants to a democs game would thus be told, after having been presented the field of nanobiotechnology, that:

One purpose of the programme is to alert the EC to issues which would need to be explored in more depth - with social science and ethics experts, and with European people generally. (...) Even though these are early days with a lot of these technologies, our experience in problems areas like GM food suggests that it's good to start discussing already with people outside the laboratory. We want to know what you think about them! Are there applications or areas of research you think are particularly worthwhile, or others that are less important? Are there some 'show-

[1] Schuurbiers and Bennett, 2005
[2] Bruce, Donald, 2008, "Engaging citizens on Nanobiotechnology using the democs game": 7
[3] Donald Bruce, S.NET conference, Darmstadt, September 2010 (personal notes).
[4] Among which Brian Wynne (Wynne, 1992; Wynne, 1993), who was an advisor to the project, and frequently quoted in the projects' documents.

stoppers' to which you'd have serious objections? What values are important for you, as you think about these issues?[1]

Mediated through the process of the game, during which participants were asked to fill tables, read "issue cards" which ask questions about the development of nanotechnology (e.g. "nano-therapies for whom?", "how to control brain stimulation?"), play the role of typified stakeholders (e.g. "professor AnneLie Beauchamp", who developed and advocated for "electric brain stimulation"), and eventually vote on seven applications selected by the organizers of the game. The final results could then be synthesized in a graph (fig. 6.1, the applications on which the participants were to vote are the following: "early diagnostics", "internal monitoring", "targeted drugs", "tissue regeneration", "brain stimulation", "enhanced food", and "enhance people").



	Early Diagnos	Internal Monit	Targeted Drug	Tissue Regen	Brain Stim	Enhanc Food	Enhanc Peopl
Yes	51%	46%	57%	75%	50%	33%	18%
Possibly	26%	34%	33%	21%	27%	21%	17%
Undecided	12%	8%	3%	3%	9%	11%	6%
Doubtful	11%	9%	6%	0%	13%	28%	32%
No	0%	3%	0%	1%	1%	7%	27%

Figure 6.1.: Synthesis of the outcomes of the Nanobio-Raise Democs games

For the project's promoters, the value of the methodology of the Nanobio-Raise focus groups was not to be found in statistical representation but in the "deliberation processes" it rendered possible, and which was deemed to provide "much greater insight into the underlying values, motivations and desires involved"[2]. Yet it also provided quantified results, which rendered possible the identification of domains of concern. The two domains for which the participants appeared less enthusiastic were "enhanced food" and "enhanced people". This was directly taken up by the nanotechnology unit at the DG Research. As the person in charge of the coordination of the nanotechnology projects at the DG Research explained during an interview:

[1] Bruce, Donald, 2008, "Engaging citizens on Nanobiotechnology using the democs game": 29

[2] "Public perceptions and communications of nanotechnology", Nanobio-Raise briefing paper: 4.

There is clearly a concern about nano in food. The ELSA projects... it was clear throughout these projects that there is an issue here. We know there is something here. We will continue work through this in the next round of projects, and if it appears that people don't want nano in food, we won't give a single euro for research on nano in food.[1].

In this excerpt, the "next round of project" refers to the call for the "European Platform on Nano Outreach and Dialogue" (NODE), which aimed to ensure a "real-time monitoring of European public opinion" (see chapter 2). Hence, the European integrated ethics was an element in the shift from public understanding to the scientific understanding of the public described in chapter 2, and made the construction of a European public part of a European approach to nanotechnology ethics.

Delegating the formulation of nanotechnology's ethical concerns to lay people was a key component of ELSA projects within FP6. One of them, DEEPEN[2], also organized focus groups in order to formulate a "lay ethics", which would, thanks to " the absence of those working in nanoscience and industry"

... allow(...) participants to define concerns and questions on their own terms and without being constrained by the more rigid formats associated with deliberation[3].

Again, DEEPEN grounded its approach on the critique of the deficit model[4]. Rather than have participants vote on a list of pre-defined applications of nanomedicine, the DEEPEN researchers identified "narratives" that lay people mobilized[5], a "key implication" of them being that the "complexity of public 'attitudes'" required them to "grapple further with how complex public concerns can be represented and included in policy"[6]. The "ethics in the real world" that DEEPEN advocated led to inquire into the opinions of lay people, but also of scientists and industrialists[7], whose "repertoires...

... reflect a specific perspective: that the promises of nanotechnology must be pushed and that ethics is a brake

[1] Interview with Matteo Bonnazzi, nanotechnology unit, DG Research

[2] DEEPEN was coordinated by researchers at Durham University (Phil Macnaghten, Matt Kearnes and Sarah Davies). Researchers at the university of Darmstadt (among whom Alfred Nordmann), Twente, and Coimbra, participated. The project led to a number of publications, among which (Davies et al., 2009) and (Ferrari and Nordmann, 2009), panels at academic conferences (I attended those of the 4S meeting in Washington DC, Oct 30 2009), and a final meeting in Brussels in September 2009, which I attended.

[3] Davies et al., 2009: 33

[4] Among the participants in the DEEPEN projects were Brian Wynne's co-authors of an influential paper, which advocated, against the deficit model, the early involvement of both social science and lay publics in order to effectively influence the content of nanotechnology programs (McNaghten et al., 2005).

[5] They were the following: " 'Be careful what you wish for'; 'Opening Pandora's box'; 'Messing with nature'; 'Kept in the dark'; 'The rich get richer and the poor get poorer'", (Davies et al., 2009: 18)

[6] Davies et al., 2009: 21

[7] This was done through interviews.

on progress. To enable critical reflection, by the enactors themselves as well as others, it is important that standard repertoires are opened up.[1]

Hence, interrogating scientists and lay people was a way not to "to operate in the currently predominant manner of generating and cataloguing concerns regarding the potential impacts and applications of nanotechnology", but to ensure the "opening up of ethics, in which the terms of debate on 'ethical issues' are returned to the political arena"[2]. Thus, the DEEPEN project pursued the call for the integration of ethics in European nanotechnology research by arguing for "integrative forms of innovation governance", which would allow policy-makers to hear from lay people, and question the allocation of responsibility that scientists favored (the "division of moral labor"). In this process, the very content of ethical expertise disappeared entirely. The report was explicitly directed against the "ethicalisation", that is, the delegation of ethical thinking to experts. It never attempted to specify what an "ethical approach" of nanotechnology research would be, as did the instruments considered above (e.g. safety procedures, information to people, training programs, ban of non-therapeutic enhancement, etc.). Rather, "ethics" became a sole matter of "democratization nanotechnology" through "collective experimentation"[3] that would ensure that lay publics were consulted through deliberation processes, and that the opinions of nanoscientists were questioned and challenged. The European principles of "inclusion" and "accountability"[4] could then hope to be operationalized in the very making of nanotechnology research, which would become more democratic in that it could be transformed by virtue of the intervention of deliberating lay publics.

The governance and ethics unit of the DG Research was interested in the DEEPEN project. René von Schomberg, a member of the unit, advocate of the Code of Conduct, and regular contributor to conferences about nanotechnology ELSA, co-edited a European Commission publication directly inspired from DEEPEN as well as other ELSA projects, and meant to promote "an inclusive governance of nanotechnology"[5]. In such a process, the Code of Conduct was central, as was the collective discussion of responsibilities and research objectives, in order to ground the definition of European research projects in the concerns of a European public composed of lay people. DEEPEN's insistence on lay ethics is not entirely foreign to the idea of the "scientific understanding of the public" that the nanotechnology unit of the DG Research developed (cf. chapter 2), in that it also delegated to the public the definition of public concerns. Yet it is also more sophisticated in that DEEPEN did not consider a public whose representations of unquestioned nanotechnology domains were supposed to be

[1] Davies et al., 2009: 15/16
[2] Davies et al., 2009: 38
[3] Davies et al., 2009: 27
[4] Davies et al., 2009: 21
[5] Von Schomberg and Davies, 2010: 6

"monitored in real-time", but focused on the processes through which publics made sense of nanotechnology. The case of DEEPEN thus highlights the ambivalence of the operationalization of the European values in the making of the responsible futures for nanotechnology, and illustrates differences of approach within the DG Research[1].

That the very existence of nanotechnology objects (e.g. nano substances and objects) and domain (e.g. human enhancement) was uncertain made it possible for the European Commission to consider that the integration of ethics in European research could be done through ongoing reflection within nanotechnology projects, continuous reviewing of research practices, and eventually orientation of nanotechnology policy through public opinion research. For the Commission, nanotechnology could thus be dealt with in this integrated and non-binding manner, which was thought to ensure a flexible approach allowing the subsidiarity principle to function with no additional regulatory requirement. Nanotechnology could thus be "a topic like any other", as the head of the ethics review unit said[2], which, for all the exceptional ethics activities it required, did not demand specific legal adaptation. As it will appear in the case of the European Parliament, this was not a shared perspective within the European institutions.

Granting legal existence to nanotechnology

Contrary to the European Commission, the European Parliament (EP) has considered that European institutions should grant legal existence for nano substances and products. The actions of the EP propose an approach to the "democratization" of nanotechnology that differs from the consultation of "lay publics".

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[1] At the final conference of the DEEPEN project, an official from the DG enterprises told me that he was "far more interested in the OECD WPN work on public engagement (see chap.5) than in DEEPEN", which was, for him, "far too abstract". M. Bonnazzi, from the D.G. research told me that Nanobio-Raise "provided more usable results" than DEEPEN. The "ambivalence and ambiguities" of the public's opinions, which the DEEPEN project insisted on, were also present in the language of the Commission, but as an acknowledgment of the "cultural variety" among European countries, which studies could evaluate, and as a remainder of the subsidiarity principle. The coordinator of the DEEPEN project, while praising von Schomberg for his support, also considered that the nanotechnology unit was following the very approach that DEEPEN was contesting (phone conversation, July 2011). This made him worry about the attempts by the nanotechnology unit to integrate the public engagement projects in the scope of its activities (see chapter 2). These tensions manifest a difference of approach between the nanotechnology and the governance units of the DG Research, which I have not explored in detail.

[2] Phone interview with Dorian Karatzas, head of sector Ethics Review, April 22, 2009.

Responding to the *Action Plan*[1], the Parliament reaffirmed its concern about the treatment of nanotechnology's "ethical issues" and the need to respect "high ethical principles". It "welcome(d) the planned review on issues such as non-therapeutic human enhancement"[2]. The EP defended the very same European principles as the Commission, but did not consider that the existing regulatory framework was sufficient to deal with nanotechnology issues. For the EP, the "European values" not only required that "informed consent" and "privacy" were protected[3], but also that "stringent ethical guidelines" were put into place. The reluctance to fund "non-therapeutic human enhancement" research was more pronounced in the Parliament than in the Commission, and the need for a "ban" was mentioned when human enhancement technologies were discussed[4]. The EP considered the Code of Conduct as "an essential instrument for safe, integrated and responsible research in nanomaterials". It stated that it had to "be adopted and respected by all producers intending to manufacture or place goods on the market"[5] – thereby advocating a mandatory ban on "human enhancement research", and transforming the flexible integrated ethics of the Commission into an approach that would require a strict definition of objects and research areas potentially excluded from the European research area. But identifying a process that would define human enhancement proved complicated and no other requirement was made by the EP than asking the EGE to work on the issue again[6].

In pushing for "stringent ethical guidelines", the EP could do little more than ask the Commission to render the instruments considered as parts of a "flexible approach" mandatory. The EP's critical opinion regarding the activities of the European Commission towards nanotechnology was made more explicit in an almost unanimous resolution that responded to the Commission's communication regarding the "regulatory aspects of nanomaterials"[7]. This communication had explained how the "principle of safety" was operationalized by the European institutions as regards nanomaterials. It had mentioned the code of conduct and the ethical review process. The Communication had concluded that

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[1] P6_TA(2006)0392, Nanoscience and nanotechnology. European Parliament resolution on nanosciences and nanotechnologies: an action plan for Europe 2005-2009. Two committees at the EP were particularly involved in the discussions about European nanotechnology policy: the Committee for Industry, Research and Energy, which discussed the proposed Action Plan before it was released and the successive Framework Program Directives, and the committee for Environment, Health and Safety, which worked on nanomaterials and nanoproducts.

[2] *Ibid.*: art. 21

[3] *Ibid.*: art. 25

[4] Concerns for human enhancement had been already expressed in the comments on the Commission's communication.

[5] "Whereas" Z

[6] The report recommended the creation of a European advisory body on the development of Human Enhancement technologies.

[7] European Parliament resolution of 24 April 2009 on regulatory aspects of nanomaterials (2008/2208(INI), hereafter "EP resolution"). 362 votes were casted in favor of the resolution, and 4 against (5 MPs abstainted). The resolution responded to the "Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee regulatory aspects of nanomaterials" (SEC(2008) 2036). It also answered the conclusion of the Competitiveness council on 25 and 26 September 2008 (12853/1/08 REV 1 RECH 264 COMPET 311, Subject: "Council conclusions on responsible nanosciences and nanotechnologies research").

the existing regulatory framework was efficient, and that no adaptation was necessary to deal with nano substances' potential risks. In its resolution, the European Parliament noted the "limited value" of the Communication "due to the absence of information about the specific properties of nanomaterials"[1]. The principle of "safety" was thus re-opened by the EP in its response to the EC's communication. Consequently, the EP:

> *did not agree (...) with the Commission's conclusions that a) current legislation covers in principle the relevant risks relating to nanomaterials, and b) that the protection of health, safety and the environment needs mostly to be enhanced by improving implementation of current legislation.*[2]

The position the EP defended was based on the "consideration of all nanomaterials as new substances"[3]. Accordingly, the activities of the EP consisted in adding amendments specifically targeted at nano substances in regulatory texts. Consider for instance the amendment it added to the cosmetics regulation (cf. chapter 5). Through this amendment, the EP solidified a legal existence for nanomaterials for the first time. It later undertook similar regulatory actions for the novel food and the biocide directives, in which it added amendments requiring additional risk evaluation for nanomaterials.

Hence, the EP considered that the principle of safety required the creation of new entities within the European regulation. While being more reluctant than the Commission to accept human enhancement, the EP also appeared much more willing to create new entities that would need to be controlled within the European regulation. Thus, the European Parliament's initiatives were consistent with previous cases related to technological regulation[4], and challenged the Commission's operationalization of the European principles by pushing an ontological argument for the existence of nano substances[5]. By the same token, it also opened up the principle of "inclusion", by asking "the Commission and the Member States to launch an EU-wide public debate on nanotechnologies and nanomaterials and on the regulatory aspects of nanomaterials"[6] and to ensure "the active participation

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[1] EP resolution: "Whereas" P

[2] EP resolution: 9

[3] *Ibid.*

[4] In 1989, the EP issued a resolution asking for a regulation banning gene transfer to human germ-line cells and for a definition of the legal status of the human embryo (Salter et Jone, 2002: 811; European Parliament, "Resolution on the ethical and legal problems of genetic engineering", Official Journal COM(096), 171, 1989). In the case of agricultural biotechnology, EP's framing of ethical issues was far more encompassing than the Commission, as the EP raised issues related to the modification of nature and the agro-industrial organization (Levidow and Carr, 1997).

[5] The implications of the position of the EP in terms of risk regulation were clearly identified by the industrial actors, who spoke about the "ultra green of the European Parliament", and complained that "even the PPE is pro-regulation" (first quote is an excerpt from an interview with a French delegate to CEN and ISO, second from a meeting at AFNOR with representatives of industrial professional associations).

[6] EP resolution: 22

of the social partners (…) from the earliest possible stage"[1]. Thus, the EP did not consider that focus on "lay ethics" was sufficient, and thereby showed that any "inclusive" process at the European level should do with the only elected body within the European institutions.

A European moral space

The description of the instruments expected to make responsible nanotechnology futures in Europe renders visible the components of a European moral space, "moral" because it is based on European values and principles, and "spatial" in that it is expected to enact an integrated European research area. The European moral space is based on "principles", among which "pluralism" is expected to deal with the variety of regulatory frameworks and ethical requirements in each member state. These principles infuse the making of the EU nanotechnology policy through the circulation of Commission officials, scientists participating in multiple European projects, experts serving as members of ethical boards, and philosophers advising scientific projects, who move about from Commission offices to scientific laboratories, from academic conferences to multi-partners projects. These principles are much more than topics of discourse. They are to be operationalized in science policy instruments such as codes of conduct, ethics reviews, funding grants, participatory events. The sites where the principles are discussed are the places where these instruments are constructed.

Following Andrew Barry's use of the network metaphor to describe the European space[2], one can talk about the "European network of responsibility", which is as much a matter of social organizations (e.g. networks of people connected through collaborative projects) and collective actions (distributed decision-making processes) as of techno-political instruments (codes of conduct, ethical reviews, regulations of objects such as cosmetics and novel food). The mode of operation of the network is not limited to European-wide loci, but can operate at the level of research projects, laboratories, or individuals (e.g. through training programs organized within European projects by ethical boards). The seemingly unified nanotechnology strategy is accompanied by a decentralized (and controversial) approach to regulation. In this approach, the benefits are "integrated" through common values and the risks "fragmented" as the Commission is reluctant to modify existing legislations[3], standardization works are delegated to ISO (cf. chapter 5), while intra-European oppositions occur as the EP attempts to make

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[1] EP resolution: 26

[2] Barry, 2001

[3] I am using here Jasanoff's words on the oppositions between the Commission and the Parliament about biotechnology: "the argument was that the risks – unlike benefits – lay not in the techniques of genetic modification, but in its specific applications. These more or less familiar risks could be targeted and adequately managed through sector-specific controls. Not all European actors, it later proved, were willing to settle for this asymmetrical representation of integrated benefits and fragmented risks" (Jasanoff, 2005b: 81).

nanomaterials part of European regulation and enforce a more centralized control of nanotechnology activities. Thus, the notion helps reflect on the nature of the political action of ethics in European institutions: by highlighting the variety of instruments and sites of intervention, it leads us to avoid the unspecific language of "soft law" that is sometimes used to describe the mobilization of ethics (or, for that matter, other domains of political activity that fall beyond the strict competences of the Union).

The European networked moral space is not based on the two dichotomies that are central in the American expertise on nanotechnology's societal implications. First, it is not based on "values" to be imposed on "facts" defined by science. The sites where the making of responsible nanotechnology futures is discussed question the European principles and the definition of the issues at stake. They are concerned with both the making of nanotechnology policy and that of the European democracy on nanotechnology. Second, the construction of the European moral space is not based on a separation between the work of experts in nanotechnology's implications and that of decision-makers. Therefore, it makes little sense to inquire about the "influence" of ethics on European science policy, since no boundary can be drawn between "ethics policy" and "innovation policy"[1].

The European network of ethics does not solidify, like the ethics committees discussed in section 1, a mode of action based on stable principles (like informed consent in the liberal version of American nanoethics, or human dignity in that of the President's Council on Bioethics) that travel from one issue to the next. It is able to deal with a shapeless issue like nanotechnology and define it as a part of the European research policy because no *a priori* boundary is put on "ethics", which leaves room for the European moral space to be re-interpreted with, and, by the same token, solidified by nanotechnology. This does not mean that nanotechnology is not a trial for European ethics. As the previous pages illustrated, the boundary between European principles preserving subsidiarity and constraining actions targeting nanotechnology objects and domains was not always easy to draw. The list of the principles themselves caused numerous discussions (e.g. as the Code of Conduct was written). This means that nanotechnology is less a new issue on which stable principles could be applied than an opportunity to re-define the European science policy, to operationalize the Lisbon strategy, and eventually construct a European identity where common principles (such as "transparency", "precaution", "sustainability", or "solidarity") are expected to be met by the use of nanomaterials for energy reduction, nano products for increasingly efficient health therapy, or nano devices for pollution treatment.

Hence the discussions on the ethics of technology is less a "depoliticized way to make politics"[2] than a specifically European way of discussing collective identity and legitimacy[1]. Ethics is not a body of

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[1] There is indeed one body specialized in ethics, the EGE, but as we saw, it functions less as a separate expert body than an element of an "integrated" European policy-making.

[2] This channel of representation is critiqued by some commentators, who contend that "the identification of 'the ethical values of all Europeans' has remained confined to the judgments of appointed expert committees" (Talacchini, 2009). This channel of representation is not, however, the only one available.

expertise expected to be neutral (as it is the case of bioethics principles), but a way through which European values are defined, and pushed forward[2]. Accordingly, the construction of the European moral space is also the construction of the European polity, of a geographical and political space where the legitimacy of the European institutions can hope to get stabilized. This implies that the European "public" is part of the European moral space[3]. Yet the European society has no uniform and uncontested channel to speak to European officials, who mobilize multiple devices to hear the voice of the "European public": ethics committees such as the EGE[4], research projects in ethics (which in turn call for more involvement of the public), methods for "lay ethics" expected to make the European public speak, and eventually "scientific understanding of the public" (cf. chapter 2). Among these multiple channels for voicing the opinion of the European publics, the European Parliament is but one, which is in many respects opposed to the Commission's positions.

How to define and operationalize the European moral principles is then a central task, which is directly connected to the definition of the European identity and the construction of the legitimacy of the Union. The discussions we encountered in the previous pages prove that this is no easy task. The very possibility to open up the European principles to collective discussions is both a clear sign that the democratic legitimacy of the Union is not granted and needs to be reworked on every new issue, and the proof that the European system (at least at the level of science policy) is flexible enough to accommodate a new entity such as nanotechnology[5]. This involves discussions about the European identity, the grounds of European legitimacy, and the content of nanotechnology as a European science policy program. That the construction of the European moral space with nanotechnology is uncertain and needs to be re-opened is a sign that European institutions have always to reinvent themselves, and to rethink the grounds of their legitimacy.

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[1] Symmetrically, the critique of the "false objectivity" of the languages of risks (Levidow and Carr, 1997) and ethics (Tallacchini, 2006) which would conceal hidden normative choices in favour of the market and resulting in the exclusion of citizens from decision-making processes does not account for the fact that it is less "objectivity" that is at stake within European governance than the construction of a European space.

[2] See Barry, 2001: 94. Barry formulates a similar comment about the European officials and their commitment to the European construction. Without having done an exhaustive study of the European civil servant involved in the construction of the European moral space, the few examples considered here (e.g. von Schomberg, Bonnazzi) are good illustrations of an ethos of the civil service less concerned with the neutrality of public action than with the enactment and stabilization of European principles.

[3] I am thus skeptical of arguments that consider that democratic progress could be made by using "innovative ethical practices" such as citizen forums (Talacchini, 2009: 302). As seen in this section, lay ethics is no less controversial than the other forms of European ethics.

[4] Talacchini, 2009: 9

[5] See (Jasanoff, 2002) for a discussion of the European values at play in risk policy. Nanotechnology is yet another situation where the European moral space is enacted.

Conclusion. Objective expertise and integrated values for responsible nanotechnology futures

The making of responsible futures for nanotechnology is related to the construction of nanotechnology policy programs in various ways. In the U.S., expertise is expected to contribute to the responsible development of nanotechnology. Ethicists and proponents of RTTA are not different from specialists in toxicology: they are specialists to call for in order to ensure the success of the short and long-term goals of the NNI. The problem is defined differently in the European Union, where "responsible innovation" is enacted through the integration of shared values in the making of nanotechnology policy. Ethics is there an integral component of science policy. It is not mobilized to provide expert advice, but participates in the operationalization of European values. Principles are elements in the construction of Europe, both at the level of "shared values" that define the European identity, and at that of institutional arrangements expected to operationalize the principle of subsidiarity. Therefore, the ethics question does not revolve around the fact/value separation, but deals with the making of European science policy. It has to do with the ways in which European institutions can grant funding for research, identify key domains for technological development, and define a strategy for European consultation with the public. As such, what nanotechnology "really is" is not a concern, since the European nanotechnology policy program is being constructed in the process, at the same time as the European polity. In the U.S. on the contrary, the fact/value distinction (whether it is solidified or displaced) is at the heart of the making of responsible innovation, which needs additionally to demonstrate its ability to provide expert advice to policy makers. Accordingly, the professional expertise of ethicists is an issue, contrary to the European situation, where ethics is the matter of multiple institutions and people (the "European public", experts, bureaucrats, individuals researchers). This does not prevent multiple connections between American and European actors. Concerns for the implications of nanotechnology and the issue of human enhancement traveled from the United States to Europe. Proponents of RTTA referred to approaches such as Constructive Technology Assessment developed in Europe, and mobilized in European research projects in nanotechnology ELSA. But these circulations cross boundaries that separate different democratic constructions.

Experiments on technologies of democracy are the empirical sites where the democratic constructions of nanotechnology responsible futures are empirically visible. These experiments hold different forms in Europe and in the United States. The European experiment involves the whole European space and the making of the entire nanotechnology policy around collective values and principles to be stabilized. Each of the components expected to make responsible futures for nanotechnology (codes of conduct, EGE, ethics review, ELSA project) is a technology of democracy, more or less stabilized, which attempts to operationalize the European values and principles, defines the roles and identity of the European public, and draws boundaries between the constraints exercised by the European institutions and the sovereignty of member states. At the American CNS, technologies of democracy are experimented within the laboratory of social science in order to provide public demonstrations of the validity of RTTA. Khushf's approach considers as "experimental" situations in scientific laboratories where neither the nature of the objects being produced, nor the identities of the (social) scientists involved are previously defined. Instead, the "experiment" is related to a collective exploration. This latter case echoes an example developed in the previous chapter, that of the French nano responsible norm.

These technologies of democracy problematize the futures of nanotechnology. They organize the crafting material existences, instruments constructing the future, public concerns, and roles for citizens and public actors. Understanding the problematization of nanotechnology's futures requires that one takes seriously the ontological dimension that we encountered in the two previous chapters. Is the existence of nano substances and products a central concern for the making of responsible nano futures? Contrary to RTTA scholars, liberal and conservative ethicists are not interested in the ontological discussions related to these objects. In Europe, the existence of nano substances and products is discussed by the European Parliament, while the European Commission is far more reluctant to introduce ontological changes in existing regulation. The existence question is not limited to material artifacts. It also extends to the making of funding plans, research organization infrastructures, strategic research directions, and responsible research practices – in short, to nanotechnology policy programs.

This exploration sheds light on the making and use of ethics expertise in policy arenas. It prevents from considering ethics as a ready-made instrument that could be unproblematically applied to nanotechnology. Rather, it is a component of what makes nanotechnology exist. But this also raises issues about the exterior position one can maintain to analyze nanotechnology. For there are indeed ethical questions at stake in the conduct of research and in the study of the construction of nanotechnology: how to conduct the analysis in an acceptable way? Are there democratic formations that are more desirable than others? This chapter warns against the temptation to use overarching principles to guide private and public actions. It forces us – as the DEEPEN project argued – to "open up" the imperative of responsibility and interrogate the various problematizations of nanotechnology it may enact. It has also demonstrated that STS-inspired concerns for the co-construction of science and society foster experiments that perform contingent democratic formations, which cannot be considered the sole and unproblematic means to ensure legitimate and democratic decision-making. Consequently, this chapter incites us to craft a "situated ethics" that can account for the ontological dimension of the construction of nanotechnology. I will get back to this problem in the following chapters, through the analysis of the modalities of the engagement in nanotechnology of civil society actors and the researcher himself.

PART III. ENGAGING WITH, ENGAGING AGAINST NANOTECHNOLOGY.

Technologies of democracy and the problem of exteriority

The second part of the dissertation has examined how the administrative management of nanotechnology's objects, futures, concerns and publics is tied to the definition of existences for nano substances, products and programs. The technologies of democracy that I have described attempt to draw boundaries between what is nano and what is not, what is responsible and what is not. Their constructions, in science policy offices and standardization bodies, are ways to problematize nanotechnology. Thus, the "science-based" international process of standard making separates the production of objects from that of public concerns related to potential risks to regulate. The European attempts to deal with nanotechnology objects and futures integrate the concerns of European stakeholders into the definition of substances and products, and the imperative of responsibility in the making of science policy programs. This integrative approach is different from what we encountered within the American science policy: in the U.S., the importance of expertise, be it scientific or social scientific, is crucial for the making of safe and responsible nanotechnology programs. Lastly, the case of the French nano-responsible norm has offered an example of a technology of democracy that indeed deals with the construction of objects, but does not draw a boundary between "nano" and "non nano" in order, precisely, to take seriously the ontological uncertainty of nano products.

The two previous parts have proposed different ways of designing technologies of democracy, experimenting with them and to using them as demonstration devices. The previous chapters can be read as stories of stabilization of technologies of democracy. In some cases (as in the international arena), alternatives to a well-solidified process are eliminated. In others (as in the case of the French nano-responsible norm), original arrangements are constructed. The experimentations involving technologies of democracy are diverse: we encountered original constructions attempted in the protected space of the science museum (chapter 2) or of the social scientific laboratory (chapter 3), real-scale, but uncertain formations (as the nano-responsible norm, chapter 5, or the safe by design approach, chapter 6), and large-scale political constructions that are experimental in that the principles on which they are based are permanently discussed (as the European nanotechnology policy, chapter 6). All these experimental processes face uncertainties, leave room for contestation that they then need to overcome.

The last part of this dissertation focuses on situations of engagement with technologies of democracy, and reflects on a problem of exteriority. I want to focus on a different form of activity involving technologies of democracy, based on the engagement with nanotechnology. My use of the term is particular. I use it to point to situations in which actors question their distance towards technologies of democracy mobilized to represent or manage nanotechnology, in order to describe and critique technologies of democracy, or propose alternate ones. Is it possible to distance oneself from technologies of democracy in order to critique or describe them? If one wants to engage in their very making, then what are the possible forms of political action for actors who are neither experts in technologies of democracy, nor members of the institutions where the existence of nanotechnology objects, concerns and programs is discussed? These questions are those of civil society actors constructing social mobilization on nanotechnology. They are also those of the social scientist wishing to describe the construction of nanotechnology while also being caught in numerous situations to which he or she is asked to contribute.

Thus, chapter 7 describes two forms of social mobilization on nanotechnology that answer the problem of exteriority in different fashions: while some attempt to put nanotechnology at a distance in order to perform a radical social critique, others consider that nanotechnology renders the exterior position impossible to sustain, and thereby requires a permanent engagement in the very making of technologies of democracy. The two positions have important consequences for the forms of collective action, the nature of activism, and the definition of the public concern on which to mobilize. Chapter 8 pursues the analysis of engagement by directing the attention to the engagement of the social scientist. Not, however, in a "reflexive" manner, as one could have expected. My point in this last chapter of the dissertation is not to reflect on the influence of my own values and interests in my research. Rather, I attempt to re-read the situations already encountered throughout the dissertation in order to reconstruct both problematizations of nanotechnology and the engagement of the social scientist for the democratization of nanotechnology.

CHAPITRE 7 : S'ENGAGER AVEC, S'ENGAGER CONTRE LES NANOTECHNOLOGIES

Ce chapitre se penche sur les formes possibles de la mobilisation sociale sur les nanotechnologies. Au cours des chapitres précédents, plusieurs modalités de la mobilisation associative ont été décrites, notamment celle d'associations américaines et européens intervenant dans les enceintes de la régulation afin d'argumenter en faveur de l'existence des nano substances ou de la définition de critère de délimitation du champ des objets « nano ». Ainsi, les exemples précédents ont mis en évidence l'intervention d'acteurs associatifs au sein même des technologies de démocratie problématisant les nanotechnologies.

Ce chapitre déplace les questionnements introduits dans les chapitres précédents en se penchant sur des cas de mobilisation prenant pour objet explicite les technologies de démocratie elles-mêmes. Il débute par le récit de la construction des programmes de soutien aux nanotechnologies à Grenoble, de leur mise en discussion publique, et de l'intervention d'acteurs critiques. Le cas grenoblois permet de voir émerger deux formes de mobilisation sociale, qui sont successivement décrite.

D'une part (section 2), le cas du groupe Pièces et Main d'Oeuvre (PMO) et des groupes qui lui sont associés permet de décrire une forme de mobilisation fondée sur la mise à distance des nanotechnologies dont il s'agit de mettre au jour les intérêts économiques et politiques qui en expliquent le développement. La mise à distance est fondée sur l'anonymat. Elle se double d'interventions spectaculaires réalisant des démonstrations de la critique produite. La mise à distance est mise à l'épreuve alors que les groupes critiques cherchent à intervenir au sein de technologies de démocratie : la distance est ainsi le résultat d'épreuves dont le résultat est incertain.

D'autre part (section 3), l'exemple de l'association Vivagora met au jour une forme de mobilisation fondée sur le refus de l'extériorité par rapport aux nanotechnologies. La trajectoire de Vivagora montre comment un objectif initial défini par la représentation à distance des controverses est peu à peu décalé vers l'expérimentation de formes d'intervention, dont certaines prennent la forme d'intervention directe dans la fabrication des objets, des futurs, des enjeux et des publics des nanotechnologies. La section décrit quelques projets menés par Vivagora, qui permettent d'illustrer à la fois la variété des formes de mobilisation de l'association, mais aussi l'instabilité de la position, qui suscite des critiques permanentes de la part d'acteurs administratifs, industriels, et des autres organisations associatives.

Les deux exemples décrits en détail ont la particularité de recouper les problèmes posés au chercheur lui-même : il s'agit bien pour ce dernier de s'interroger sur les modalités théoriques et pratiques de la distance qu'il entretient avec les nanotechnologies comprises comme entité composite, non stabilisée, et prompte à internaliser ses propres représentations. Le chapitre se conclut donc sur la nécessité de revenir sur le type d'engagement universitaire dans les nanotechnologies, les connaissances qu'il produit et les réalités qu'il contribue à faire advenir.

CHAPTER 7. Engaging against nanotechnology, engaging with nanotechnology

In September 2010, I was invited in Amsterdam, the Netherlands, for a workshop devoted to the "national nano dialogues". The Netherlands had been concerned about its nanotechnology innovation policy and its social impacts for a few years. At OECD WPN (see chapter 3), the country's delegates were among the most active participants in the "public engagement" project – some of them attended the Amsterdam meeting. In May 2009, the Dutch administration launched the *NanoPodium*: organized by an independent commission, it was supposed to "stimulate the debate on nanotechnology and develop public opinion in this area, more specifically on the social and ethical issues involved" by financing projects such as science cafés, television programs, debates and dialogues, meant to provide "important input for Dutch policies on nanotechnology and its applications"[1]. At the Amsterdam meeting, the *NanoPodium* was presenting its results, and was to reflect on the "next steps" for its work. Well-known scholars of the science study world were present, among whom Wiebe Bijker, who chaired the session I was participating in, and Arie Rip, as a leader of the technology assessment branch of the national Dutch nanotechnology program. Using his recent work at the time, Andy Sterling advocated processes that could "open up" decision-making processes instead of "closing them down"[2]. As for myself, I was sitting in this meeting not by virtue of ethnographic distance, but as an "invited expert" expected to talk about the French case and the experience with public debate. During one of the separate sessions, I described participatory attempts in France, and the contestation that occurred (see chapters 2 and 3, and further examples in this chapter), while a participant from an Irish science communication center made the point that NGOs "did not have enough time and resources" to get involved. To which participants reacted in various ways: a Dutch scholar contended that "the minute there would be a problem, then you would see the NGOs", another one was "almost jealous" of the French situation, where social movements were, if critical, very vocal, contrary to the Dutch ones, which appeared nowhere to be found by well-intentioned STS scholars.

This short episode is significant of a global concern for the "engagement" of the public, which we already encountered in the previous chapters. The discussions during the Amsterdam meeting also tell a lot about the quandaries in which the proponents of participation are caught, particularly actors who have been pushing, as academics, for the "democratization" of science, and have been asked to intervene in the making of nanotechnology policy – either as informal advisors, or active participants in

[1] http://www.nanopodium.nl/english/ accessed January 10, 2011. The other quotes in this paragraph are excerpts from the notes I took during this meeting.
[2] Stirling, 2008

nanotechnology programs[1]. The question seems to be that of the identification of a "public" that is nowhere to be found. As the participants in the Amsterdam meeting seem to imply, there would be no "active NGO" in nanotechnology policy, no actor with whom to conduct dialogues such as those the *Nanopodium* was organizing. This is only partly true, as examples from the previous chapters show. But this understanding made participants in the Amsterdam meeting find the French example rather curious. Indeed, nowhere else in the world were activists so visible, and so vocal in the refusal of the very participation in nanotechnology. Hence a tough question for the proponents of the democratization of science: what should be done with social movements who refuse to engage in any kind of dialogue?

Using the example of French anti-nanotechnology activists, and that of a civil society organization called *Vivagora*, this chapter starts from these questions in order to explore the forms of social mobilization with nanotechnology. It does not take the collective character of social mobilization for granted, but considers it as a part of the format and stake of the mobilization. How to convince others to join and define common goals for collective action? How to organize oneself in order to mobilize on nanotechnology? These questions have been long-term concerns of the sociology of social movements[2]. The examples I will be considering in this chapter illustrate the challenges nanotechnology raises for those who try to answer them.

The previous chapters have already provided numerous examples of social movements being involved in controversies related to nanotechnology. Recall the fight of ICTA (in the US) or the EEB (in Europe) for the recognition of nano substances as "new" chemicals (cf. chapter 4). In the meantime, we also encountered numerous devices expected to speak for the public, whether when creating a neutral citizen (chapter 2) or through the "monitoring of public opinion" (chapter 1, chapter 6). The opposition between "participation" and "mobilization", between "participation from below" and "participation from above" is a common theme in political science and sociology[3]. One could attempt to read the previous examples in these terms: negotiation arenas at the European Commission, and public debates and dialogues would be "invited participation", whereas petitions and legal actions (e.g. ICTA petition to U.S. EPA) would be "uninvited participation". Yet this chapter does not follow this line of analysis. For in focusing on two specific cases in the French nanotechnology scene, it demonstrates that nanotechnology produces forms of social mobilization that cannot be described according to the participation/mobilization dichotomy. Accordingly, I describe the case of radical activists who put "participation" and "mobilization" in the same set of objects needed to be criticized (a case I examine in

[1] Sismondo speaks about the "Low Church" of STS to designate "a diverse grouping united by its combination of progressive goals and orientation to science and technology as social institutions", which is "concerned with making science and technology accountable to public interests" (Sismondo, 2008: 18; the expression was used by Steve Fuller (Fuller, 1997)).

[2] For a review, see (Cefaï, 2007).

[3] See for a classic example (Langton, 1978), and a discussion in (Joly and Marris, 2003b).

section 2 of this chapter), and that of a civil society organization (which I describe in section 3) that engages in the organization of participatory mechanisms, and thereby does not differentiate between participation and mobilization.

Going beyond the participation/mobilization dichotomy in the understanding of "public participation in science" is natural if one follows the American pragmatists. As Noortje Marres explained, both John Dewey and Walter Lippmann, regardless of their differences, conceived the "public" as the result of mobilization on a certain "problem" not taken care of by existing institutions[1]. This dynamic view contends that no public exists without a problem, and directs the attention of the analyst to the mutual construction of "publics" and "problems", regardless of the "participatory" format or the modalities of "mobilization". This echoes the studies of "concerned groups" that STS scholars have undertaken[2], and which have described the processes through which social movements constitute themselves at the same time as they transform the objects of their mobilization. In so doing, the objects of mobilization (e.g. rare diseases) are directly connected to the identity of social movements and play a central role. For it is through the direct attachment (physical in the case of patient organizations) to the problem on which they mobilize that concerned groups are constituted, can voice their concern, and eventually intervene in the making of the issue at stake[3].

In the case of nanotechnology, understanding social mobilization as such appears much more problematic. The problems caused by nanotechnology do not affect people directly. Health risks *might* occur but have not been proven. Future developments *might* affect human health, individual or collective values, but this connection cannot be easily drawn (see chapter 6). Thus, mobilizing on nanotechnology implies that unidentified substances, uncertain risks and undefined concerns are rendered visible. Nanotechnology resembles, for that matter, other objects, like radioactivity, which need to be made visible in order for social mobilization to be possible[4]. This implies various technologies, involving material devices, practices of social mobilizations, and the engagement of the media[5]. The social movements I described in the previous chapters did this, to a certain extent. They would gather data in order to demonstrate the noxiousness of silver nanoparticles, or would argue for the extension of the scope of nanomaterials at the European Commission (cf. EEB and the limit of 300nm in chapter 4, and, later, the discussions over size distributions in chapter 5). ICTA's efforts in arguing for the existence of nano silver, and EEB's push for a definition of nanomaterials that would be broader than industries' propositions were attempts to render the objects of mobilization explicit. Thereby, these civil society organizations entered a discussion on the definition of substances, which implied boundary-

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[1] Marres, 2007
[2] Callon et al., 2009
[3] Callon, 2007b; Rabeharisoa and Callon, 1998
[4] A telling example is that of the mobilization of veterans of nuclear testing (Barthe, 2010).
[5] On this later point, see (Lemieux 2008).

making about what was "nano" and what was not. Consequently, the analysis of social mobilization on nanotechnology should not consider that the object on which to mobilize is stable, but that it is to be constituted as part of the mobilization[1].

Making the problems of nanotechnology visible is also about making a "public" visible, especially in a context where the public itself is thought of as a problem. In a situation where no crisis is to be seen, and no affected public (e.g. patients groups) are heard, then the representation of concerned publics is also at stake. Both ICTA and EEB, when intervening in the legal arenas of the EPA (for the former), or in the offices of the European Commission (for the latter) paid special attention to "speaking for the public". The "principles for the oversight of nanotechnology", which gathered a dozen organizations at the initiatives of ICTA (see chapter 4) were a way of doing so. As the "integration of the public" was a central topic of concern for the science policy officials (see chapter 1), "making the public speak" was also undertaken by science policy bodies. Chapter 2 described the objectives of the "scientific understanding of the public" of the European Commission, and chapter 3 the importance of the measure of public perception at OECD in order to "know the public" and ensure its "engagement".

The construction of publics and their problems, to paraphrase John Dewey's famous expression, is therefore a shared issue. The examples I am interested in in this chapter work on these two dimensions, but displace the forms of mobilization we encountered in the previous chapters. Apart from the relative easiness of the empirical exploration (as compared with drawing an exhaustive landscape of all forms of social activism about nanotechnology), these two groups interest me for the displacements they propose in the forms of mobilization with nanotechnology, and for their influence on the French and international scenes. First, the two groups I describe in this section do not claim to represent publics, either because they do not want to be considered as "publics" of nanotechnology, or because they intend to shape a new social movement. Second, they problematize the ontological questions of nanotechnology and do not take for granted the definition of the problem of nanotechnology as that of boundary-making between "nano" and "non nano", "responsible" and "non responsible". Accordingly, they displace the discussion about the definition of substances in terms of size limits and thresholds - either to put it at a distance, or to question the nature of what is to be constructed. Thus, this chapter explores the making and critique of other technologies of democracy, as actors attempt to distance themselves from nanotechnology in order to advocate a world "free of technologies", including technologies of democracy (first case), or intervene in the construction of technologies of democracy (second).

[1] This is an important difference with the sociology of social movements interested in the "framing" of a given problem by social groups attempting to convince others to join. The works of David Snow and his colleagues describe trajectories through which frames can be "bridged", "amplified", "extended" or "transformed" in order to recruit more participants in the mobilization (Benford and Snow, 2000), thereby separating the "problems" and their "representations". See comments in (Cefaï, 2001) and a review in (Cefaï, 2007).

Thus, the constructions of "publics" and "problems" examined in this chapter are quite specific, and displace some of the dichotomies (old/new, institutions/issues), which both the language of "concerned groups" and the stakeholders' forms of mobilization rely on. In so doing, the engagement on nanotechnology they propose directly echoes the objectives of this very dissertation, in that they consider nanotechnology not as a given set of substances and products, but as a global science policy object in search of stabilization. There are indeed multiple crossings between my own engagement as a researcher, and the groups this chapter describes: the analysis of engagement proposed here is thus also an analysis of the modalities of scholarly engagement with nanotechnology[1].

In the following, I start the description of these groups with an analysis of nanotechnology debates in Grenoble. Grenoble, a city in the French Alps and a major hub for nanotechnology research, is the place where they interacted for the first time, and a site where many of the actors so far encountered in this dissertation met. In Grenoble, the connections are numerous between the making of nanotechnology objects, the definition of its development programs, the management of its related concerns, and the mobilization of its publics. The Grenoble case will ground the discussion on the forms of mobilization proposed by a group of anti-nanotechnology activists (section 2), and an NGO engaged for the "democratization of nanotechnology" (section 3)[2].

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[1] This latter point owes a lot to conversations and work with Michiel van Oudheusden (Laurent and van Oudheusden, forthcoming). It will be further explored in chapter 8.

[2] The first section is a revised version of (Laurent, 2007). The two others develop examples and arguments introduced in (Laurent, 2010a: 193-221).

Section 1. In Grenoble: introducing social mobilization on nanotechnology

Nanotechnology and the Grenoble model

Scientific and industrial research in Grenoble has a long tradition, especially in the physical sciences. Grenoble was the place where physicist and Nobel Prize Louis Néel developed research programs in magnetic science and made Grenoble one of the most important locations in France for research in physics[1]. One of the research sites of the *Commissariat à l'Energie atomique* (CEA) is set in Grenoble, and its main laboratory, LETI comprises more than 1,000 researchers. Whereas CEA activities were traditionally related to nuclear research, CEA's research strategy diversified in the 1990s. Biotechnology and nanotechnology became priorities of the Grenoble-based CEA research centers, developing projects in micro- and nano-electronics, nanobiotechnology and robotics. In the early 2000s, Grenoble became a major reference for the public bodies that attempted to draw the landscape of nanotechnology research in France[2], and a focus of interest for the science policy instruments that were expected to foster nanotechnology research. Grenoble was thus targeted as a recipient of a national *pole de compétitivité* grant, and was one of the few qualified as "global" – an acknowledgment of the transformation of the city into a major hub for nanotechnology research[3]. In 2009, the French national support plan for nanotechnology, *NanoInnov*, made Grenoble one of the three areas (along with Toulouse and Saclay in the South of Paris) that received dedicated public funding for nanotechnology research.

Nanotechnology research in Grenoble has developed through tight collaborations between industrial, scientific, and administrative actors. Indeed, scientific and industrial research in Grenoble has received strong support from local administrations. The Grenoble city council, the Grenoble metropolitan area Council (nicknamed *La Metro*) and the Rhone-Alpes region have been providing funding for scientific projects. Collaborations between public and private institutions for micro- and nanoelectronics R&D were launched in the early 1980s[4]. In February 2003, President Chirac opened

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[1] Pestre, 1990

[2] See for instance the references to scientific research in Grenoble in nanoelectronics and nanomedicine (Office Parlementaire d'Evaluation des Choix Scientifiques et Techniques (OPECST), 2003, *Microélectronique et Nanotechnologies: une chance à saisir*, Paris, OPECST; 2005, *Nanosciences et Progrès Médical*, Paris, OPECST). The Grenoble research institutions were central in the making of a national wide networks of public and private research bodies working on nanoelectronics, the *Réseau Micro Nanotechnologies*, which was the first initiative undertaken in nanotechnology by the French ministry of industry (interview with Ivan Faucheux, French ministry of economy, Paris, September 2007).

[3] For instance, Grenoble is used as an example in a paper presenting the way nanotechnology "promises to revolutionize the life sciences" (Thomas and Acuna-Narvaez, 2006).

[4] Robinson et al., 2006

Crolle 2 a joint research centre in nanoelectronics that was financially supported by local administrations and was established with funds from STMicroelectronics, Philips and Motorola. Micro- and nano-electronics R&D reached a higher level of development with the *Minatec* Research Centre, which aimed to "become Europe's top centre for innovation and expertise in micro and nanotechnology"[1]. CEA, *La Metro* and other public education and research institutions signed the agreement launching the *Minatec* Institute in January 2002. The official opening occurred in June 2006, and three years later, *Minatec* employed about 1,000 researchers and 1,000 students.

Another core research area in Grenoble is nanobiotechnology. The *Nanobio* project was launched in 2001 by CEA and the Joseph-Fourier University, with the financial support of local authorities. *Nanobio*, which was conceived as a part of the European Network *Nano2Life* (cf. chapter 1), brought together engineers, physicists and biologists within a broad portfolio of activities, from bio-imaging and bio-detection to surface chemistry, "at the interface of biology and micro and nanotechnology"[2]. In addition, the Joseph-Fourier University launched the *Biopolis* project in 2001 to host newly created companies from universities and research institutions. This incubator also received funding from *La Metro* and opened in the fall of 2002.

The tight connection between industries, local administrations, and public research had another dimension in the insistence on the strategic objectives of scientific research in the Grenoble area. Science – and in particular nanotechnology – was to be developed for its economic value. When they explain their support for the *Minatec*, *Nanobio* and *Biopolis* projects, officials stress the economic dimension of these research programs. *Biopolis* is designed to host newly created companies from academic research, *Nanobio* seeks to "stimulate company creation and technology transfer"[3], and *Minatec* is part of *Minalogic*, one of the *Pôles de Compétitivité* created by the French government in 2004 in order to foster university-industry relationships. The description of nanotechnology research projects as opportunities for economic development is frequently referred to by national officials[4], and even more explicitly by local ones. In the information letter from the *Minatec* Research Centre, André Vallini, the president of the local council (*Conseil General)* of the Isère department, explained:

This unique pole in Europe will generate thousands of jobs during the next decade, with positive impacts for

[1] Lettre Minatec 1, 2001

[2] Agence d'Etudes et de Promotion de l'Isère, 2003, *Les biotechnologies. Une convergence de disciplines pour les sciences de la vie*.

[3] These words are those of Geneviève Fioraso, a city councilor, talking about Nanobio in a session of the municipal council (Conseil municipal de Grenoble, 2006, 'Pôle d'innovation nanobiotechnologies "Nanobio", Convention de fonctionnement du pôle', Grenoble, November 27, 2006).

[4] It was the case, for instance, when President Chirac spoke during the inauguration of an industrial research unit within the Crolle 2 project on 27 February 2003.

Isère as a whole. Minatec is thus emblematic of the new and ambitious economic policy of the Isère local council.[1]

For local elected officials who, for most of them, belong to the Socialist Party, the definition of nanotechnology as an engine for the creation of jobs is in line with the left-wing understanding of technical progress as an engine for social progress, particularly against the background of increasing worries about unemployment. Nanotechnology is to be developed for its strategic value, at the same time as it is understood as the inescapable future. As CEA officials explain:

the convergence of micro-nanotechnologies and nanosciences will be the reality of the next decade.[2]

This deterministic vision of technological development extends to the whole industrial landscape of the Grenoble area:

Minatec *represents an attitude and a frame of mind, the one that will ensure the diffusion, in our whole region, of new technologies in traditional industries.*[3]

And if "convergence" is to be the "reality" of the future, then it is rational to make the most of this future development[4].

The connection of public and private actors, scientific institutions and industries, for the sake of techno-economic development did not arise in Grenoble with nanotechnology. It followed a path opened after the Second World War, which embedded research in the physical sciences in a tight network of collaborations between scientific and industrial actors as well as with the public administration[5]. The reference to Louis Néel, the Grenoble-based physicist who received the Nobel Prize in 1970 for his work on the magnetic properties of matter, allows local actors to stress the tradition and continuity of the "Grenoble model". In his speech marking the inauguration of *Minatec*, the president of the local council of Isère, explained how the new research centre was being launched in the spirit of Louis Néel:

Professor Louis Néel . . . said: 'I wish to develop a multi-disciplinary institution and link it to the whole set of

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[1] Lettre Minatec no. 2, 2002b
[2] Lettre Minatec 9, 2005
[3] Lettre Minatec 8, 2004
[4] This is what Erik Fisher and myself have called the "neo determinism" vision of nanotechnology development - "determinism" in that it contends that nanotechnology development has an autonomous development, and "neo" in that it supposes that investments (e.g. training, education of the public, social science research) are needed in order to "keep pace" with the inescapable development.
[5] Caron, 2000; Pestre, 1991

regional industrial activities, as well as to the university and the CNRS'. It is this vision that has inspired the Minatec innovation centre, and that is why Minatec is situated on a square to which we gave the name of the 1970 physics Nobel Prize.[1]

Hence, for the Grenoble actors, the initiatives of CEA officials who pushed for the development of nanotechnology by administrative bodies, industrial firms and public research institutions were pursuing the "Grenoble model" on yet another scale – that of the "technology of the future"[2]. The "model" has practical meaning for the government of scientific research. A CEA official explains how in Grenoble:

The local administrations are strongly involved in the emerging scientific issues. Everyone knows each other here, in the industries, in the labs, in the city council... So decisions are made quickly, and engagements are respected... Grenoble is quite unique in this respect.[3]

This specificity of the 'Grenoble model' has been used as a reference for national policy for the development of innovation clusters. For instance, reports commissioned by the Government to identify processes ensuring national competitiveness referred to Grenoble as the "good example", a place where the close connections between university, industry and local administrations were able to produce scientific knowledge and transfer it[4]. In the discourse favored by local officials, the "Grenoble model" is both integrated and comprehensive, the result of the past and a marker for the future. It is both a condition for the success of scientific projects and the reason for the continuation of scientific activity in Grenoble. Hence, nanotechnology is inscribed in a continuous process of scientific and industrial research, and is, at the same time, part of national initiatives (like the Pôles de Compétitivité) and European networks (for instance *Nano2Life*: see chapter 1 and 5).

The Grenoble model conflates the technical contents of the various S&T fields with the organizational aspects that render multi-disciplinary connections possible. Research activities in the Grenoble area associate nano-sciences, basic technological research, industrial R&D and also expertise in software technologies, biotechnologies and energy micro-sources[5]. At the level of the laboratory, it means that the institutional arrangements, the scientific instruments, the research projects, and the work status of the researchers and engineers are redefined according to the need of the complete

[1] André Vallini, 2006, "Discours pour l'inauguration de Minatec", June 2, 2006?
[2] The expression was used by a CEA official (interview, Grenoble, January 15, 2007). Jean Therme's strategy has been described as that of an "institutional entrepreneur" (Mangematin et al., 2005; Delemarle, 2007).
[3] Interview with A. LeRoy, Grenoble, January 15, 2007.
[4] The example of Grenoble was central in a report to the Prime Minister about competitiveness written by MP Christian Blanc (2004).
[5] This enumeration is presented in numerous local publications, such as (Lettre Minatec numéro spécial, 2002a).

innovation system. Researchers in nano electronics laboratories share instruments across scientific disciplines and institutional boundaries, thereby redefining the nature of their projects in terms of both "fundamental" and "applied" research[1]. Research in nanobiotechnology led to bring patients previously cared for in the local hospital to CEA buildings, where, within a project called *Clinatec* physicians, biologists, and physicists could experiment with nanomaterials-based cerebral probes.

The recomposition of institutional, disciplinary, and cognitive boundaries in the Grenoble area has been accompanied by a growing concern for the management of risks and the interrogation about potential ethical issues. François Berger, the promoter of *Clinatec*, sat in *Nano2life* ethics committee, and developed a constant preoccupation for the "ethical questions of nanotechnology research" (cf. chapter 6). CEA is a major partner in successive programs for the study of the health risks of nanoparticles. Regular meetings called *Nanosafe* are organized at *Minatec*, which gathered European researchers interested in "nano safety"[2] and during which initiatives such as containment are discussed (see chapter 4), but also others about the integration of the safety concern in the very design of objects (cf. chapter 5). Employees of CEA participate in national and international discussions about the standardization of nano substances. CEA's lead occupational physicist is a member of the French delegation to ISO, the leader of the control banding project in TC229 WG3 (cf. chapter 4), and an active participant in the nano responsible project (cf. chapter 5). In Grenoble, the concern for the public is also visible. Chapter 2 described the numerous initiatives of the local science center, and its involvement in the display and practice of the "public debate" about nanotechnology.

It thus appears that Grenoble is a place where the identity of nanotechnology as an assemblage of objects, futures, concerns and publics is clearly visible. Accordingly, critical social movements in Grenoble consider nanotechnology as an entity that need to be understood not as a collection of disparate applications, but as a global and heterogeneous program.

Against the Grenoble model

In June 2006, the *Minatec* research center was officially inaugurated. Jacques Chirac was expected, as well as other ministers and multiple representatives of French and European research institutions. Yet what should have been the symbol of the success of the Grenoble model was disrupted by a demonstration on the streets of the city. Allegedly the first anti-nanotechnology march in the world[3], the

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[1] Cf. (Hubert, 2007).

[2] These conferences are held within a European project called *NanoSafe* (www.nanosafe.org, accessed December 12, 2010).

[3] This is a claim the activists made. I did not find other examples of a demonstration against nanotechnology before this date.

demonstration, which gathered about 1,000 people, had been announced on the website of the *Oppositions Grenobloises aux Nécrotechnologies* (OGN) – which had caused, according to the activists, the defection of the President and eventually the shift of the inauguration day from June 1st to the following day[1]. The OGN demonstration was only a culmination of a series of actions opposed to nanotechnology, which had taken various forms in the Grenoble area. Activists occupied a crane in 2003 during the construction work of the *Minatec* research centre, and organized various counter-events in bars comprising movie projections and discussions about nanotechnology. A parody of the local information bulletin was distributed in 2005: this hoax announced the dissolution of *La Métro* and the cessation of nanotechnology research in the area. Over the 2000s, the contestation of nanotechnology became visible in Grenoble as "no nano" mottos appeared on the city's walls. At a national level, activists interrupted "dialogue days" at the Paris Cité des Sciences (cf. chapter 2), and in 2009, public meetings during the national public debate on nanotechnology (cf. chapter 3). But the most important production of the anti-nanotechnology activists in Grenoble was by far the writing of texts, in which anonymous authors would describe the tight connections between the Grenoble scientific, industrial and administrative actors engaged in the promotion of nanotechnology.

At the origin of the contestation of nanotechnology was a group in Grenoble called "Pièces et Main d'Oeuvre" (PMO), which defined nanotechnology as a "necrotechnology", that is to say a technology that has to do with "death" (Greek: necros)[2]. Indeed, the activists described scientific research in Grenoble as part of a global program of control over nature and human beings. PMO targeted the blurring of boundaries that nanotechnology produced. By merging biology and physics in the making of hybrid objects, such as diagnostic tools and brain implants, nanotechnology, so the activists argued, was a threat to the integrity of the human body, and a potential provider of devices controlling human beings; by associating fundamental and applied research, academic and industrial research for the sake of economic development backed by public and private actors, it destroyed the autonomy of science (including social science), and subsumed the public good to economic interests. This position is fuelled by frequent references to Ellul's and Illich's works, as well as Dupuy's "metaphysical program" of converging technologies (see chapter 6). It also made direct references to the activities of the Canadian NGO ETC Group, which was the first civil society organization to call for a moratorium on nano substances in 2003. The director of ETC Group marched in the streets of Grenoble with the local activists during the *Minatec* demonstration.

PMO is composed of no more than a few people, who are joined by other activists in planning activities, writing texts, or demonstrating. Hence, speaking of the "anti-nanotechnology activists" should

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[1] "Minatec: inauguration policière", *Opposition Grenobloise aux Nécrotechnologies*: http://www.piecesetmaindoeuvre.com/spip.php?article77, accessed Dec 2, 2010.

[2] The material for the analysis of PMO is based on observations of activists' meetings, interviews in Grenoble and texts written by activists (available on the group's website, or distributed during meetings).

not suggest that they form a consistent social movement. They are mostly a collection of people coming from various backgrounds, most of them being loosely associated with various activist groups. Consider the trajectory of a member of OGN, interviewed in a radio program:

I was trained as an engineer. I worked for a big company. After a few years of this work, I was fed up with dissociating my professional consciousness and my moral consciousness, (...) I felt a dissonance between my principles, which lean toward ecology and democracy, and my work. I decided to quit, for a life with much less money but also many more friends and much more political concerns. Since then, I gravitate among the opponents of the race for high-tech. Not only in this group though.[1]

As this person, the activists I interacted with (in interviews or meetings) were mostly educated people, who had decided to engage "against technology". What an engagement "against (nano)technology" means will be explored at length in the following pages. At this stage, suffice it to say that the activists' description of the "Grenoble model" is quite different from that of public officials. For the activists, the Grenoble model is not a success story in terms of technological and economic development, but rather an illustration of the increasing domination of market interests without public legitimization, eventually resulting in the weakening of democratic processes of decision-making.

Hence, when discussing the close relationships between industry and basic research, activists point to how this is mainly the result of the significant engagement of private capital in military research. A symbolic figure like Louis Néel is thus deconstructed as a representative of unacceptable contacts between basic research and military and economic interests[2]. For the activists, nanotechnology research is a manifestation of another type of convergence, that of political, scientific, military and economic interests, which leads to decisions based on military or market interests, and, therefore, opposed to the general interest. Decisions in Grenoble, the activists claim, are made by a small group of people without prior consideration of citizens' interests. Officials and scientists constitute what the activists call the "techno-gratin", i.e. a small elite group that has close ties to one another. The case of the mayor of Grenoble, a former engineer in CEA and founder of a spin-off research center, is often used to illustrate this situation. This criticism is reinforced by the connection to local events apparently not directly connected to technology itself. For instance, the activists' definition of the 'Grenoble model' includes references to past corruption scandals that involved high-rank local officials[3]. Another example is the arrest of demonstrators by the police during the demonstration against *Minatec* in June 2006: this

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[1] Excerpt from the radio program *Là bas si j'y suis*, France Inter, "Nanotechnologies: refus de modernité ou d'inhumanité?", June 2, 2006.

[2] PMO, 2004

[3] Alain Carignon, mayor of Grenoble from 1983 to 1995 was involved in a corruption scandal and sentenced to jail for 5 years.

was interpreted as an attempt to enforce decisions about technology, as was the police intervention during the inauguration of the Grenoble nanotechnology exhibit (cf. chapter 2). As such, it was seen as another example of the program of control inseparable from scientific research.

The growing concern of local officials for "risks" and "ethical issues" was included in the critique of nanotechnology. As the activists said:

If nanotechnology has been criticized in Grenoble for four years, it is not because of its "possible abuse" or its "unwanted and unforeseen side effects", but because of the world view it represents[1].

Such critique is not foreign to others, which, in the case of biotechnology, have been shown to be framed less in the language of "risks" that could be assessed and managed than in terms of interrogations about global programs relying on political and economic choices, and about the capacity of official institutions to deal with emerging technologies[2]. In this case as in others, the reduction of technology's problem to a matter of risk management[3] solidifies a role for the citizen based on the recognition of the importance of technical expertise for the examination of risks, and the exclusion of the long-term objectives of technological development from the scope of public discussions[4]. This was well perceived by anti-nanotechnology activists, who integrated this refusal of the "reduction to risks" within a form of action directed toward the critical examination of how decisions were made in Grenoble. This is what PMO articulates through the notion of "critical inquiry", which implies that the activist performs a detailed examination of the local decision-making process, and thereby proposes a form of citizen action contradicting that of the model of the "reduction to risks".

'Public Dialogue' as another locus for oppositions

The opposition to scientific projects was not ignored by local officials. The local councils commissioned various events that were variably described as 'dialogues', 'debates' or 'forums'. At the initiative of a councilor of a minority group, *La Métro* commissioned a report to a group of STS scholars

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[1] "Nous n'avons pas peur, nous sommes en colère", http://pmo.erreur404.org/spip.php?article80, accessed Dec 12, 2010.
[2] Marris et al., 2001 provides a thorough study of public perceptions of biotechnology that gets to this conclusion.
[3] Heller (2002) used the term "riskification" to designate this process.
[4] See Wynne (2003a) on a discussion of the constructions of citizenship through the framing of public issues in terms of risks.

in 2005. They were asked to work on nanotechnology and the local democracy in the Grenoble area[1]. The report made the importance of the Grenoble model explicit, and recommended that participatory mechanisms should be put in place. It recommended in particular the organization of a citizen conference – which was ridiculed by PMO, as a lame attempt to display a fake concern for democracy while continuing supporting nanotechnology development[2].

No citizen conference was then organized, but *La Métro* commissioned a series of public debates called *NanoViv*, which the civil society organization Vivagora organized. We encountered Vivagora in the previous chapters, as it was involved in the making of the nano responsible norm at AFNOR (cf. chapter 5) and in the organization of the Ile-de-France (cf. chapter 3). When it intervened in Grenoble, it had been working on nanotechnology for a couple of years. It had organized a series of public meetings in Paris about nanotechnology, which were meant to "expose the opposing views", "confronting the arguments", and eventually "come up with recommendations" for a "more democratic, more transparent, more inclusive governance of nanotechnology"[3]. The same model was followed in the organization of *NanoViv*.

In Grenoble, Vivagora and PMO directly opposed each other. As the director of Vivagora, Dorothée Benoît-Browaeys, asked PMO to participate in the meetings she was organizing[4], the activists released texts in which they explained that *La Métro* was "trying to recruit them" – and that they would not participate in this "parody of public debate"[5]. For them, any public debate could be nothing but a component of the global nanotechnology program, which was to be mobilized against. Vivagora was not luckier with the administrative and scientific officials: they were "asked to participate in the meetings"[6] but no official acknowledgement of the recommendations was produced at the end of *Nanoviv*. These recommendations were general, and mostly targeted the "lack of transparency" in nanotechnology research in the Grenoble area as they were advocating regular discussions with civil society organizations. They were not well received among Grenoble officials. Years after the Grenoble debates, scientists and officials who had participated in the debate would still regularly tell me that "Vivagora had made up the recommendations".

For both activists and Grenoble officials, the intervention of Vivagora was to be criticized. For the former, it intervened in the very making of nanotechnology policy (of which dialogue was a central

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[1] Joly et al., 2005; interview with J. Caunes, councilor at *La Métro*. Caunes was a councilor from a minority group who advocated "public dialogue". There were oppositions at *La Métro* about the calls for social scientists. I did not attempt to describe them in detail.
[2] PMO, "La Métro tente de recruter pièces et main d'oeuvre", http://www.piecesetmaindoeuvre.com/spip.php?article56, accessed Dec 12, 2010.
[3] Vivagora's internal document.
[4] She used PMO's anonymous email address
[5] PMO, "La Métro tente de recruter Pièces et Main d'Oeuvre", http://www.piecesetmaindoeuvre.com/spip.php?article56, accessed Dec 12, 2010.
[6] The phrase was used by a Grenoble scientist in biomedicine (interview, Grenoble, January 2007).

component to ensure at best the "management of impacts" of an unquestioned technology program, at worst the "enrolment" of passive populations) and thus could not pretend to observe nanotechnology from the neutral position PMO contended to occupy. For the latter, Vivagora was involved in ways that went far beyond what it was paid for (i.e. organizing public discussions through which "nanotechnology and its impacts could be presented in a manner that would take the heat out of the debate"[1]). Vivagora's interventions could have been acceptable if it had been an expert in public debate (like the poll institutes and the citizen conferences seen in chapter 3), but its inability to solidify the procedure, to make it independent of the object being discussed, and to eventually produce uncontested results, made it a target for the critique of the Grenoble actors[2]. The alternative propositions of Vivagora - defining nanotechnology as a project to be collectively constructed, and the citizen as an active participant in the construction of local nanotechnology programs- were accepted neither by the proponents of the "reduction to risk", nor by the advocates of critical inquiry.

Two forms of social mobilization in Grenoble

Grenoble is a site from which the components of nanotechnology appear clearly. In Grenoble, many of the actors encountered in the previous chapters meet, as the local construction of development projects is connected to the global construction of nanotechnology. Ethical concerns are voiced, nano substances are contained and filtered as risks are taken care of, and nanotechnology's publics are engaged. It is a place where the development of nanotechnology as an entity gathering objects, futures, concerns and publics is undertaken in a visible way. In Grenoble, one cannot reduce nanotechnology to a set of unconnected applications, to a problem of risk management, or to anticipatory visions. Accordingly, it is the place where some forms of social mobilization consider nanotechnology as a global program to be targeted, in ways that differ from those of the civil society organizations we encountered in the previous chapters. Opposing a model sustained by local officials, which contends that nanotechnology should be developed for the sake of local economic development while the citizen recognizes the validity of expert knowledge and witnesses the management of the risks of each individual nanotechnology product, anti-nanotechnology activists define nanotechnology as a global program of control over nature and human beings, against which citizens need to engage through critical inquiry. This latter proposition implies that activists refuse to engage in participatory activities, in order to

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[1] Interview with H. Mialet, city councilor, January 2007.

[2] Similar problems occurred for the social scientists asked to advise the local administrative bodies in Grenoble (cf. p.407). The report written by a team of STS scholars and commissioned by *La Métro* was never followed by concrete actions. The experience was reflected on by two of the authors of the report, who discussed the practical difficulties of the abstract "upstream engagement" objective (Joly and Kaufmann, 2008).

critique them – as components of the global nanotechnology program they oppose. In arguing for the "democratization of nanotechnology", Vivagora takes a different stance that contends that nanotechnology should be open to collective discussions, which the organization would be in charge of setting up. This seems to imply that the mobilization is based on procedures meant to transform nanotechnology into a series of projects to be constructed by engaged actors, whether experts, administrators, or interested citizens – a proposition that was not well received in Grenoble.

The two following sections describe successively the cases of PMO, and Vivagora, and analyze the "publics" and "problems" of nanotechnology that their respective engagements produce. Each case is based on a particular construction of distance to nanotechnology as the object of social mobilization: critique at a distance in the first case, intervention in the construction of technologies of democracy in the second. As it will appear in the remainder of this chapter, the solidification of PMO's critical distance requires constant care, while Vivagora evolved from the organization of dialogue processes expected to "democratize nanotechnology" to more complex constructions of the distance to nanotechnology. Thus, both forms of engagement will appear more complex, subjected to trials, and highly dependent on constant investment in order to be stabilized.

Section 2. Engaging against nanotechnology

Grenoble is a perfect place to identify a critique of nanotechnology considered as a global program that needs to be rejected as such – and not because of accompanying "risks" or "ethical issues" that could be adequately managed if taken into account. In the following, I describe some of the characteristics of this critique of nanotechnology, the democratic order it constructed (and, consequently, the form of social mobilization it proposes), and the trials it needs to pass in order to stabilize itself. I start by describing the refusal of the anti-nanotechnology activists to gather into a social movement, and the demonstrations on which they base their engagement. This leads me to analyze their oppositions to the political parties and civil society organizations engaged in nanotechnology. I then describe the difficulties the anti-nanotechnology activists need to overcome in order to stabilize the exterior position on which they base their critique.

Demonstrations without a social movement

Anonymity

A first important point in the critique proposed by PMO is the anonymity of its voice. This is not trivial, as constant complaints are heard on the part of officials and scientists, who blame the opponents for not "playing the game of democracy" by "refusing to appear as persons with a name"[1]. That democracy is at stake is certainly the case. Not because PMO would not follow the "rules of democracy", but because it proposes a model of citizenship in the democratic society based on "critical inquiry" (*enquête critique*) performed by an individual and neutral "simple citizen" (*simple citoyen*), situated outside of the making of political, economic and technical decisions. As one of the members of PMO explained:

Refusing to display our identities was deliberate. There are so many people who want to be known ("se faire un nom"). *We are not here to build our notoriety; we do not want to be celebrities on these topics* (…). *There are three types of authority: scientific, political and related to the media. We have wanted to act out of all that. Judge us on what we do* ("sur pièces"), *on the texts we write, which are all sourced*[2]

[1] These expressions are excerpts from an interview with a city councillor (Grenoble, January 2007).

[2] Excerpt from the radio program *Là bas si j'y suis*, France Inter, "Nanotechnologies: refus de modernité ou d'inhumanité?", June 2, 2006.

Constituting PMO into a social movement would have meant that the group would have fought for a particular stake, whereas it precisely sought to avoid being part of the negotiation game. Rather, it preferred to conduct critical inquiry, through which a fine-grain description of the interests of the involved actors could be performed. Such position is not foreign to social science. It echoes that of Bourdieu's sociology, which objectifies social categories in order to conduct the (social) scientific demonstration. For the Grenoble activists, the problem of exteriority was solved not by the recourse to reflexivity, as social critique would have done through the "objectification of the process of objectification"[1], but by anonymity - a necessary requirement for the critique of PMO to be articulated.

This directly impacts the form of mobilization, as the contestation of nanotechnology cannot be constituted into a "social movement". PMO itself is composed of mostly a couple of people, while friends set up the website, and friends of friends organize meetings and debates. A student at Grenoble University who had written a humorous (and critical) account of one of the *NanoViv* public meetings thus explained during an interview:

Yes, we all know each other… I had a friend who knew Yannick (the initiator of PMO). *I went to a few meetings in Grenoble. I had a good idea of what is happening in Grenoble. In this case, I found it fun to write a short piece (…) This is often how it works. Someone takes the initiative to write something, and then we circulate it. There is not much more organization.*[2].

This does not mean that no organization exists at all. There are indeed multiple connections between people interested in the contestation. Information is exchanged, informally as the previous quote illustrates, or through alternative web media platforms[3]. An ad hoc group of people (called OGN, for "Opposition Grenobloise aux Nécrotechnologies") organized the demonstration against the inauguration of *Minatec*. They came from various backgrounds, and gathered people that were concerned with various technological issues:

What interested me in the Opposition Grenobloise aux Nécrotechnologies was that many people concerned with these issues were present, knowing that we don't all share the same political ideas, the same philosophy, etc. But we told ourselves 'we will do something together. We will gather together to have more strength, we will work together for 6 months (…). OGN, it's 40 people, maybe 60 if you enlarge it. But yesterday night, there were 400 people at

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[1] Bourdieu, 1980

[2] Interview Grenoble, January 2007

[3] *Indymedia Grenoble* is one of them. It is part of a global network (Independent Media Center, Indymedia) created after the demonstrations in Seattle in 1999 and devoted to independent information on an anti-globalization agenda (Morris, 2004).

the public meeting we organized on nanotechnology. It's huge for a topic like this. People joined us from all over the country[1].

The networked and loose organization of the anti-nanotechnology activists could allow the "converging fights" to be brought together:

The idea is also to federate a maximum of fights, to weave links with other groups (...) There are people coming from Toulouse who mobilized after AZF (an industrial accident in 2001). *They came to help us. When they need it, we will come and help them. There are people fighting against GMOs, who came from Tarn, from Ariège. Well, against converging technologies, we try to organize the convergence of fights. The idea is to weave links among all the fights against the race for high tech overlooking social, environmental and health consequences*[2].

The diversity on which OGN was built was not meant to found another social movement, with interests to fight for. As the members of OGN repeatedly claimed and announced on their website: "the website will disappear after the demonstration". OGN was merely a temporary organization expected to ensure that the converging fights would result in the first anti-nanotechnology demonstration.

<u>*Demonstrations*</u>

The anti-Minatec demonstration is interesting, since there is more at stake here than a few hundred people marching in the streets of Grenoble. The notion of "converging fights" points to a central concern: critical inquiry is meant to be a focal point where all the potential issues of discontent should converge in order to render the strength of the contestation visible. This leads me to a central aspect of the anti-nanotechnology mobilization, that of *demonstration*. Andrew Barry used the term to describe the "public proofs" performed by activists. Performing these public proofs can be understood in terms of the scientific demonstration as well as that of the social event. Barry's example to illustrate this point is a case of mobilization against a planned highway in the British countryside, in which the demonstration being made was that of the connection between the people and the land[3]. The demonstration that the Grenoble anti-nano activists propose is of a different nature, and brings together a wide range of public proofs. First, PMO and its friends in the Grenoble area have worked hard to render visible the multiple connections that constitute the "techno-gratin", i.e. the network of people in

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[1] Excerpt from the radio program, *Là bas si j'y suis*, France Inter, "Nanotechnologies: refus de modernité ou d'inhumanité?", June 2, 2006.

[2] *Ibid.*

[3] Barry, 1999

scientific, industrial and administrative spheres that regularly interact and allow the Grenoble model to be sustained. One of the most distributed productions of PMO is a graph that displays the multiple links between the officials in the local administrative bodies, the industries, and the management of scientific research. Connected to this representation of the control of the local decision-making process by a small group of people is the demonstration of the physical transformation of the city of Grenoble, by the occupation of a crane during *Minatec* construction work. Hence, the demonstration was a core component of the critical inquiry PMO proposed. The argumentative demonstration was to be displayed in literary and other supports. It was also complemented by ironic and humorous interventions: the parody constitutes a second type of demonstration performed by the anti-nanotechnology activists. Consider for instance the description of a personal chip card presented in a fake official information newsletter of the local council: the card, named "Lybertis", was supposed to be mandatory, and, "thanks to nano electronics", able to store all potential information about its holder's activities. The initiative, "a progress for society" as the president of the local council was supposed to have said, was accompanied by an ethics committee supposed to "make sure that everything is being done the right way". This first example targets the uselessness of the intervention of ethics in a context where everything is decided out of every moral principle people would ordinary accept. The national nanotechnology debate organized in France in 2009 by the *Commission Nationale du Débat Public* (CNDP, cf. chapter 3) provides a second example. Playing on the fact that the public debate was supposed to "be inclusive", and "have anybody speak", a man dressed in black spoke for 10 minutes at the beginning of a meeting in Marseille in December 2009, complaining that there were "no ecclesiastic in the room". In both examples, the attempts to include as many components as possible in nanotechnology (whether ethics issues or publics to engage) were ridiculed.

Demonstrations performed by the anti-nanotechnology activists were spectacular interventions meant to render the critical gaze directed toward nanotechnology immediately visible . They required infrastructure to make sure they would circulate and be actually visible for as many people as possible. Thus, anti-nanotechnology activists constructed, outside the scope of the official one, a parallel public space composed of websites, independent media, and places in the Grenoble area (and, during the CNDP debate, all over the country) where public meetings were held and activists discussed nanotechnology. In so doing, demonstrations were meant to render the contestation visible, so that it could transform the audience into critical citizens, able to join the ranks of the activists.

For the local officials and research administrative actors, PMO was "not representative". As a member of the Grenoble city council said:

An overwhelming majority of people supports the development projects. These people are a tiny fraction of Grenoble inhabitants... They're not representative[1].

The same type of critique ("not representative") was repeatedly heard during the CNDP public debate. The "non representativeness" was a recurring critique of the president of the Commission, who would present the number of connections to the website, the number of participants in the public meetings, and would compare these figures with the "reduced numbers" of activists[2]. Whether the quantitative arguments hold true or not[3], the critique misses the point. That anti-nano activists are not numerous is not what matters, since the type of critique they articulate cannot be differentiated from the particular format of action they propose[4]. Spectacular actions are part and parcel of the very objectives of PMO's mobilization, that of turning passive people into critical citizens. As such, they are not expected to "represent" particular stakes or social groups. Rather, they propose a type of mobilization that considers that there is no other way for the citizen to mobilize against nanotechnology than through the association of critical inquiry and spectacular demonstration.

The enemies of the simple citizen

<u>*Critics vs. managers*</u>

In the model of the critical inquiry that the anti-nanotechnology activists propose, the figure of the "public" of nanotechnology is twofold. One the one hand, the "official public" is part of nanotechnology programs, which comprise public meetings, dialogues and forums, and measures of public opinion. On the other hand, the "critical citizen" is expected to put nanotechnology at a distance in order to demonstrate the interests behind their development and the noxious links on which it relies. Thus, the "public" of nanotechnology, and its "problem" is conceived at two separate levels by PMO. On the one hand, the "problems" of the "impacts" of nanotechnology and their associated publics fit

[1] Interview with a city councilor, Grenoble, January 2007.

[2] I saw the president of the Commission doing this presentation in two conferences in 2010. Other presentations were reported to me by the actors I interviewed.

[3] The quantitative argument is not that certain. According to one of the members of the expert group assisting CNDP in the organization of the debate, CNRS (a public research body) told laboratories to ask their researchers to come and fill up the rooms.

[4] I paraphrase here a remark made by Dubuisson-Quellier and Barré about the anti-advertisement movements. Their argument is a little bit different, since they argue that the format of mobilization, by requiring collective action, allows individual commitments to gather into a collective movement (Dubuisson-Quellier and Barré, 2007: 211). This dimension is certainly present in this case, as spectacular actions are opportunities for activists to meet and act in common. But they are not meant to be the basis for the construction of a social movement, as argued above.

perfectly well within the global nanotechnology program that is to be rejected. On the other hand, nanotechnology *as a global program* is a problem for which individual critical citizens need to mobilize – under a specific format that cannot rely on the constitution of a social movement with identifiable stakes (and which could easily be included in the global program) and is grounded on spectacular demonstrations.

This means that anti-nanotechnology activists extend their opposition to the contributors to the global program of nanotechnology, be they social scientists or social movements. Hence, PMO produces numerous critical accounts of social science, whether commenting on STS scholars advising *La Métro* to organize a citizen conference[1], or discussing the concepts of "technical democracy" – which does not question, according to the activists, the very logic of technologic development[2]. Civil society organizations involved in public discussions about nanotechnology were also directly targeted by PMO's critical inquiry. Consider, for instance, an episode involving the Grenoble branch of the left wing, anti-globalization organization ATTAC. ATTAC got concerned about local nanotechnology projects in the early 2000s. When the Grenoble members of ATTAC interviewed Claude Feuerstein, the president of the local university, who was a promoter of the *Nanobio* project, PMO commented on the preparatory phases of the hearing on its website. It used an internal document prepared by ATTAC, which comprised a list of questions Feuerstein should be asked[3]. Among the issues to be discussed were the "problem of risks", and the "economic concept" (that is, the use of public money for private development). PMO commented on the episode as follows:

In February 2002, Ethics Feuerstein (a pun on the insistence on "ethics" voiced by the president of the university) *already congratulated himself about the "serious, constructive dialogue" led with ATTAC (…): hence one can say one is "against globalization" in general and ignore the commercialization of the living here in Grenoble (…). Good consciousness and bad faith, a well-known association…*[4]

The critique performed by the "simple citizen" was restated, and included ATTAC itself in its scope:

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[1] PMO, *La Métro tente de recruter Pièces et Main d'Oeuvre*, http://www.piecesetmaindoeuvre.com/spip.php?article56

[2] *Ibid*. "Technical democracy" is an expression used in (Callon et al., 2001) (*démocratie technique*). PMO members are familiar with this academic reference.

[3] How PMO got this information is another story. When asked about the origins of the information it released on the website, PMO members explain that "they have friends in many places", and mentioned "labs", "administrative offices", and "social movements" (interview, Grenoble, January 2008).

[4] This is an excerpt from a text written by "simples citoyens" (2002), commenting on an ATTAC internal document that prepared the meeting with Claude Feuerstein.

Beyond hazards (…) it is against the Grenoble model of development that we protest, against the domination of industry on science, against the technologization of Grenoble planned by the technogratin (…)

The problem is not about safety (the risks), economy (public investments, private gains), ethics (scientific morals), but develops from these three registers to reach the political field. What world do we want? Brave new world? Or is another world possible? These are questions the board of ATTAC-Isère was not able to ask.[1]

Hence, local civil society organizations were scrutinized by PMO, which was attentive to making their integration in the very making of nanotechnology policy visible. Accordingly, PMO was careful to distance itself from the activities of civil society organizations, Green and left-wing political parties. The first critique was that of a late intervention on the topic of nanotechnology, at a time when PMO had been vocal on the topic for a number of years. For instance, one of the pamphlets of PMO ridiculed the reaction of the Green party after the anti-*Minatec* demonstration, by explaining that ecologists re-used with years of delay the same arguments as PMO's only attenuated by a shift from the global critique to a reduction of nanotechnology concerns to problems of "risks":

This encyclical (…) re-uses elements and references of PMO's texts. The added value of the Green consists in using "mega risks" instead of "maxi servitude". And this is not insignificant. "Big risks" are not equivalent to "maximal servitude". "Major risks" are the political niche of ecotechs[2]*. And we know how they respond to them: by the "risk culture", i.e. by the domestication of population, alert exercises, iodine pills, containment, "awareness" meetings organized by Kermen* (a Green councilor in Grenoble)*. As for ourselves, we have no doubt about the meaning of the development of nanotechnology: this is an irresistible move toward techno-totalitarianism.*[3]

The critique is more than that of an earlier involvement. It is also a denunciation of a questionable silence at a time when PMO was already alerting against nanotechnology projects. For instance, PMO described as follows the intervention of a local left-wing councilor, who voiced concerns about nanotechnology after the inauguration of *Minatec*:

It would have been easy for him and all those of his group to alert us on Minatec, Nanobio and Cie. He could have alerted us about the projects the techno-gratin prepared for us (…) Let us say this: we have been looking for information about Biopolis for a year: they have been acting in perfect solidarity with their colleagues. They have respected the secrecy of the decision-makers, and have ignored the critiques (…) And this is how you participate

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[1] *Ibid.*

[2] PMO calls "ecotechs" the Green parties involved in the collective management of industrial risks.

[3] PMO, 2006, *La Gigue des Nanos*

through these doubles agents in the reinforcement of domination while you could think you were helping the contestation.[1]

The last sentence is important. The "double agents" are "publics" of a "problem", that is, part and parcel of nanotechnology programs. They "manage instead of critique", which, for PMO, cannot constitute a mobilization against nanotechnology:

It is thus useless to distinguish, as Raymond Avrillier and Maryse Oudjadis (two councilors from left wing parties) *do, between what would be "dangerous" and the "interesting technologies.*[2]

The "managing position" that the green and left-wing organizations and parties have adopted in Grenoble, so PMO's arguments go, contributes to stabilizing a problematization of nanotechnology that seeks to deal with the "impacts" of technological development without questioning its logic, for the sake of little more than petty advantages like electoral gains through alliances with majority left-wing political parties[3], or financial support from official administrative bodies[4].

Historical oppositions

PMO makes explicit its opposition to the civil society organizations intervening in Grenoble nanotechnology programs through a historical reconstruction that goes back to the past internal fights within the anti-nuclear movement in the Grenoble area. Members of PMO participated in the anti-nuclear mobilization in the 1970s, which culminated in a demonstration against a nuclear power plant in Creys-Malville in 1977, during which one of the demonstrators died. The question of violence at Malville, and, behind that, the possibility of fighting against the State supporting nuclear industry was a heavily debated issue among the anti-nuclear movements: PMO's reading of the story presented the "non violent" side of the activists as responsible for the poor organization of the 1977 demonstration, and, eventually, of the failure of the mobilization to continue its opposition to the nuclear industry, as the leaders of the nonviolent side were gradually occupying official administrative positions in the public management of the environment.

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[1] PMO, *Grenoblois, encore un effort pour être républicains!*
[2] *Ibid.*
[3] *Ibid.*
[4] For instance, PMO insisted during the national nanotechnology public debate on the financial support *France Nature Environnement* (FNE, the only environmental movement that followed the entire process) received from the ministry of ecology, and called FNE "*écologistes à gages*" (paid ecologists), who were "colleagues" of the public bodies.

The history reconstructed by PMO[1] is telling, as it presents a continuous movement meant to distance the critique from compromises and losses. What matters here is less the "real" history than the stability of the critique: from Grenoble, PMO reconstructs the history of activism, and this provides an interpretation of social mobilization, and a critique of those who are connected with local administrative bodies and want to play the game of negotiation. Contrary to them, the anti-nanotechnology activists contend that technology policy is to be fought from the outside – violence being the ultimate way not to enter the encompassing extension of technology policy.

Hence, the creation in 2009 of a *Collectif sur les Enjeux des Nanotechnologies à Grenoble* ("Collective for Nanotechnology Issues in Grenoble", CENG), composed of city councilors[2], union leaders, and ecologist activists, was interpreted by PMO in the continuity of the Malville story – which was all the easier as members of CENG had been members of the "nonviolent" side of the anti-nuclear movement. CENG meant to "question the local processes of nanotechnology development". For the founders of CENG, PMO "had a point" in the critique, and it was necessary to continue investigating local decision-making processes[3]. Thus, CENG would undertake legal actions in order to gain information about research projects funded by public money. But for PMO, the CENG was merely a tool "meant to accompany the development of necrotechnologies":

What have these people been doing for six months? They have been playing the game of the middle ground ("le juste milieu"). *"Our objective is certainly not to develop pro or anti-technology, pro or anti-nano discourses", explains* ("glougloute") *François August* (a member of CENG) *on the World Social Forum website. Neither for nor against. One can see the high vision of these fake activists. "We want to engage in a true discussion" explains seriously Jean Caunes to the Daubé* (pun on the name of the local newspaper). *They both swear: "We are not anti-nano". That's a relief!* (ouf.). *(...) CENG is a chance for Grenoble. Thanks to its contribution, the nanoworld will be sustainable, fair and citizen-friendly.*[4]

PMO considers that the "neither for nor against" position cannot perform the critique work, which requires a stable exterior position. This implies a critique of actors unable to maintain a stable distance to nanotechnology: ethicists who intervene in the making of nanotechnology, sociologists who advise local administrative bodies about the need for "public debates", ecologists who discuss with officials the management of the impacts of nanotechnology developments. The at-a-distance position cannot allow the anti-nanotechnology activists to participate in participatory mechanisms (they are part

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[1] This is presented in a text written by PMO and entitled "Memento Malville".
[2] J. Caunes, who had been at the origin of the commissioning of a report to sociologists about the public debate on nanotechnology in Grenoble (Joly et al., 2005; cf. section 1), was a founding member.
[3] Interview, R. Avrillier, Grenoble, January 2007.
[4] PMO, *Aujourd'hui le nanomonde*, 15 juin 2009.

of the global nanotechnology and need to be considered as such), and causes them to critique the groups who do so. For when social movements try to participate in participatory mechanisms, they are caught in the game of the debate from which, according to PMO, they have no hope of emerging in a positive fashion. Consider the example of les *Amis de la Terre* (the French branch of Friends of the Earth), which initially participated in the national CNDP public debate, but later withdrew from the process. PMO commented on the event as follows:

Not only have les Amis de la Terre *been used to serve the interests of the organizers* (servir de caution), *but they have also accepted the humiliation of facing the most arrogant of nano-career people.*

The "humiliation" occurred because the Amis de la Terre agreed to discuss with experts on equal grounds, thereby entering an argumentation game based on the very premises PMO sought to counter. Thus, PMO quoted a dialogue between the representatives of the Amis de la Terre ("Mme Frayssinet"), and a researcher: ("M. Vieu")

- M. Vieu: *(…) refusing knowledge, it's opening the doors to ignorance, to potential manipulation. When you say that nanoparticles will be diffused everywhere, where do you get this information from? Who told you that?*
- Mme Frayssinet: *there are tyres with carbon nanotubes, as they get old… There are nanoparticles in concrete. I am just reading what is written*
- M. Vieu: *nanoparticulate matter has been used for centuries*
- Mme Frayssinet: *the problem is that it will be done at such a high level that…*
- M. Vieu: *you are explained that this matter and these effects will be better understood. You are refusing this understanding. This is strange position.*[1]

PMO then concluded blandly: "Here is what comes out of lowering oneself down to the level of the expert", thereby noticing an impossibility to dialogue with the expert. The first reason for participating is that there is no exchange to have with experts, since the problem is not about risks but about the "global program of nanotechnology". The second, and more general reason is that the very problematization that the public debate enforces is contestable: the very logic of the discussion with experts has no hope to allow civil society representatives to make their ideas heard.

[1] PMO, Grenoble 16 janvier 2010. Excerpts from the transcripts of the CNDP public debate.

Constructing distance to nanotechnology

The refusal of nanotechnology that PMO proposes is more complicated than a request for a moratorium, as some civil society organizations advocate[1], and which requires boundary work in order to distinguish what is "nano" and what is not. By defining nanotechnology as a global program comprising social science and participatory procedures, and the form of mobilization as spectacular demonstrations grounded on critical inquiry, PMO refuses to enter the process of definition of nanotechnology from within, and blames what shifts and blurs boundaries: scientific developments that are at the same time economic development programs, social scientists who intervene in the conduct of nanotechnology research, and opponents who discuss with industrialists. PMO seeks to stand at a distance from the technologies of democracy experimented to stabilize nanotechnology, in order to undertake their critique.

Hence, the whole challenge of PMO's social mobilization is to maintain this distance. This is not an easy task, especially because of the constraints of the demonstration, which requires spectacular actions gathering participants from diverse activist origins within the converging fights, and because of the nature of nanotechnology as an enterprise that is expected to integrate its own critique. In the following, I thus illustrate two examples of trials PMO faces in the construction of its distance to nanotechnology.

Re-affirming the distance

As anti-nanotechnology activists participate in numerous events and activities, they might cross the trajectories of other actors, whose integration in the converging fights might appear possible, but uncertain. Consider for example an event that happened in 2007 in a town called Die, located south of Grenoble, where a parodic theater play was supposed to be performed by a group of people from Grenoble. The play was called "NanoVent"[2] and mimicked a radio show during which typical characters of the Grenoble nanotechnology policy scene were ridiculed. The local politicians, the MPs, and the local political scientist who believed in "participatory democracy" to "make technology more consensual" were characters of the play, which wittily used the clichés routinely voiced in the Grenoble area ("nanotechnology development for the creation of jobs" being one of them). When the authors and actors of the play realized they were to perform in a room where Dorothée Benoît-Broways, the director

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[1] For instance, the Canadian NGO ETC Group has been advocating a moratorium on "nanomaterials" since the early 2000s.

[2] This is a play on words on NanoViv using "vent", meaning "empty" in French popular language.

of Vivagora, was invited to speak, they eventually refused to join and preferred to distribute tracts at the entrance of the room, explaining their refusal by the fact that

Dorothée Benoît Browaeys is in a process of acceptabilization of nanos. She thinks she works for participatory democracy, but only supports the power of decision-makers. If she is critical, it is only to limit the negative consequences of necrotechnologies, as she argues, for instance, for the co-management of nanotechnology by ethics or citizen committees. Dorothée Benoît-Browayes has already access to all the institutional channels. One day she organizes a debate in Grenoble, paid by the public bodies, the next one she participates in a parliamentary hearing in Paris or answers the questions of a journalist. Therefore, we consider that one should not also grant Dorothée Benoît-Browaeys the legitimacy of a "critical expert" in an ecology festival meant to be opposed to nanotechnology. [1]

Hence, even places that appear safe at first sight ("ecology festival" organized by local activists groups well known in the Grenoble area), and are regarded as important sites in which to intervene in order to "extend the scope of critical inquiry", may trap the activists in the global nanotechnology program. In this case, the arrangement was that the theater play was not performed, but information was circulated at the entrance of the room:

To Die or not to Die? We have thus decided – after long internal discussions – to cancel the performance of our play, without leaving the scene to Dorothée Benoît-Browaeys. The documents we brought will provide additional explanations for any interested person. Our play is a humorous introduction to the issue of Grenoble's necrotechnologies. A friendly moment we want to share. We will be back in Die as soon as we have the opportunity. Because we want to talk, inform, without seeing our words being re-endorsed for contestable reasons. [2]

After the event itself, the group reflected on what had happened, published a narrative of the night, explained the reasons for the refusal to participate, and, retrospectively, provided more arguments by analyzing the role of Dorothée Benoît-Browaeys as an "expert" of "public debate":

The way she positions herself is noxious: she claims to be one of the people critical to nanos, she uses a vocabulary that perfectly corresponds to what some of the spectators of the play would say (a non-violent vocabulary, like "we need to re-open dialogue", "what society are we going to build together?"). Similarly, in the middle of an interesting informative discourse, she introduces what she considers evident: "research has no definite aims", "nanos

[1] "Un débat contradictoire sur les nanos à Die ?!", "par un acteur de Nanovent", February 7, 2007 (http://grenoble.indymedia.org/2007-02-05-Un-debat-contradictoire-sur-les).
[2] *Ibid.*

are still there, refusing their presence is absurd"... She goes as far as saying that we are not opposed in our fights, that they is a need for diversity in the approaches![1]

In this case, the trial for the distance was an opportunity to reaffirm the position of the activists and make their differences with Vivagora clearer, possibly at the price of the limitation of their impact on the participants in the Die event, albeit limited thanks to the distribution of information and the extension of critical inquiry into the event itself.

Distance on trial

The previous example shows that the appropriate distance from which the critique can be voiced is the result of a combination of writing strategies, practical arrangements, and forms of militant activities. In other cases, such an arrangement appeared more difficult to sustain, particularly in the case of large-scale events meant to be as inclusive as possible. The 4-month debate organized in 2009-2010 by the *Commission Nationale du Débat Public* (CDNP) at the initiative of the French Government, is perhaps the best example of such devices, about which the investments necessary to maintain the distance were visible for the analyst looking at the strategies of the activists. What to do with the CNDP debate was indeed an issue for the anti-nanotechnology activists. Not that participation alongside NGOs, industries and government bodies was considered for a minute. The organizers did contact PMO and asked them to participate as an "official" member. But participating was of course not an option, for it would have meant that the activists would have entered the game of public discussions about nanotechnology. This had happened before[2]. Each of these attempts had failed, much to the pleasure of the "simple citizen", who could then laugh at the attempts made to "recruit PMO"[3]. The CNDP debate followed the same path, encountered the same refusal, and the same ironic response. Yet maintaining the distance, in this case, could not be limited to a refusal to participate. For the national debate on nanotechnology was a opportunity not to be missed to perform spectacular demonstrations: demonstrations that the device was organized by the proponents of nanotechnology, that it was driven by the interests of nanotechnology development, that participation was not an acceptable way for the citizen to act, and, eventually, that the objective of "total inclusion" was absurd.

This triggered parodic interventions during the public meetings. But the inclusive character of the CNDP device manifests itself by more than the constant effort to make people participate. The CNDP nanotechnology debate was based on the replication of a procedure used on infrastructure projects, and

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[1] *Ibid.*

[2] The authors of the report commissioned by *La Métro* on public debate about nanotechnology in Grenoble (Joly et al., 2005) wanted to meet PMO, and the organizers of NanoViv had invited them to participate

[3] PMO, *La métro tente de recruter Pièces et Main d'œuvre*

meant to be flexible enough to include every actor potentially interested in the issue being discussed. Hence, organizers of CNDP debates regularly go and look for people willing to be involved in the debate. A president of an organizing committee thus told the following anecdote, concerning a public debate about the extension of a nuclear plant:

After having talked to people, I understood there were fishermen who would go to the river, in an area that is not legally accessible. These people, well, most of them were illegal migrants. Well, it was very close to the plant. (...) And I thought it was necessary that they participated, that we, the organizers, heard their opinions about the project. So I eventually came at night trying to talk to them. Of course they did not show up in the public meetings. But I could eventually learn a thing or two. That they needed to fish in this place... simply to eat.[1]

Therefore, the CNDP device is meant to include as many forms of expression as possible, and the organizers are ready to adapt the procedure in order to look for diverse participants[2]. This was not ignored by the activists when they discussed the format of their interventions.

In February 2010, a meeting in Paris gathered about 50 people, who came to prepare for the first Parisian meeting that was to be held the following week, in Orsay, a college town to the south of Paris[3]. Many of them knew each other, as they had participated together in previous meetings of the nanotechnology public debate. There were people coming from various cities in France. Some of them had been traveling across the country, going from one debate to another. The meeting started with a presentation of the CNDP device, and of the reasons why the people gathered in the room considered it necessary to mobilize against it. After introductory talks, someone who had participated in a previous meeting in Marseilles explained the demonstrations that had happened before and how the organizers had attempted to throw the activists out of the meeting room. The meeting then proceeded to the practical examination of the actions to perform the following week, during the Orsay debate. An issue that was debated was the opportunity to stress the negative aspects of nanotechnology in order to convince people to join the anti-nanotechnology movement. The proposition was not well received:

But if we begin to examine this... we're down. Because it will mean we have to start asking questions, and looking if one can control this or that...

- yeah, I understand, but our objective is also to show that one should engage... well, it's the converging fights.

[1] Interview with PF Ténière-Buchot, former president of public debate commissions, Paris, March 2008.
[2] That the CNDP procedure is not as much solidified as the citizen conference (see chapter 3) makes this objective easier to reach. On CNDP, see (Revel et al., 2007).
[3] Quotes from this paragraph are excerpts from the notes I took while sitting in this meeting.

This problem about the stabilization of the distance to nanotechnology has been met before. It grew to a larger scale with CNDP, as activists were almost certain to reach out to numerous participants in meetings, either individuals unfamiliar with the critique of technology or members of activist groups that were, in one way or another, connected to the anti-nanotechnology activities. But "risks" could not be an accepted category for the social mobilization. This was known and accepted, and yet regularly discussed ("we're always getting back there") in a context where it was thought to be used as a tool to attract the interest of a critical citizen to be. Eventually, the object of the critique was stabilized as that of the "machine man in a machine world": this had the advantage of grasping the overall vision of a technologized society, while also allowing the activists to use as an argument the health risks produced by technological development.

Yet even if the "machine man in a machine world" was accepted as the object of the critique, the forms of the demonstration were not given, and could potentially be harmful for the activists, since it could also render explicit *to the organizers of the public debate* a position that could then be included as "the opinion of the activists" alongside that of the participants in the debate. The activists did not ignore this, as they reflected during the February meeting on the possible means they could use to perform the demonstration[1]. First, "taking the mic" (*prendre le micro*) was considered, but eliminated because of the risks that the activists would take to appear "just like the other participants". "Shouting" was another option, which caused participants to point to the fact that "what we would say would be written down in the *compte-rendu* of the debate". Discussions about the banners lasted for a few minutes. The activists had crafted a series of mottos, and published them on the website. But the problem was still present. For instance, one of the mottos claimed "GMOs, nuclear, what wouldn't you do for a salary?" (OGM, *nucléaire, qu'est ce qu'on ne ferait pas pour un salaire*), thus targeting the financial interest the organizers of the public debate would have followed in setting up the debate. At the Rennes meeting, the organizer of the debate could directly answer this critique, and start a discussion about the wages of the members of the organizing commission members ("it's a good thing you ask, because we are not paid"; *ça tombe bien que vous posiez la question, parce que nous ne sommes pas payés*). Hence, every formulation of argument within the perimeter of the public meeting, under one form or another, was to be considered within the dialogue device and then be trapped into it.

In fact, the organizers of the debate were able to devote a large part of their final report to the interventions of the activists. The organizers presented the opponents as participants who had been able to shift the debate to questions that the organizers considered more interesting ("opportunity").

The opponents justified their position by arguing that the public debate was useless since public decisions were already taken, and continued being so during the debate. For them the debate had been launched for a single

[1] The quotes in this paragraph are excerpts from notes I took during the meeting.

objective, ensuring the promotion of nanotechnology. It is evident that decisions being announced during the debate by the government let participants think that the debate had only a minor importance. This is regrettable since the debate was commissioned by the government, and deeply hindered the work of the Commission.[1]

Shifting the debate to the opportunity and the modalities of the debate itself is common within the CNDP mechanism: the interventions of PMO were said to have rendered this shift possible. More than that, the organizers re-stated the critique of the alleged "anti-democratic" positions of the activists, while also considering the positive side of their interventions in terms of the visibility it provided to the debate:

Even if the experience proves that the confrontation of arguments is hard to organize, nothing can justify a critique that prevents dialogue. One can wonder whether it is enough to shout "we don't care about the debate, we don't want no nano" (le débat on s'en fout, on ne veut pas de nanos du tout), *whether claiming that "participating is accepting"* (participer, c'est accepter) *justifies that freedom of speech should be overridden. At least – and this is not its least important paradox – the perturbation made the media look at the public debate (...). But on the other hand, the media also provided a channel for the expression of the opponents to the debate.*[2]

Some questions raised by the activists were even re-endorsed by the organizers:

Who drives industrial choices? How to control them? What governance and how far should we go in the application of the precautionary principle? In short, "what society do we want" was the question being asked during the debate.[3]

That being said, the distance was indeed stabilized, and the anti-nanotechnology were not treated as part of the actors involved. They had forced the organizers to alleviate their inclusion objectives, by conducting debates on the Internet, separate rooms open to the public and others where invited participants talked, and eventually cancelled the final public meetings (see chapter 3). Indeed, the demonstrations they conducted eventually did not even try to convey arguments. Demonstration was to be either parodic or meant to render the conduct of the debate impossible: activists would blow whistles, shout unformed words, and refuse to talk to whoever was asking them questions[4]. This was the price to pay in order to stabilize the distance to an inclusive device absorbing every argument, while in the meantime conducting spectacular demonstrations. This does not mean that no discussion occurred

[1] CNDP, 2010, *Bilan du débat public sur le développement et la régulation des nanotechnologies*: 3
[2] *Ibid.* : 4
[3] *Ibid.*: 5
[4] The anecdote was told to me by a participant of the debate who had tried to talk to the activists.

regarding the form of interventions. For instance, the fact that two women threw a bottle of ammonia at the beginning of the Toulouse meeting was commented as follows:

- *I do not approve what happened in Toulouse. I don't think we should do that…*

- (someone sitting next to me) *Nobody even knows who these girls were. They must have decided this on their own.*

In a context where many different people were gathered and no central decision-making process existed, the form of intervention was routinely discussed. But the problem it might raise was not just the moral issue of violence. It was also the practical issue of acting within an integrating device like CNDP while maintaining the exterior critical position. Following the approach adopted in chapter 3 about the replication of technologies of democracy, one could insist on the difficulties the organizers of the CNDP process met in adapting the device to the case of nanotechnology. The difficult construction of the anti-nanotechnology mobilization within this debate shows that this event was also, if not more, a trial for the social mobilization that the activists proposed.

Engaging for exteriority: a simple citizen watching the global program of nanotechnology at a distance

As the CNDP debate was held all over the country, it was also an opportunity to make the "converging fights" visible by connecting people from different cities, and exchanging information about technological development projects. Meetings like the one I attended in Paris in February 2010 were held in the various cities in France where CNDP meetings happened. The last one occurred at the same time as that of the final public debate. In a room in the North of Paris, at least 150 people met to talk about the follow-up to the debate and the actions to undertake[1]. The demonstration had been successful: the public debate had been replaced by a closed, private one, and most of the civil society organizations had withdrawn from the event. The distance had been maintained, and the "converging fights" had managed to bring together many people coming from various backgrounds and interests. During their final meeting, activists considered the future actions to undertake in order to sustain the mobilization that had been constructed during the national debate. People from various parts of the country explained that they intended to mobilize against various initiatives (such as the construction of research centers, or the introduction of chip cards in library cards). Others intervened to propose collaboration with other organizations. Someone explained that he "had been working with *Sortir du*

[1] Quotes from this section are excerpts from the notes I took while I was sitting in this meeting.

Nucléaire (a French federation of anti-nuclear organizations)" and that "there were more contacts to draw with them", while an elderly woman detailed the experience of her "friends at the *Confédération Paysanne* (José Bové's anti-GM movement)". A student in an engineering school suggested that activists "needed to explore the next steps", and described projects of "alternative design" for industrial products.

The references to other organizations were met with skepticism by many of the participants, who "knew what this (was)". Some of them were suspicious of the value of the mobilization of organized civil society groups ("there would be a lot to say about those people..."). This is not surprising considering the work undertaken to differentiate the anti-nanotechnology mobilization from the construction of a stakeholder movement. The distance at the heart of critical inquiry was eventually re-stabilized by the head of PMO himself:

> *Well the question of collaborations and practical propositions also comes back.* (But I would say that) *our role is to write texts, to display where decisions are taken, and then to spread and circulate all this.*

Thereby, he restated the importance of critical inquiry and the impossibility to partner with existing social movements, or even to propose alternatives. Hence, the necessary distance for the critical inquiry is always to be stabilized, and the critique has to be voiced from there. Any other form of action is bound to be met with skepticism by PMO members. The pessimistic position PMO holds is that if part of the critique is heard by decision-makers, then the situation will be even worse, since it will be a sign of a questionable compromise, a sign that the critique has been integrated for the sake of nanotechnology development. The objectives of critical inquiry cannot be met by politicians, industrialists, (social) scientists, or social movement activists, since reaching them would imply that funding flows are stopped, that the autonomy of science (including social science) from economic interest is never threatened, that "stakeholders" do not argue for "stake" anymore, and that the isolation of man from technology is perfect... in short, that rigid and unbreakable boundaries are constructed amidst the heterogeneous ensembles that constitute nanotechnology - fundamental and applied science, social science and physical science, technological development and economic interests. But this does not stop the simple citizen, for whom critical inquiry is almost a matter of civic duty:

> *if we had lived in Strasbourg or Toulouse, we might have mobilized against something else.. In Grenoble, it was clear that nanotechnology was to be the target. We had to go and look at it in details. This is our role, as citizens*[1]

[1] Interview, PMO, Grenoble, January 2008.

Therefore, PMO's public of nanotechnology's problems is a collection of individuals engaged in critical inquiry, and able to maintain their identity of exterior abstract observers and demonstrators without presence. Social mobilization here is both a (social) scientific model, and a political one, as it produces public objectivity and a democratic order.

One could then wonder what studying PMO means for the social scientist. Including the anti-nanotechnology movement in the global sphere of nanotechnology to be described at a distance would replicate PMO's approach. But rather than adopting PMO's exteriority solution, one can avoid introducing another distance (in the continuity of the methodological approach in this dissertation), and contrast PMO's production of exteriority with other ways of producing distance – and particularly those in which the analyst himself or herself is engaged. If we follow this approach, PMO is less an object to be put at a distance than a group of colleagues, asking, after all, pretty much the same questions as this very dissertation: that of the good description of the issue at stake, that of engagement, and that of the construction of democratic orders.

As the anti-nanotechnology activists produce facts and demonstrate their values, they rely on the exterior position to ground their arguments. Hence the difficulty they face when nanotechnology actors want to include them. The constraints of the demonstration then make it more difficult to ensure the exterior position, by rendering possible the collective discussion about the facts produced by PMO (for instance, the financial link between the organizers of the CNDP debate and the French government). The next section will contrast PMO's production of exteriority with the multiple distance produced by another organization, Vivagora, as it defines different "publics" and "problems" of nanotechnology.

Section 3. Engaging with nanotechnology

Engaging for the democratization of science

In Grenoble, the intervention of Vivagora in the organization of the *NanoViv* debate series was contested. Vivagora tried to "listen to all the actors involved", and "make visible the oppositions"[1], but failed to convince both the activists and the local officials. The objectives of Vivagora's interventions in Grenoble were, according to its director at the time, to "construct publics and issues". What this expression means will be explored in this section. This will allow me to describe a form of mobilization that draws links with multiple types of actors (experts, civil society groups, industries, administrative bodies), and proposes other definitions of the "problem" of nanotechnology and of its "publics".

When I started to work on Vivagora in 2007, the organization employed just one person, Dorothée Benoît-Browaeys. Five years later, four people worked full time, as well as a couple of interns, and part-time employees. The organization had had great ambitions about newsletters and papers to write and distribute, public meetings to organize, and "pluralist expertise processes" to put into place. These were the typical activities Vivagora was undertaking, for a large part through the work of its permanent and part-time employees, and for the rest through the involvement of the members of the organization. In early 2011, Vivagora comprised about 100 members, which made it a very small civil society organization in comparison with other structures like, in the French landscape of environmental movements, the *Amis de la Terre*, or *France Nature Environment*. Yet its influence was determining in the French nanotechnology landscape.

Pretty much like PMO, albeit in an opposite fashion, the example of Vivagora allows me to expose a form of social mobilization with nanotechnology that displaces the boundary between "participation" and "mobilization". Vivagora is an organizer of "public dialogues" – such as, in Grenoble, the *Nanoviv* debate series. One could be tempted to conceive of Vivagora as a "mediator" which would "not take part" in the discussions it helps organizing. This would separate nanotechnology from its treatment within a public debate arena, organized by a specialist that would be *Vivagora*. This, however, does not account for the activities of the organization: neither a "stakeholder", nor an "advocate of public debate" using participatory instruments independently of the issue at stake, the case of Vivagora is significant of the impossibility to delineate *a priori* boundaries for nanotechnology. The organization indeed became part of nanotechnology programs, allied to administrative actors, involved

[1] I use a variety of empirical material in this section: notes taken during public meetings and Vivagora's internal meetings, discussions with Vivagora's members, and public and internal documents related to Vivagora's activities. Unless otherwise specified, quotes in this section are excerpts from my fieldwork notebooks.

in the making of science policy, while, at the same time, constantly reflecting on the specificity of its position.

Another characteristic of Vivagora is indeed to be self-reflecting. Members of the organization and employees regularly gather to discuss the objectives of their group. During the *Assemblées Générales* and *Conseil d'Administration*, members invite external speakers, express their wishes about the future of the organization, and discuss its "identity". "We have an identity crisis" is a sentence I heard many times during my exchanges with Vivagora members and employees. That the organization was so concerned about its identity, its "values" and "objectives" is connected to the nature of its engagement for the "democratization of technology". As it will be seen in this section, Vivagora's concern for democratization could not be separated from an engagement in the actual production of nanotechnology objects and policy instruments. This makes the case of Vivagora different from that of the experts of participatory procedures encountered in chapter 3, and prevents the organization from stabilizing a participatory procedure that could ground its identity.

As I was participating in numerous meetings about the definition of nanomaterials, the identification of ethical issues, or the design of science exhibits, I had multiple interactions with Vivagora, which was present in all the fieldwork I worked on. Vivagora participated in the two-day public event at the Paris Cité des Sciences, collaborated with the Grenoble museum of science in the organization of public meetings in Grenoble in connection with the nano exhibit (cf. chap. 2). Vivagora's director was a member of the organizing committee of the Ile de France citizen conference (cf. chap. 3). Vivagora participated in discussions at AFNOR about standardization and the nano-responsible project (cf. chap. 5), later joined the European Environmental Bureau, and had regular contacts with the American ICTA (cf. chap. 4). Hence, any narrative about Vivagora cannot be conceived as separate from all the empirical sites I have explored in the previous chapters. This means that the following pages are not meant to introduce new empirical sites (although I will point to projects and activities I did not describe in the previous chapters). Rather, they are aimed to revisit some of the narratives I provided so far, in order to describe stories and controversies from the angle of the specific form of social mobilization Vivagora proposes.

A great part of my knowledge about Vivagora stems from my active involvement in the organization. As I began working on the nanotechnology debates in Grenoble, and, more generally, on the assemblage of nanotechnology in democracy, I interviewed members and employees of Vivagora and observed some of the events they were organizing. I was more and more involved in their activities. I then became a member of Vivagora and entered a process of perpetual negotiations about my role and relationships with the organization. Thus, the description of Vivagora's activities cannot be separated from that of my own engagement in the study of nanotechnology.

The multiple terrains of intervention of Vivagora imply that the distance of the organization to the fabrication of nanotechnology (in the laboratories, industrial production chains, and government offices) could not be stable, but had to be experimented. And as I demonstrate in this section, the "experiment" is also that of the researcher being involved. This "view from within" does not mean that there were no disagreements and lengthy discussions about the scope of my intervention with the organization. Hence, the evolutions of the activities of the organization also interrogated my own position as a sociologist wishing to explore the modalities of social mobilization on nanotechnology.

In the following, I explore some the experimentations that Vivagora proposed, and thereby the forms of mobilization that the organization constructed. I start by focusing on the example of a debate mechanism called the *Nanoforum*, in which Vivagora was actively involved. This helps me describe the specific position of the organization, and, at a later stage, the implications of this position for the experiments it undertakes in the construction of social mobilization on nanotechnology.

The experience of the Nanoforum: from an expertise on public debate to the construction of publics and problems

<u>Launching the Nanoforum</u>

The founders of Vivagora were science journalists. When they created the organization in 2003, they conceived public meetings as the outcomes of the transformation of science journalism, which would then render controversies visible. The director of Vivagora introduced as follows the first public meeting of the *Nanomonde* debate series, organized in Paris in 2006:

Why discuss the theme 'nanoworld'? Lots of researchers and industrialists work on nanotechnology, funding is impressive and the public does not know what is happening. Our role in the participation of public debates requires that we provide knowledge back to the public[1].

As scientific journalists, the founders of Vivagora were concerned with the circulation of information, and the visibility of "knowledge" for the public to understand where the "important stakes" were. In this original formulation, "providing knowledge back to the public" implied a neutral position from which the organization could picture the oppositions at a distance. But after the Grenoble experience, the neutral position could not be held much longer, as officials accused Vivagora of being

[1] Introduction by D. Benoît-Browaeys, personal notes written during the *Nanomonde* meeting, Paris, September 2006.

anti-nanotechnology, while PMO voiced the opposite critique, considering that the organization was merely helping the construction of the global nanotechnology program for the sake of its own financial interest.

Facing this quandary, the director of Vivagora was "a bit lost". She "did not know what to do after all that happened in Grenoble". Was the solidification of the procedure (that is the transformation of the organization into an expert of a solidified technology of democracy) the good strategy to pursue? This could have been the case, since after the *Nanomonde* and *Nanoviv* debate series, Vivagora was also increasingly recognized as an organizer of public dialogues[1]. Yet the projects in which Vivagora intervened after Grenoble made it move away from the expertise on stable procedures able to be replicated. One of the main activities of Vivagora after Grenoble, called the *Nanoforum*, transformed an original liability (i.e. its difficulty to use a stabilized technology of democracy universally recognized as a tool for the production of public debate) into an asset. The Paris-based *Nanoforum* was designed – pretty much like the public debate series Vivagora had been organizing – as a series of public meetings held in 2007-2009. Devoted to particular aspects of nanotechnology, they were attended mostly by academics and civil servants. The *Nanoforum* was not intended to produce "recommendations", and, contrary to *Nanomonde* and *Nanoviv*, it never attempted to stabilize a procedure. It was conceived as an "ad hoc procedure" open to transformation according to the requests of the involved actors and the needs to explore particular nanotechnology issues.

The *Nanoforum* was initiated by Vivagora and a former high rank official at the French ministry of health, William Dab, who had become professor at CNAM (a Paris school of engineering) while maintaining regular contacts with the administration he came from. Dorothée and Dab set up the *Nanoforum* with support from the French ministry of health. As the officials in the ministry of health were starting to worry about the potential risks of nano substances, Dab's proposition of a "permanent structure for public discussions" was positively met by the ministry of health[2]. The ministry funded the process, and sent two of its administrative officials to the organizing committee. Representatives of other ministries joined, as well as of Vivagora, *France Nature Environnement*, and academics.

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[1] French officials considered the outcomes of *Nanomonde* and *Nanoviv* debate series alongside the rapports of public agencies and publicly commissioned consensus conferences when organizing a national event at the Paris *Cité des Sciences* in January 2007, which aimed to synthesize the outcomes of the public discussions about nanotechnology that had been held at the time. At the European level, Vivagora's debate series were some of the few mentioned as "activities on ELSA and governance of nanotechnology in European Member States" in the report in which the D.G. Research of the European Commission detailed the "European activities in the field of ELSA and governance of nanotechnology" (Hullmann, 2008: 7).
[2] Interview with J Boudot, former director at the French ministry of health, Paris, October 2010.

Making nanotechnology issues public

A first series of meetings in 2007-2008 focused on various industrial domains of application of nanotechnology (e.g. construction and cosmetics). They were examined through the participation of invited industrialists, civil servants, and representatives of NGOs. For the people at the ministry of health, the *Nanoforum* was "a way of questioning industries", and to "force them to tell what they do"[1]. As civil servants in various ministries were uncertain about the nature and problems of nanotechnology, the *Nanoforum* appeared as a site where they could learn about a topic that sparked interests and concerns, but was not explicitly taken in charge in the administration by more than an informal group of civil servants across ministries.

Learning could occur for the participants to the public meetings, as well (if not more) for the members of the organizing committee. During these meetings, information circulated within different parts of the administration, and between officials, NGOs and academics[2]. During the meetings of the *Nanoforum* organizing committee, the civil servants in charge of nanotechnology in various ministries would meet, informally collect information about the expectations and concerns of various actors, exchange information with civil society organizations, and, eventually, they could craft the position of the French administration for later presentations in international arenas[3]. Thus, the original objective of the *Nanoforum*, which was to "make nanotechnology a public affair", was not only about discussing nanotechnology publicly, but also about providing a space for the few French administrative actors concerned with nanotechnology to think about the transformation of the topic into an issue that could be dealt with by the administration.

Involved from its inception in the organization of the *Nanoforum*, Vivagora had insisted on including civil society organizations in the process. Dorothée had invited *France Nature Environnement* (FNE), a federation of French environmental movements, to participate in the organizing committee. During the meetings of the organizing committee, she repeatedly pushed for inviting CSOs to speak during public meetings. For instance, FNE presented its experience in the local management of industrial waste in the Toulouse region as a potential model for the involvement of environmental movements in the local management of nanotechnology industry. But the integration of civil society actors in the *Nanoforum* was intended to provide more than a tribune for existing social movements. In the mind of Dab and Dorothée, the *Nanoforum* was also intended to "help actors mobilize on

[1] Quote from an interview with A. George-Guitton, assistant of W. Dab and former official at the ministry of Health (Paris, January 2008).

[2] I attended most of these meetings from 2008 to 2009. I did not attend the first meetings.

[3] Interview with the official in charge of nanotechnology at the French ministry of health, (Paris, November 2008). Cf. Chapter 5.

nanotechnology"[1]. In the spring of 2008, two public meetings of the *Nanoforum* were devoted to the case of Grenoble, focused on local development, and were meant to be opportunities for CENG (cf. the previous section) to confront local actors. For members of CENG, the intervention of Vivagora and the possibility to intervene in the *Nanoforum* was "a chance", it allowed the group to devote time to the examination of the newly created *Clinatec* research center, and undertake legal actions to force public actors to disclose the funding structure for the project[2].

The case of the Grenoble actors and their connections with Vivagora is an example of what Dorothée called the "structuration of civil society" (*la structuration de la société civile*). The "structuration of civil society" was to be undertaken, in the context of the *Nanoforum*, for the sake of the construction of nanotechnology policy program, within an approach that "refused both the 'no data no market' and the 'laissez faire' positions"[3]. Thus, the *Nanoforum* could be included within a strategy of responsible innovation, wishing to integrate as many actors as possible in the early identification of risks and concerns, for the benefit of administrative actors concerned with nanotechnology development in a responsible manner. It was another means through which the French nanotechnology policy could be formulated, another device that was conceived by its policy instigators as a tool to "transform the governance of technology", as "one could not manage technology as it was done before"[4]. As such, it was a technology of democracy grounded in the convergence of academics', social movements', and civil servants' interests. From the viewpoint of PMO, such a device would of course be impossible to accept. For participants in the *Nanoforum*, the device appeared as a place to "make issues public". As the nano-responsible norm, the *Nanoforum* reveals both a shift within the French administration, and an attempt on Vivagora's part to construct a form of mobilization that raises questions related to scientific uncertainty (e.g. the impossibility to use known risk measurement methods), administrative interrogations ("how to deal with these issues within the administration?"), and difficulties for civil society groups to engage in public discussions ("how to mobilize on such a topic?").

Questioning the public management of nano substances and products

When the first series of meetings ended in early 2008, participants had had to face the problem of the representation of nanotechnology. They had invited representatives of a wide range of industrial sectors (among which construction, cosmetics, and chemistry), who had appeared uncertain about their use of nano substances and products, or unwilling to disclose information that the members of the organizing committee considered much needed. Considering the ontological uncertainty of nano

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[1] Notes taken during a meeting of the organizing committee.
[2] Interview with a member of CENG, Paris, September 2008.
[3] Document of presentation of the *Nanoforum*.
[4] These words were those of a civil servant of the ministry of industry.

substances (cf. part 2), these difficulties are not surprising. They led the members of the working group to reflect on the evolutions of the device that could move the exploration of nanotechnology forward.

As the organizers were rethinking the specificity of the *Nanoforum*, I was invited by Dorothée to participate in the organizing committee. Thus, I was directly involved in the preparatory discussions for the second series of meetings of the *Nanoforum*, and from this point, describing what the committee did is also describing my own involvement in its work. The second series of meetings of the *Nanoforum* attempted to consider seriously the ontological uncertainty of nano substances by focusing on "a particular case rather than glancing over the general landscape"[1]. The objective was to consider an example among nano substances and products and interrogate the collective management of its potential risks. At that time, the nano silver petition to the EPA had been released, and Vivagora had signed the "principles for responsible nanotechnology oversight" that ICTA had initiated (cf. chapter 4). Inventories of consumer products containing nano substances were circulated in administrative offices, at national and international levels, and they all targeted the dominance of silver as one of the main materials being used under its nano form in consumer products[2]. For organizers of the *Nanoforum*, nano silver appeared as an interesting object on which to focus the investigations conducted during the public meetings. As for myself, I had been working on silver nanoparticles as well, was interested in this case[3], and argued for a focus on nano silver. Thus, the second series of meetings of the *Nanoforum* were devoted to the case of nano silver.

The meetings discussed the instruments expected to manage nano silver, in particular risk-benefit evaluations and labeling. This corresponded to pressing demands from the civil servants and civil society organizations that were part of the organizing committee of the forum. Initially devoted to the ways in which these instruments could be applied to nanotechnology, meetings led participants to question their very making. All participants had to bring up the issue of characterization of the substances: the impossibility to define easily what to put on a potential label, or how to evaluate risks and benefits prevented from considering labeling and risk-benefit evaluation as ready-made tools to be applied to nano silver. Consequently, the *Nanoforum* was a site where "what to put on a label" and "how to evaluate risks and benefits" for products containing nano silver were discussed. It subsequently offered opportunities for the participants to explore the respective importance of physico-chemical

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[1] To be fair, the first series of the Nanoforum had made much more information explicit than the general report of the CNDP debate. The presentations and discussions within the *Nanoforum* were quoted in an expert report released by public health agency (for instance in Agence Française de Sécurité Sanitaire de l'Environnement et du Travail, 2010, *Evaluation des risques liés aux nanomatériaux pour la population générale et pour l'environnement*, Rapport d'Expertise Collective: p.63, about the concentration of nano silver in consumer products; p.82 about the use of nano titanium dioxides in concrete).

[2] Cf. for instance the inventory released by the Project on Emerging Nanotechnologies of the Woodrow Wilson Center (cf. chapter 4).

[3] I was working on this case for a paper later published as (Laurent, 2010a) and re-used in chapter 4 of this dissertation.

characteristics of substances, the properties of the product they wanted to make explicit, and the modalities of a future control[1]. In this respect, the *Nanoforum* experience was a preparatory stage for the later nano-responsible norm (see chapter 5) – a project in which the organizers of the *Nanoforum* participated. Indeed, the *Nanoforum* demonstrated for the participants that the situation of uncertainty was an opportunity to orient public discussions towards the modalities of instruments for the public management of nano substances and products.

Experimenting engagements with nanotechnology

Beyond the organization of public debates

The example of the *Nanoforum* illustrates the trajectory of Vivagora after the Paris and Grenoble debate series. Rather than stabilizing a technology of democracy that could have been replicated independently of the issue at stake, the organization preferred to set up ad hoc procedures that could evolve according to the need of the participants and the questions that were raised. This means that the "above the ground" position, which could have been supposed to allow Vivagora to organize debates during which "all the positions" could be represented was not possible anymore. As a member of the board said during a general assembly on March 4, 2009:

> *We have been in a process of collective reflection on the vocation of Vivagora since 2008. At the beginning, we were above all interested* (orienté vers) *in public debate. Today, we think it is better to intervene on innovation processes. We need to go beyond what we have already done* (aller plus loin), *we need to think about the ways in which social experiments are possible. How to launch new formats of public debates*[2].

"Going beyond" the organization of public debates was at any case something the members of Vivagora had been doing. Dorothée had coauthored a book, *Alertes Santé*, which targeted the threat of unsupervised chemicals, and many members of Vivagora were also members of other environmental movements such as CRIIGEN, which gathers information about the potential risks of GMOs. "Going beyond" could imply, as in the *Nanoforum*, some work in common with social movements, administrative officials, and industrialists, in the making of nanotechnology a public concern, rather than organizing participatory procedures thanks to a procedural expertise. It caused lengthy explorations

[1] Cf. (Laurent, 2010d) for a more detailed exposition of this argument.
[2] Notes taken during the meeting. Unless otherwise specified, quotes in this section are excerpts from notes I took during meetings and conversations with Vivagora members and employees.

about "what Vivagora stands for", which were opportunities for Vivagora's employees and members, including myself, to interrogate their commitment to the democratization of nanotechnology. From this time, Vivagora continued organizing public meetings on technological issues, such as synthetic biology, and ambient intelligence. But as far as nanotechnology was concerned, it considered that the public debate job had been done after *Nanomonde* and *NanoViv*, and that it could even be "a trap" if it was used to pursue discussions artificially while delaying the introduction of constraining regulatory decisions. In other words, the organization felt it could not sustain a separation between the mobilization on the content of nanotechnology issues and that on the "democratization of science".

A variety of projects

In addition to the publication of articles on its website and through its newsletter, which critically examined technological innovation and the evolution of national and European regulation (for instance by commenting on public agency reports, and blaming the administration for not regulating nano substances), Vivagora was involved in 2008 in 17 different "projects"[1]. About two thirds of them dealt with nanotechnology. Some of them consisted in the organization of public meetings on the model of the *Nanomonde* and *Nanoviv* debate series. Others were punctual events (such as an "Innovation and Responsibility colloquium"), or ad hoc processes such as the *Nanoforum*. Another group of activities were projects funded by public bodies, and meant to study participatory democracy on technology issues and experiment forms of public dialogue. Other projects were regular events organized for industries (e.g. "Opinions sur Rue", breakfasts meant to present the positions of various stakeholders to industrial actors), or within partnerships with industries in order to experiment "participatory design" (that is, industrial design involving representatives of civil society organizations[2]). Eventually, Vivagora also participated in public committees where CSOs were invited to intervene. For instance, when the National Council for Consumption (CNC, an advisory body of the ministry of Economy) launched a working group for nanotechnology, Vivagora was one of the two CSOs represented in the committee, alongside a consumer group. Vivagora was also represented at the French National Agency for Research (ANR)'s committee for nanotechnology research, in the AFNOR nanotechnology committee, and, later, in the nano-responsible project. As a member of the European Environmental Bureau, Vivagora was also involved in the European discussions about the definition of nanomaterials.

My objective at this point is not to be exhaustive and present in detail all the projects that Vivagora was conducting. Rather, it is to point to the evolution of the activities of the organization, and

[1] "Projets 2008-2009", internal document, Vivagora.

[2] This latter initiative is close to the "safety by design" approach I described in chapters 5 and 6. At the time of writing, it is still in its early preparatory phases.

its shift from its initial position of public debate organizer to that of an actor engaged in the making of both the "problems" and the "publics" of nanotechnology. This was the explicit objective of many of Vivagora's projects. The "Open Innovation" project was conducted in partnership with a cosmetics company that agreed to enter a process of "collaborative design" for one of its products. "Coexnano" was a "pluralist expertise" process, funded by the French ministry of the environment, during which Vivagora brought together representatives of environmental movements in order to interview industrialists of the construction sector about the use of nano silver and nano-titanium dioxide in paints and coatings.

<u>*Uncertain distances*</u>

Constructing the "publics" and "problems" of nanotechnology impacts the distance Vivagora established to nanotechnology policy. This was reflected upon by the organization itself. During one of the 2009 general assembly, the president of the organization, Bernadette Bensaude-Vincent, explained:

this is a globalizing process. Everything is included: social sciences as well, as they are asked to monitor the changes and the evolutions, and tailored to the overall objectives of development and growth. Everyone becomes a stakeholder, everyone is included. There is no exteriority any more. Even for ourselves as citizens. Then the question is how can we adopt the position of the critique? I think we don't have many choices. We have to act from within, and experiment with new methods.

Affirming the "no exteriority" motto shifted the form of mobilization from the organization of public debates to that of the participation in the construction of nanotechnology. Such choice – opposed to that of PMO – had particular importance for Bensaude-Vincent. As a historian and philosopher of science working on nanotechnology, she wrote books and papers on the topic, and was regularly asked to talk publicly about nanotechnology. Her own engagement as president of Vivagora was regularly at stake. Listening to her, taking notes, and participating in the collective discussion about the impossibility of the exteriority position for Vivagora, I was (arguably at a much smaller scale) in the same quandary. This meant that as social scientists, we (that is Bensaude-Vincent and myself) were always caught in the same problem of distance the other members of Vivagora faced when working with industrial or administrative actors. For the organization, "being included" meant that it had multiple links – including funding ones – with private or public institutions. It forced Vivagora to be constantly involved in negotiations about the nature of its mobilization, while feeling permanently threatened of being used as an alibi. For the researchers involved, "being included" was both a condition for the empirical work about the organization, and a trial of one's own engagement with nanotechnology.

Multiplying the forms of engagement

Multiplying the forms of engagement for the sake of social mobilization

The organization could voice its concerns for the collective discussions of the existing and future risks and benefits of nano products, and for the "constructions of publics" (an expression Vivagora's members would regularly use) through various channels. Consider for instance the Coexnano project, a process of "pluralist expertise" funded by the French ministry of the environment, during which industries from the construction sector were interviewed by Vivagora and representatives of civil society organizations. Coexnano made visible the use of nanomaterials in coatings and paints while gathering representatives of civil society organizations in order to make them voice their concerns and expectations. Thereby, Vivagora could voice a concern for the evaluation of the benefits of nano silver and titanium dioxide, and the life-cycle analysis of the products[1]. Participating in the AFNOR nanotechnology committee and in the nano-responsible norm project, Vivagora could further push industries to discuss their practices, and argue for life cycle analysis and the collective evaluation of benefits, as the following comments to a preparatory document of the nano-responsible norm illustrate:

The document does not consider the interest and the modalities of the participation of civil society in the evaluation of risks, benefits, and uncertainties. (...) Devices meant to understand citizens' concerns and expectations, the issues, and eventually build robust innovations can be useful. (...) The reinforcement of relationships with downstream customers may be useful to limit the impacts of potential risks (e.g. by communicating on recommended uses of the product). But there are other tools that should not be neglected: specific recycling streams (e.g. for nano coating), allocation of a share of the R&D budget for toxicology, etc.

Thus, Vivagora could use its diverse forms of involvement to argue for the integration of the evaluation of the "societal aspects" in the core of the standardization process of "responsible nanomaterials". In so doing, Vivagora did not distinguish between the mobilization on "technical democracy" that would have focused on participatory procedures, and the mobilization on "nanotechnology issues", which implied calling for the stricter regulation of substances, the evaluation of the benefits of nano products, and life-cycle analysis.

[1] *Les nano-argents et les dioxydes de titane dans les revêtements: état des lieux des connaissances, incertitudes et controverses*, Rapport d'expertise intermédiaire du processus pluraliste Coexnano, Vivagora, November 2010.

The multiplicity of Vivagora's forms of engagement is also visible when considering its ability to intervene at various levels within a single participatory initiative. The most significant example is certainly the CNDP national debate. As an organizing member of the *Nanoforum*, Vivagora signed a "contribution" to the CNDP debate, which was neither a formal contribution from an established stakeholder[1], nor a part of the dossier that the government submitted. Yet the organization also felt it important to be involved in the very making of the debate. During a meeting of the administration board in February 2009, some members wanted Vivagora to "intervene to provide its opinion on how to organize the debate". Vivagora did eventually write a contribution, which argued both for the "democratization of science" and the need to put into place risk management devices specifically targeted to nano substances and products. But the organization also operationalized the arguments of its written contribution when it intervened, before the beginning of the debate, as an expert for a potential contractor to CNDP. In a briefing note, it advocated local meetings targeted to the local industrial and scientific activities (which was eventually the choice made by the organizers). As public meetings were conducted, Vivagora regularly published notes on its website, describing the format of the debate and the questions being discussed. This watchdog role took another dimension later in the process. As the contestation forced the organizers to use separate rooms for the invited participants and the "general public", Vivagora considered it necessary to clearly withdraw its support for the process. Bernadette Bensaude-Vincent and Dorothée Benoît-Browaeys co-authored a paper in *Le Monde* that criticized the procedure, much to the dismay of the organizers and commissioners of the debate, who had relied on the support of the organization.

Multiplying the forms of engagement for the sake of the research work

Multiplying the forms of engagement and the types of relationships with the actors of the nanotechnology scene was also what I did, as a researcher, to gain knowledge about nanotechnology, and, more specifically, to work with/study Vivagora. As I was experimenting various forms of engagement with the organization, I faced the same type of problems as those Vivagora met. For the social scientist involved, the practical problem of inclusion is manifest in situations where he or she is expected to "give voice" to the organization. I was indeed caught in situations in which I could speak for it, and others in which I could not. Invited to participate in the *Nanoforum* process by Vivagora, I could insist on the critical examination of instruments like nanoparticle labeling, as I thought it was necessary in order to critically account for the development of nanotechnology. In the somewhat informal

[1] These contributions are known as "cahier d'acteurs" in the CNDP public debate (cf. chapter 3). I appeared as a co-author of the contribution of the *Nanoforum* and as a co-author of a paper relating the experience (Dab et al., 2010).

organizing committee (in which other academics were also present and which did not have the rigid nature of a long-standing administrative body) I could negotiate the specificities of my position as both a member of Vivagora and as an academic, and feel comfortable with the research environment I was a part of. Throughout the various exchanges with the organization, my interventions contributed to the evolution of the *Nanoforum*, as well as to that of Vivagora, while the various projects of the organization transformed the research I was doing. My growing interest for the variety of technologies of democracy mobilized with nanotechnology contributed to as much as it was informed by projects the organization undertook, such as those experimenting with pluralist expertise (e.g. Coexnano) or collective monitoring of nanotechnology research (e.g. ACEN, see below).

However, such relative easiness to speak with/for the actors did not easily translate to other situations, in which 'traditional' forms of representation were expected. Consider for instance the following exchange between Vivagora's administrator, M, and myself:

M: *We're looking for someone to represent Vivagora at the meeting with DGCCRF* (a French administrative office).

B.L: I don't know if I feel comfortable doing this... I don't think I can advocate Vivagora's positions.

M: *That's always the problem with you academics... you know, we want to be in action. (...) You should take more responsibility in the organization.*

B.L: As I see it, I can contribute in my own way...[1]

In this case I refused to participate in the 'official' terms set by the administrator. The example indicates that the nature of my relationship was permanently at stake and explored through constant negotiations with Vivagora. As the organization was experimenting with various types of distance, so did I, when accepting or refusing to represent the organization.

'Giving voice' has been a long-term concern of feminist studies that seek to expose the oppression of women in politics, science, art, etc. and do away with such discrimination[2]. Yet my interactions with Vivagora imply more than a desire to make the voice of the organization heard. The members of the organization and myself faced a variety of situations in which our mutual relationships were not given from the start. As my position complicated the process through which the social scientist could "give voice" to the social groups he or she studies, so the un-stabilized position of Vivagora made its objective of "structuring civil society" more complicated than just "giving voice" to civil society organization. This is the focus of the next sub-section.

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[1] Phone conversation, October 16, 2008 (my translation).

[2] (Gorelick, 1991). The use of this expression in terms of *empowering* dominated social groups has led to a somewhat romantic understanding of the term (Rip, 2000a).

Constructing nanotechnology's publics, constructing engagement

Helping "wild actors"

Discussions within Vivagora had focused with insistence on the need to "connect with" the general public and the civil society organizations. In a first step, the public meeting was conceived as the device through which people could learn about nanotechnology, "in an impartial manner", understand the "conflicts" and "underlying logics" of nanotechnology development, in order to act as "concerned citizens" (*citoyens concernés*). Thus, the objective was to "give voice" to the various stakeholders, so that they could expose their conflicting interests, in order to provide the necessary element for the citizen to voice his or her concerns. This initial model relied on the representation of nanotechnology at a distance, and proposed a two-step process in which the mobilization of the individual citizen followed the presentation of nanotechnology. The recognition of the limitation of this model stemmed from the difficulties Vivagora met in Grenoble. Its critique was also linked to the gradual understanding of the consensus conference as a counter example. As one of the members of the organization said during a general assembly: "the citizen conference is a scientistic device, which supposes that one can feed a 'neutral citizen' with objective scientific knowledge". Vivagora knew this from within, since Dorothée had been a member of the organizing committee of the Ile de France conference, and had been one of those who had attempted not to limit the representation of nanotechnology as a series of unconnected applications, but as a global program (cf. chapter 3). By acting as a destabilization factor, displacing the expectations, and questioning the otherwise self-evident choices, she had become wary of the "neutral citizen".

Moving away from the model of representation implied an active engagement in the constructions of publics. This was part and parcel of Vivagora's mobilization on nanotechnology, as Dorothée said:

If we fight for responsible and shared innovation, the issue is to look for the instruments that render a collective management possible. Public debate is not enough as soon as the possibility of the emergence of "wild" actors or impromptu events is quasi inexistent. Vivagora can play a role: supporting the development of competences and the public speech of minority actors. This is the spirit of our support for the nano collective in Grenoble within the Nanoforum.[1]

[1] Email written by Dorothée Benoît-Browaeys, June 12, 2008, emphasis added.

Hence, Vivagora gradually understood its role as a "support" for helping "wild actors" and "impromptu events" emerge. When Dorothée wrote this email, she had in mind the Grenoble-based CENG, which had been created after the *Nanoviv* debate series and was supported by Vivagora. In 2008-2009, members of CENG (city councilors and local organization leaders) and Vivagora employees would regularly meet in order to prepare *Nanoforum* meetings, and, later, public conferences in the Grenoble area. As one of the members of CENG explained, it was "thanks to Vivagora" that the group remained active, and undertook various activities, among which legal actions in order to force local administrative bodies to disclose their funding plans for nanotechnology projects[1]. In doing so, Vivagora was closely associated with a small consulting company, Mutadis, which had made its business on the construction of "empowered groups", particularly in the domain of nuclear energy[2].

"Structuring civil society". The example of the XENOP project

Mutadis and Vivagora were eventually in charge of an initiative called XENOP, funded by the French ministry of Health as a follow-up to the *Nanoforum*. During six months in 2010, Vivagora and Mutadis met with people in Grenoble, Toulouse, Saclay and Bordeaux in order to "listen to their expectations", and "help them constitute local groups that could mobilize on nanotechnology". The people were known of Dorothée through her multiple activities in nanotechnology in the previous years. In Grenoble, they were CENG members; in Saclay, they were members of a local group which had been created to contest the project of nanotechnology research center led by CEA; in Toulouse, local environmental groups and France Nature Environnement (FNE, a national federation of environmental movements) had been asked to join.

A XENOP meeting in Paris in November 2010 gathered about 25 people from the four cities, which I attended. It focused on the means that were available to "question the development of nanotechnology", to "learn from the Grenoble example" (and the legal prosecutions the members of CENG had undertaken). This had particular relevance for the inhabitants of the Saclay area, which was promised to become a "center of excellence" in nanotechnology research within a national program of nanotechnology development called *NanoInnov*. A representative of the ministry of health sat at the meeting where members of local civil society organizations were discussing their forms of mobilization, their interests in nanotechnology and the objects of their work. She intervened in the discussion to voice her personal concerns about the use of nanotechnology for medical applications, and the fact that such research was conducted outside hospitals, and thus, out of the scope of medical regulation.

[1] Intervention of R. Avrillier during a meeting organized by Vivagora and Mutadis, November 9, 2010.
[2] Mutadis had been involved in a European project related to the local management of the Chernobyl area, and in a project aiming to implement consultation bodies in the vicinity of nuclear power plants.

For Vivagora, the XENOP project was part of its objective of "structuring civil society". For the French ministry of health, funding activism in nanotechnology was considered to be a necessary task. As Jocelyne B., the official at the ministry of Health who had commissioned the XENOP project explained:

We need this, for public discussion. After the Nanoforum, we really needed to see who were those with whom we could talk, and how to pursue the discussion. We were pretty interested in the idea of looking at the local levels. And to explore what regional nanoforums could be. Anyway, the problem is also more general. You need to know whom you are talking to if you want to talk.[1]

"Knowing who are those with whom one (that is, the administration) can talk" had particular relevance for Jocelyne B. She explained this to me right after the end of the national CNDP public debate. As PMO and the anti-nanotechnology activists had appeared far too radical during the CNDP debate, it was necessary for the French officials convinced of the need for "dialogue" to find publics to talk to. Hence the interest of the work of Mutadis and Vivagora in manufacturing local publics. That the construction of (often critical) civil society groups was funded by the French administration could appear surprising[2]. It is less so if one considers that nanotechnology had become a science policy issue, which required, for the civil servants involved, inclusive forms of policy-making.

Contested initiatives

But such an institutionalization of the "wild actors" was not appreciated by all. Hence, during a meeting of the planning committee of the *Nanoforum*, Josée C., the representative of FNE criticized the XENOP project[3]. She considered that:

we (that is, social movements) *do not need the ministry of health to mobilize (se mobiliser).*

The critique was eventually included in the minutes of the meeting. Josée C was quoted:

1° One can regret that DGS (General Direction of Health) *did not at least inform the committee members about its decisions, and did not circulate the mission letters addressed to Vivagora and Mutadis.*

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[1] Interview with Jocelyne B., former director at the French ministry of health, Paris, October 2010.

[2] A recent initiative of the groups that originated from the Xenop project was a critique of the draft decree requiring the mandatory declaration of "substances in the nanoparticle state".

[3] Josée C. was otherwise well introduced in institutional settings. A local leader of FNE in the Toulouse area, she has regular interactions with regional administrative services on topic related to the management of industrial risks. She has been co-leader of a working group on "emerging risks" created after the *Grenelle de l'Environnement* in order to monitor current scientific work related to environmental risks.

2° In some cases, environmental movements do not want to participate in the Xenop project; they do not accept the people sent by DGS and the modalities of the project.

3° She (Josée C.) *explains that in Midi-Pyrénées* (the Toulouse administrative region, where Josée C comes from), *the construction of negotiation spaces with various stakeholders has been undertaken with no external direction at a national level.*

For Vivagora, such a critique was a clear sign of a difficult position[1]. On the one hand, it wanted to "make the wild actors speak", while, on the other, it tried to "work with established social movements", with financial support from the French administration. The particularities of the position did not go unnoticed, but for members of Vivagora:

I don't see a contradiction. We don't sell public debates. We're just trying to use whatever devices we can get, whatever opening we have, and try to open it, enlarge it. We're small, if we want to do something, we have no choice.[2]

Hence, the "activism" (*militantisme*) had to follow whatever routes it could find. For Vivagora, this worked well with the ministry of health, which was thought to hold a particular position within the French administration:

The ministry of health has been helping us since the Nanoforum. You can say they are engaged. About Xenop as well, there was a trustful relationship. And the local groups could be as critical as they wanted, they were not censored. It would have been different with other public entities.[3]

But in other cases, numerous discussions about the opportunity to participate in this or that project, to join this or that activity, occurred. The case of the nano-responsible norm described in chapter 5 provides examples of the quandary in which the organization was often caught. Therefore, the impossibility to ensure an exterior position implies a continuous exploration of the forms of distance and engagement, which in some cases, resulted in conflicting relationships with established social movements. This is even more visible in another project meant to "structure civil society".

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[1] Mutadis, however, could take this lightly. As its director explained to me, the company was accustomed to critique since they had been working on the local management of areas affected by Chernobyl. Anti-nuclear groups produced harsh critiques of Mutadis, accused of minimizing the risks of radiations and using local negotiation to make nuclear energy more acceptable (e.g. "Mutadis consultants: la désinformation nucléaire", available at http://www.alternativelibertaire.org/spip.php?article386, accessed July 20, 2011).

[2] Notes, Vivagora AG, April 2009.

[3] Notes, Vivagora AG, January 2011.

A failed attempt at "structuring civil society"

Citizen monitoring and the ACEN project

The evolution of the position of Vivagora, and its growing concern for the constitution of the "publics" and "problems" of nanotechnology meant that its initial concern for the circulation of information (that of the scientific journalists who funded Vivagora) had to be transformed. The issue for the organization was to define an information that would question the representation of nanotechnology, and which would allow Vivagora to undertake a "role of whistle blower" (*un rôle de lanceur d'alertes*) on emerging technologies, where there was a need, so the argument went, to create new social movements. Vivagora considered that it could connect both objectives by pushing for the "collective production of information" in order to ensure a "citizen monitoring" (*veille citoyenne*) of nanotechnology. This was the objective of a project called "Citizen Alliances on Nanotechnology Issues" (*Alliance Citoyenne sur les Enjeux des Nanotechnology*, ACEN). ACEN was both a project that was supposed to ensure the mutual production of the "publics" and "problems" of nanotechnology, and the most visible failure of Vivagora in financial and symbolic terms. In accounting for the (short) history of ACEN, I do not intend to allocate responsibility but to illustrate the instability of Vivagora's position. ACEN indeed provides an illustration of the specific form of mobilization that Vivagora attempts to construct, how it defines nanotechnology as an object for social intervention, and the many trials that the organization needs to pass in order to make itself accepted by its potential partners.

"Citizen monitoring" had been regularly mentioned among Vivagora's members as a long-term objective of the organization, when Dorothée managed to secure funding from a private foundation, the *Fondation pour le Progrès de l'Homme* (FPH). Vivagora organized a preparatory meeting in September 2009 in the Parisian headquarters of FPH. The meeting, which I attended, gathered about 25 people coming from various health and environmental movements, who agreed to bring people together, and to produce information that would be available on a website to help social movements engage in public discussions about nanotechnology. As an organizer of this meeting, and the contractor with FPH, Vivagora was commissioned to organize the whole process, which subsequently ran for several months. Dorothée invited me to participate in this meeting. The original form of social mobilization ACEN seemed to propose interested me, and I joined the process in order, in Dorothée's words, to "voice concerns" and "clarify possible objectives"[1].

[1] I thus attended the vast majority of the projects' meetings, and had access to internal documentation. Unless otherwise specified, quotes in this paragraph are excerpts from the notes I took during the meetings of the project.

From September 2009 to June 2010, the two members of Vivagora in charge of the project organized numerous meetings. Other members of the organization would regularly participate (usually 3 or 4, including myself), as would members of the League for Human Rights (*Ligue des Droits de l'Homme*, LDH), ATTAC, WWF, trade unions, and a local Saclay-based group. For the participants, the *veille citoyenne* consisted in gathering information on nanotechnology (whether scientific publications or regulatory decisions), and to present them on a website in such a way that it would support their activist engagement. The example that was in the mind of all the participants was that of a *veille citoyenne* devoted to GMOs called Inf'OGM. Created in 1999 by a coalition of NGOs and financially supported by the FPH, Inf'OGM was expected by Vivagora to be the model for the future *veille citoyenne* on nanotechnology. Hence, Eric, an employee of Inf'OGM, participated in all the meetings of the project.

Engaged neutrality for the making of social mobilization on nanotechnology

As Eric explained several times during the ACEN meetings, Inf'OGM produces information for the mobilization of its member organizations through a website managed and fed by a team of employees, who write about the evolutions of the biotechnology field in an "engaged neutrality" manner (an expression used by the Inf'OGM employees). Eric could both stress the importance of the "objectivity" of the information being produced by Inf'OGM employees, and insist on the "usefulness" of this information for the mobilization of the members of Inf'OGM. This position is not an abstract objective, but a product of organizational formats, writing styles, and procedural choices that precisely define when and how the member organizations can voice their expectations and concerns about the selection of topics and the validation of the articles written by the employees of Inf'OGM and posted on the website. As a result, Inf'OGM produces articles that are both targeted to the expectations of the members, and accepted as reliable information (cf. an example in the following box).

An example of engaged neutrality[1]

In January 2010, the European Commission authorized the commercialization of a genetically modified potato expected to be used in starch-consuming industrial processes. The information was circulated and commented upon on the Inf'OGM website. The article started with a historical perspective of the GM potato. It explained the production methods, the place where it had been produced (in Sweden), and the legal process followed by the producer in order to be granted the authorization. Then uncertainties related to the potential health risks of the potato were focused on. This case was then related to others, from which the decision of the European Commission could be contested. For instance, the article described another (non GM) potato, which would present the same properties. Eventually, activist actions were described: "in Berlin on March 1st 2010, 500 Greenpeace activists drew a huge "nein" (no) viewed from the sky, in front of the Brandenbourg Gate". Thus, Inf'OGM could both provide elements about potential legal actions, activist initiatives, and inform about the scientific and legal basis of a decision that was to be made visible because of its political importance.

But what had been stabilized by Inf'OGM could not be easily transferred to ACEN. The careful organization of Inf'OGM, through which it could produce engaged neutrality, was not in place at the beginning of the ACEN project. Numerous debates and discussions occurred about how to organize the future ACEN website. It was eventually separated into a general presentation of nanotechnology ("what?","where?", "who?", "is it controlled?") which insisted mostly on the uncertainties related to the definitions and identifications of nano substances and products, and a list of "themes of concerns" (health, environment, geopolitics, ethics, and democracy), which were then divided into series of issues that were meant to be "topics on which social movements could engage, intervene in regulatory arenas, or organize collective monitoring". Organized as such, the website was conceived as an answer to the fact that "nanotechnology was a reality to be constructed" (an expression used by the two Vivagora's members in charge of the website):

This is the role of an initiative like ACEN. This is precisely because each actor has only a partial view of the issue that we need to present the various components of nanotechnology. The point is that civil society groups need to see what nanotechnology is, that they cannot raise the environmental issue without entering the problem of allocation of funding. It's all about the type of society we want.[2]

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[1] This is a comment on Inf'OGM, 2010, "UE-OGM: La pomme de terre Amflora autorisée à la culture", 5 mars 2010: http://www.infogm.org/spip.php?article4372, adapted from (Laurent, 2010a: 211).
[2] Notes, ACEN meeting, May 2010.

The last sentence was also used by PMO. But questioning "the type of society we want" was not done by putting nanotechnology at a distance, but by displaying nanotechnology issues and potential action sites where NGOs could mobilize. Hence, the WebPages related to "health" detailed the uncertainties about risk evaluation, the sites where potential regulations were (or could be) enforced, and the means through which civil society could intervene (for instance, by participating in consultation processes organized by the European Commission). This was complemented by direct circulation of information. As Vivagora's employees in charge of the project would send at least an email per week, participants would be informed about the current discussions about the standardization of nanomaterials, and would be advised about concrete actions to undertake (for instance, backing or commenting on a proposition made by the EEB in a European consultation process, which argued for the definition of nanomaterials through the criteria of size and specific surface area[1]). Thus, ACEN was conceived as an instrument expected to render possible the mobilization on nano substances, products and programs as they were being crafted. For members of Vivagora, ACEN could be an instrument that would allow "publics" to emerge (participants in the process and visitors to the website), and the "problems" of nanotechnology (that is, those of the constructions of substances, products and science policy programs) to be made explicit. Accordingly, Vivagora considered it necessary *not* to define a *stake* on which to mobilize (e.g. defining nanomaterials by the 300nm size limit) but to make nanotechnology a problem of constitution of material elements, future developments, public concerns and social movements that could, thanks to ACEN, later intervene in regulatory arenas or voice their positions in public dialogue.

Writing for engaged neutrality

Publics and problems were to be shaped through the organization of the website, and through the writing of texts to be posted on the website. Writing was also the main activity of PMO: in this latter case, the simple citizen was the author of the text, and was supposed to disappear behind it. In the case of ACEN, writing was supposed to be the locus of collective work among partners gathered by Vivagora. And the problems started there. The writing of the website's articles was undertaken by members of Vivagora, who produced dozens of articles in the spring of 2010, but nonetheless voiced numerous concerns. One of them thus explained:

"I don't know how to write these articles. First Dorothée told me the style was dull ("plat"): *I was writing about occupational safety, and listed the regulations, the reports… She wanted something more engaged… Others told me that too. Bertrand* (a member of ATTAC France) *is all about clear positioning* ("un positionnement

[1] This specific example is linked to a European consultation process about the definition of nanomaterials.

clair"). *So I rewrote the article and insisted on the loopholes, on the need for more regulations. But then I'm not sure this is what all the partners think. I'm trying to be more direct in the writing, and I'm still criticized* ("ça me retombe dessus").[1]

Indeed the quality of the articles was frequently discussed, and subjected to many criticisms. The president of Vivagora was concerned about the scientific value of the articles ("we're bad on the overall quality"), and the writing style caused lengthy discussions[2]. From its inception, Inf'OGM had faced similar problems. According to Eric, Inf'OGM gathers organizations that hold "a great variety of positions" (e.g. anti GM activist groups which undertake illegal actions, and large scale environmental movements participating in the regulation of biotechnology products in official bodies). Consequently, Inf'OGM had to learn how to "train people who work there, so that they know how to write". "Knowing how to write" was as much a matter of procedures and organizations (who decides, who has the power to choose the topics and the framing of the papers), as it was a matter of writing skills. It implied that Inf'OGM separated the process of writing from that of the strategic definitions of topics, for practical (ensuring that writers can do their job) and political (the production of "engaged neutrality") reasons:

Eric explains that if ACEN seeks to receive information and then process it "through the filters of the members", the project will be difficult to manage. Contrary to this "version 1", Inf'OGM has journalists post information online. Version 1 is difficult because 'not everyone has the same political vision, the same strategy, the same entry points'. And: 'eventually members can formulate the problems in all different ways'. Inf'OGM decided to set up a team of journalists, and to have administrators intervene at some points to define the general orientation. Then, "partners know how to go and look for articles that they can use"[3]

But modeling ACEN's organization and procedure on Inf'OGM was not straightforward. Was it necessary to have a group of qualified people who could advise the writers? How to involve participants in the making of texts? Inf'OGM had managed to stabilize a writing procedure on GMOs. ACEN participants contended that nanotechnology required a more flexible organization, since the project attempted to turn the construction of substances, products and science policy programs into objects for social mobilization:

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[1] From notes I took during a conversation with a Vivagora employee in charge of the website.
[2] For instance, the use of ellipsis caused many discussions. One of the articles was entitled "the current regulation cannot even hope to identify nano products…", ending with ellipsis. Members of Vivagora used this as an example to question the quality of the texts produced.
[3] Personal notes, ACEN meeting, Sept 1, 2009.

They (i.e. Inf'OGM) work on well-defined objects. (...) They see the objects on which they are engaged. The problem is different for nanos. We need to construct both the issue and the social movement ("le problème et la mobilisation sociale"). *This is the reason why the writing process itself, the production of information itself, must be the basis of the engagement of all the partners.* (...) *Texts need to illustrate and make the problems explicit, the fact that one needs to mobilize in order to make nanos the right way* ("faire les nanos dans le bon sens").[1]

During the first months of the project, a lot of time was thus devoted to the fabrication of a wiki-based tool through which people could contribute to the future website by participating in the drafting of texts. The objective, according to the member of Vivagora who constructed this online tool, was to build an infrastructure for the emergence of "new social movements", of the emerging public of nanotechnology.

A failed project

The process eventually caused the failure of ACEN as it was originally meant to be. Concerned about the advancement of the project, the difficulties the writers faced, and the quality of the website, Dorothée became wary of the wiki, and advocated more and more a device modeled on Inf'OGM, with "professional writers", "advisory groups", and a clear separation between the production of information and the mobilization activities of the partners. Her position conflicted with the attempts from other partners to "collectively construct" a social mobilization, whatever the content of the *veille citoyenne* might have been. Indeed, when pushing for writing procedures, with professional writers and external experts, Vivagora attempted to solidify a technology of production of "problems" and "publics", through a process that was meant to be collective – and had to be if it was to be stabilized within the collective ACEN project. Yet throughout the meetings, participants appeared reluctant to intervene in the writing of texts, while, simultaneously, they occasionally voiced concern about the form of mobilization ACEN was proposing. Some contended that "ACEN should launch legal processes", others that "the quality of the texts was not the main point" and considered that "what was important was the capability to question nanotechnology". The oppositions then grew bigger as the participants originally supportive of Vivagora's initiatives became very critical of the actions of Dorothée, who wished to push for the solidification of the device in a manner they thought was far too quick. Hence, the somewhat idealist perspective on which the ACEN initiative was launched ("constructing social mobilization through the collective production of information") faced increasing difficulties. On the one hand, Vivagora was not "engaged enough", in that it relied on the construction of information supposed to be neutrally relevant (or relevantly neutral). But on the other hand, it was "too much engaged" in the crafting of the device,

[1] Personal notes, ACEN meeting, March 2, 2010.

since it feared that the newly formed mobilization would be captured by some of the participants and eventually weaken the position of "engaged neutrality"[1].

Eventually, vivid oppositions brought the project to an end. Vivagora decided in June 2010 to make ACEN an autonomous organization, of which Vivagora would be a partner among many. Dorothée and the board of Vivagora started to negotiate with a team of six people who had been involved in the project and who were to be the future board of the independent ACEN[2]. Discussions were violent, and the separation of the new ACEN from Vivagora was rendered complex by financial matters, as Vivagora hoped to share a future grant promised to the new ACEN by FPH, the foundation that had funded the project. If the early discussions had revolved around the topics of social actions in nanotechnology, this much more conflicting stage did not involve any nanotechnology-related topics: it focused mainly on heated debates about the value and ownership of the existing website, and eventually resulted in the cancellation of the whole project. No funds were granted by the FPH[3], and ACEN was eventually the target of a short notice written by PMO, which accused Vivagora of doing "citizen business" (*business citoyen*) and "manipulating publics"[4].

The ACEN example shows that the construction of "problems" and "publics" by Vivagora, and the transformation of nanotechnology into a topic for social mobilization, have no hope to be consensual. "Giving voice" under the format of the "structuration of civil society" appears as an uneasy process, which might provide results and transform mobilization in some cases (e.g. CENG in Grenoble[5]), but which is permanently contested, faces the interests and the questions of existing organizations, and has to cope with a great variety of expectations.

Experimenting distances

Since the first events it organized in Paris and Grenoble, Vivagora has moved from an initial position of a mediator at a distance to a much more complex (and also less stable) position, in which it actively participates in the making of nanotechnology's objects, futures, concerns and publics. This case

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[1] While I was actively involved at the beginning of the project in the formulation of the objectives of ACEN, I took a more external position during these discussions. Somewhat involuntarily, I was engaged in a mediation work, which eventually failed to reconcile the participants in the project.

[2] Two of them were members of Vivagora, while others were members of other organizations (trade unions, local civil society organizations, environmental movements). They were helped by a temporary employee of Vivagora who had worked on the ACEN project.

[3] To be sure, the new organization was founded, but dissolved itself within a week. I was directly involved in the discussions, and could not manage to settle an agreement between the two parties.

[4] This means that one of the members of the ACEN working group forwarded the details of the discussions to PMO.

[5] One of CENG members told me that "if it hadn't been for Dorothée, (they) couldn't have done this".

thereby provides an illustration of an intervention in industrial activities, science policy instruments, and social mobilization processes, in order to participate in the construction of technologies of democracy. The multiple interventions and experiments of Vivagora attempt to shift the positions of local officials from a sole concern for local economic development to the collective construction of nanotechnology, to encourage environmental NGOs not yet active in nanotechnology's programs to mobilize on the construction of programs and products, and to incite industrialists developing nano products to dialogue with NGOs.

This implies, for the organization, a particular form of engagement, based on a multiplicity of experimental sites, types of relationships (e.g. partnerships with NGOs, contracts with official bodies, interventions in participatory mechanisms) and forms of actions (organization of dialogue, participation in the making of norms, voicing concerns in national newspapers…). The consequence is a perpetual uncertainty about the object of the engagement, which cannot be grounded on a stable stake to mobilize for, or on a stable technology of democracy to circulate from one issue to the next. Rather, the organization needs to permanently interrogate the objects and means of its engagement. Accordingly, Vivagora's members always ask themselves what they are and how they should act, and are always criticized by all the other actors, for the form of mobilization they propose has no hope to get stabilized.

How to describe such mobilization is then an issue for the analyst. Like PMO, but for opposite reasons, Vivagora is suspicious of social scientists. PMO thinks they are too involved; Vivagora that they are too external. As I talked with her, Dorothée would regularly say that socials scientists "just want the money to study people from above", without being able to "take sides", to intervene in the construction of nanotechnology in one way or another. My own engagement with Vivagora was a way for me to participate with the actors in the problematization of nanotechnology – as a domain to be constructed through the making of instruments. It rendered possible a description of the organization as well as a transformation of both Vivagora's and my own initial interests in "participation in nanotechnology" to the more central problem of the "democratic construction of nanotechnology" – of which this very dissertation is an exploration.

The positions of Vivagora in the nanotechnology landscape echo that of the researcher trying to study the problematizations of nanotechnology. But the scholarly contribution requires re-establishing a distance with the actors again. Accounting for his own relationships with the French Muscular Dystrophy Organization, which he studied at length with Vololona Rabeharisoa, Michel Callon speaks of the dual "engagement/detachment" strategy of the analyst, who produces social realities with the actors he studies/works with, but nonetheless needs moments of detachment in order to write accounts of the interactions, craft his own repertoire of description, and confronts empirical cases with one another[1]. The case of Vivagora points to the many adjustments, the multiple negotiations and the micro trials that are part of the day-to-day interactions with the actors, and necessary conditions for the stabilization of a situation of work and analysis. For articulating attachments and detachments is clearly not easy or straightforward. My own experience with Vivagora demonstrates some of the difficulties it may entail, and that switching from "attached" to "detached" requires permanent adjustments with the actors. As much as the organization needs to constantly question its form of engagement with administrative, industrial, or civil society actors, I had to constantly question the modalities of my own engagement with Vivagora (and, consequently, nanotechnology) when studying and working with the organization.

[1] Callon, 1999

Conclusion. Nanotechnology trials for social mobilization

Nanotechnology is a trial for social movements. Environmental movements wishing to push for stringer regulation of nanotechnology need to make visible the risks of nano substances and products, and, consequently, the substances and products themselves. This means that any mobilization on the environmental or health impact of nanotechnology will necessarily result in the participation in boundary-making for the definition of the "nano-ness" of substances and products. This implies that these organizations enter the sites (legal arenas, standardization institutions, European regulatory bodies) where the definition of nano substances and products are discussed, and adopt a form of mobilization that solidifies a stake on which it can fight for (e.g. "nano silver is a new substance", or "300nm is an appropriate upper size limit to define the nano-ness").

Such a construction of "publics" and "problems" adopts the form of negotiation among stakeholders about risk issues. It is part of nanotechnology as a technical domain about which regulation is discussed. As seen in the previous chapters, it might conflict with the mobilization of the "broad public" by science policy officials, and, consequently, with the objective of the collective and consensual construction of nanotechnology. In Europe for instance, the insistence of the EEB for stringer regulation, and, in parallel, the preferred route of the "scientific understanding of the public" on the part of the European Commission illustrate the differences of positioning among the actors of the European moral space. In the U.S., NGO actors explicitly disregard the intervention of science museums (see chapter 2) or the small-scale social science experiments meant to demonstrate the interest of real-time technology assessment (see chapter 6). As Jaydee Hanson, in charge of nanotechnology at the International Center for Technology Assessment said, "they claim they want to listen to the public, but that doesn't make the nano people listen to what we say"[1]. For Hanson, the mobilization of ICTA through the petitions it sent to EPA was the only way for civil society to make itself heard, that is, out of the scope of nanotechnology programs' initiatives aimed to the construction of publics.

For all the oppositions among civil society and industrial and administrative actors, the problematization of nanotechnology that these forms of mobilization propose is based on the discussion around the modalities of the definitions of nano substances and products. As such, it directly fits within collective discussions that occur at ISO, OECD, U.S. EPA or the European Commission. This does not mean that from their own viewpoints, the conditions of intervention of NGOs could not be made easier[2]. But it does illustrate that NGOs can play the game of the negotiation in the definition of "nano-ness", through the defense of "stakes" by organized stakeholders. Hence, the nanotechnology trial can be

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[1] Interview, Washington DC, March 29, 2010.

[2] Thus, participants in a EEB meeting on nanotechnology in September 2010, which I attended, insisted on the difficulties for NGOs to attend ISO meetings because of financial costs, and be numerous enough to participate in the works of multiple technical committees.

passed, through the transformation of nanotechnology into a topic of negotiation under the adversarial format EEB or ICTA are used to.

The examples of mobilization that we encountered in Grenoble do not follow this pattern. Equalizing negotiation with integration in the making of nanotechnology, anti-nanotechnology activists consider that what matters the most is the construction of a distance from which critical inquiry can be performed. Starting from the very same refusal to reduce nanotechnology to a matter of negotiation on well-defined stakes, Vivagora contends that the exteriority position cannot be sustained, and that, consequently, the object of social mobilization is the very construction of nanotechnology's problems and publics. In both cases, the position needs to be stabilized through constant adjustments. In both cases, the problematization of nanotechnology is less about negotiating about the nano-ness of substances and products than about considering – pretty much as this dissertation does- nanotechnology as a global program of development gathering objects, futures, concerns and publics. PMO considers that the global character of nanotechnology requires putting all its components (including participatory mechanisms and stakeholder negotiation processes) at a distance. It criticizes the technologies of democracy described throughout the dissertation (be they participatory instruments or risk management methodologies) for the connections they perform between the development of nanotechnology and the engagement of citizens, between science and science policy programs, between science and social science. In turn, it hopes to propose a "pure" critique at a distance, which would avoid the complex arrangements nanotechnology is made of, but which requires constant care to be sustained. Vivagora, on the other hand, considers that the social mobilization has to cope with the impossibility of being exterior to nanotechnology. This implies experiments to produce publics and problems, intervention in the very making of technologies of democracy, and, consequently, permanent uncertainty about the identity and objectives of the organization. Whereas PMO works hard to distance itself from any form of organized social mobilization, Vivagora hopes to "structure civil society" by circulating information, meeting with representatives of environmental social movements, participating in collective actions in the U.S. and Europe, inviting members of NGOs to speak at events it organizes or to participate in projects it undertakes. The mobilizations of PMO and Vivagora problematize nanotechnology through practices of engagement and modes of collective and individual actions. How to mobilize is then part of what to mobilize on. The spectacular demonstrations and the critical inquiry are part and parcel of the critique of the global program of nanotechnology, as much as the various experiments undertaken by Vivagora are components of its mobilization on the "democratization of nanotechnology". Problematizing nanotechnology through social mobilization is at the same time problematizing social mobilization itself.

In such a process, the engagement of the actors crosses that of the social scientist. Whether he or she adopts a position at a distance to describe activists (e.g. PMO) or engage with others in the experimentation of technologies of democracy, the problematization of nanotechnology and social engagement in it is, by the same token, that of the engagement of the analyst. Stabilizing forms of mobilization requires the stabilization of particular arrangements between the analyst and the actors. The case of Vivagora is, for that matter, very different from that of PMO, as well as others in the dissertation (cf. the OECD case in chapter 3). The collection of various situations throughout the sites considered in the dissertation made it necessary to examine at further length the practical and theoretical significance of the engagement of the social scientist with nanotechnology, and the forms of description and critique such an engagement produces. If one takes seriously the impossibility to distinguish the forms of engagement from its content, doing so implies a work of re-assemblage of all the elements that have been explored and described throughout the previous chapters. This will be done in the next chapter.

CHAPITRE 8 : S'ENGAGER POUR LA PROBLEMATISATION DES NANOTECHNOLOGIES

Ce chapitre reprend les terrains examinés dans les chapitres précédents afin de revenir sur les modalités d'engagement du chercheur dans les nanotechnologies, les reconstructions qu'elles permettent, et la nature de son intervention dans la problématisation des nanotechnologies. En conséquence, ce chapitre final n'introduit pas de nouveaux terrains, mais propose une lecture transverse des éléments examinés précédemment.

La première section s'interroge sur les modalités de l'engagement du chercheur dans les nanotechnologies à partir des différentes formes de distance analytique rencontrées au cours des descriptions précédentes. Il apparaît que la distance du chercheur à son objet n'est pas fixe, mais évolue en fonction des épreuves rencontrées, qui mêlent les acteurs, le chercheur et les modalités de leur travail en commun. Une forme d'engagement expérimental est proposée pour rendre compte des descriptions introduites au cours de la thèse. Elle s'appuie sur les travaux des pragmatistes américains, relu au prisme des études sociales des sciences.

Cette discussion permet d'introduire les reconstructions de problématisation auxquelles la thèse permet de parvenir. La seconde section décrit ainsi quatre problématisations des nanotechnologies, plus ou moins stabilisées, chacune réalisée par l'intermédiaire des technologies de démocratie décrites dans les chapitres précédents. La question de l'objectivité de l'expertise est centrale aux Etats-Unis, où la séparation entre technique et politique, entre sciences et sciences sociales, impose le maintien de démarcations centrales dans la fabrique de la science. Ceci implique que les problématisations anti-dualistes soient traduites en des termes compatibles avec les nécessités de la production de l'expertise. En France, les nanotechnologies donnent lieu à des expériences dont les objectifs sont incertains et controversés. La problématisation expérimentale des nanotechnologies est une composante de la définition de la stratégie nationale de développement responsable des nanotechnologies. La question des valeurs est centrale dans la construction des programmes européens de développement des nanotechnologies, elle impose la mise en place d'un espace moral superposé à celui de la régulation. Enfin, l'espace international de traitement des nanotechnologies est caractérisé par l'importance de la distinction entre la souveraineté nationale et la construction de la normalisation technique (ou politique, via la standardisation des technologies de « public engagement »). Dans tous les cas, les problématisations des nanotechnologies sont fondées sur la mise en œuvre de technologies de démocratie, engagées dans des opérations de démonstrations et d'expérimentations.

Sur la base du paysage ainsi dessiné, la troisième section du chapitre insiste sur les mécanismes de stabilisation progressive des problématisations, et met en évidence les lieux où sont éliminées les alternatives. Ainsi, c'est au sein des épreuves de stabilisation que l'intervention du chercheur est possible. La forme d'engagement décrite au début du chapitre trouve ici le lieu de sa réalisation. Il est donc possible de revenir sur la charge politique des descriptions effectuées, non pas distinctes du travail empirique, mais au contraire élément d'un processus qui consiste à mettre en évidence les investissements nécessaires à la stabilisation des problématisations, et à ajouter de la réalité aux problématisations alternatives.

Chapter 8. Engaging in the problematization of nanotechnology

> "Je ne peux m'empêcher de penser à une critique qui ne chercherait pas à juger, mais à faire exister une oeuvre, un livre, une phrase, une idée; elle allumerait des feux, regarderait l'herbe pousser, écouterait le vent et saisirait l'écume au vol pour l'éparpiller. Elle multiplierait non les jugements, mais les signes d'existence; elle les appellerait, les tirerait de leur sommeil. Elle les inventerait parfois? Tant mieux, tant mieux. La critique par sentence m'endort; j'aimerais une critique par scintillement imaginatifs. Elle ne serait pas souveraine ni vêtue de rouge. Elle porterait l'éclair des orages possibles."
>
> Michel Foucault, "Le Philosophe Masqué", entretien avec C. Delacampagne, *Le Monde*, 6 avril 1980, in *Dits et Ecrits II*, Paris, Gallimard, 2001: 925-926.

The previous chapter concluded with the question of the engagement of the researcher. Studying Vivagora was for me part and parcel of an engagement that I had to constantly put on trial and restabilized, and which was a necessary condition to undertake the empirical research work. This chapter extends this concern by exploring the forms of research engagement nanotechnology can lead to. Raising the question of engagement means interrogating both the conduct of research, and its political value. How to do research in practically feasible and "acceptable" ways for the actors and the researcher? What does it mean to engage in politically relevant research on nanotechnology? As I have been arguing throughout the previous chapters, studying the construction of nanotechnology implies studying the formation of political entities, and the stabilization of democratic orders. What forms of engagement of the researcher do these stabilized formats imply? How to maintain a position from which these formats can be described?

Thus, this chapter considers the question of research ethics and the question of political intervention. It starts with a discussion of the modalities of my involvement in the analysis of the problematization of nanotechnology, using empirical materials presented in the previous chapters. The analysis of nanotechnology raises "ontological issues" in that it explores the existence of objects, futures, concerns and publics. It implies a form of engagement in which exteriority is not a given, but experimented with the actors involved[1].

[1] This section is a revised version of a paper written with Michiel van Oudheusden (forthcoming).

Following a choice to reconstruct problematizations of nanotechnology, the second section of this chapter then proposes descriptions of four stabilized problematizations, which, for some of them, re-enact geographical boundaries. I describe American, French, European and international constructions of nanotechnology as a collection of objects, futures, publics, and concerns. In these four cases, I identify operations of problematization based on demonstrations and experimentations of technologies of democracy. Thus, I propose an international comparison that originates from the description of technologies of democracy – and, by the same token, of nanotechnology itself. In turn, this allows me to further develop, in the third section of this chapter, the analytical and political value of the research engagement, in proposing a realist critique of nanotechnology.

Section 1. Experimental engagement

In this section, I describe the forms of intervention I have had throughout the research that led to this dissertation. A seemingly natural distinction between "description" and "intervention" must be questioned. Consequently, I analyze the forms of my engagement in terms of "interferences", which leads me to reflect on the political value of scholarly work, as well as the research ethics it implies.

Engagements

It is tempting to identify two modalities of scholarly engagement in the various fieldworks encountered in the previous chapters. In some cases, I displayed the processes of stabilization of problematization of nanotechnology. I highlighted the investments necessary to overcome the critiques and alternative propositions. For instance, I described the work necessary to ensure the production of nanotechnology publics in science museums (chap. 2), replicate consensus conference devices (chap. 3), produce international standards that are consistent with the expectations of the national participants (chap. 4 and 5), and construct "responsible" science policy programs (chap.6). In doing so, I described how technologies of democracy such as science exhibits, participatory devices, processes of standard-making and science policy-making for "responsible" nanotechnology programs stabilize some problematizations of nanotechnology at the expense of others.

But I did not only explored technologies of democracy at a distance. In the previous chapters, I also focused on situations in which I was directly involved, and actively contributed to the making of technologies of democracy. For instance, my study of Vivagora (chap. 7) was inherently tied with an actual participation in the work of the association. I participated in the *Nanoforum*, pushed (along other actors) for its focus on nano silver, helped the director of the organization define her position regarding the ethics of nanotechnology, and played a role in the voicing of the association's self-definition as a "mediator". In chapter 5, I described the nano-responsible norm project and explained that I was directly involved in it. I pushed for an approach that would be flexible enough to integrate the future technical evolutions as well as potential future requests from concerned groups. I insisted on the need to differentiate the approach from the known norms and standards, such as the risk management tools separating "evaluation" from "management".

In the previous chapters, it has appeared that some technologies of democracy are well stabilized, and replicated on nanotechnology after having been used on other topics (e.g. the consensus conference or standard-making at ISO), while others are experimented in the case of nanotechnology (e.g. the nano-responsible norm), and displace the identities of the involved actors. Following the previous descriptions, it seems that the former imply a "descriptive" position, while the latter stimulate more direct involvement.

For all its analytical clarity, the dichotomy between "description" and "intervention" is not entirely satisfactory though. It does not help to account for the many adjustments and evolutions that occurred throughout the research process[1]. I described, in the previous chapter, some of the micro-trials that were part and parcel of my work with Vivagora. As I was directly involved in the projects of Vivagora, I had to negotiate a specific position. In some cases, it could be thought to be that of the "representative" of the association. In others, my work (such as the description of the various forms of nanotechnology ethics) was read and commented on by the organization's members or employees, who then could use it to describe their mobilization. For instance, the director of Vivagora used an early version of chapter 6 of this dissertation, in which I discussed a "constructivist" ethics opposed to a "representationist" one to define the position of the association in science policy arenas. In yet other cases (like ACEN), I was directly involved in the initiatives undertaken by Vivagora, and helped formulate their objectives. But in many others, I preferred not to be involved in the activities of the association, and observed them from the outside. My work on/with Vivagora is certainly the most telling illustration of the difficulty to maintain a dichotomy between "description" of and "intervention" in the fieldworks I have studied. This is not surprising, considering the particularities of Vivagora's mobilization. Vivagora could have been caught in a similar dichotomy between "description" (as performed by science journalists) and "intervention" (as undertaken by activists). But, as the previous chapter demonstrated, it eventually engaged in a series of experiments in which it was involved at various levels in the construction of nanotechnology objects, programs, concerns and publics. Throughout the trajectory of the association, the modalities of its engagement evolved: it shifted from the external position of the debate organizer to a more complex mobilization based on a variety of distances to the making of nanotechnology. Similarly, the modalities of my own engagement with Vivagora evolved, as we faced different situations, which eventually resulted in the transformation of both the activities of the organization (from the organization of "public debates" to the intervention in innovation and social mobilization processes) and that of my research work (from the study of "public participation" to that of the problematization of nanotechnology). Examples I considered in the previous chapters provide other illustrations of changing distances to the actors I was studying. Thus, my active participation in the OECD WPN, which I originally meant to be a collective construction of expertise about "public engagement in nanotechnology" eventually resulted in the reproduction of the detached position of the exterior analysis (cf. chapter 3).

[1] This does not mean that a categorization in terms of "analytical" and "activist" positions could not be drawn, although it is not the perspective I follow in this chapter. See for an example in science studies (Woodhouse et al., 2002).

Understood not as an opposition between "description" and "intervention", but as a spectrum of practical situations in which the relationships with the actors are negotiated, scholarly engagement is, in all the cases considered in the previous chapters, an engagement in problematization processes. Whether it describes the processes through which problematizations are constructed or participates in the machinery of technologies of democracy, this form of engagement allowed me in all cases to better understand the processes of problematization themselves. And the way of doing that, throughout the spectrum going from active participation to external description, was to focus on the sites where controversies and conflicts were visible. In the European example, I focused on controversies about the operationalization of the European principles and values for the making of the European moral space. The description of the experimentation of procedures and the trials for the replication of existing ones led me to highlight situations of uncertainty and reluctance on the part of the French actors. The oppositions between stakeholders, and the use of sound science as a response to legal conflicts appeared constitutive of American nanotechnology policy-making. In international arenas, negotiations among participants, national delegations, public and private actors, NGOs and industries were part of the descriptions of nanotechnology. These oppositions, controversies and conflicts are the locus of engagement for the analyst and the actors themselves. They are the places where the components of technologies of democracy are visible, and where propositions for alternatives are voiced. As the previous chapters have made it clear, they are the places where the existence of nanotechnology as an assemblage of objects, futures, concerns and publics is produced and contested. These contestations relate to the very existence of the components of nanotechnology. As such, they involve the exploration of ontological questions.

Interferences with ontological processes

Ontological questions are central concerns of Anne-Marie Mol in her description of human diseases[1]. She explains that anemia and arthrosclerosis are enacted in various places, so that multiple versions of the disease (practical experiences of the patient, statistic knowledge, practices of physicians…) co-exist. Less than differences in perspectives of the same object, these versions produce different realities, multiple ontologies – of the disease, of the human body, of medical practice. There is, with nanotechnology as well, an ontological multiplicity resulting from scientific and policy practices, only at a more developed level, as categories of chemicals and consumer products, public policy programs, public concerns, and publics are multiple. The case of nanotechnology compels us to extend Mol's analysis of the human body, which holds materially together the multiple realities: there is indeed one

[1] Mol, 2002

single material "body", however "multiple" it may be. In the case of nanotechnology, the uniqueness is not given. It requires the mobilization of complex infrastructures able to stabilize new categories for chemicals, science policy instruments inscribing futures in operational collective actions, mechanisms defining public concerns and ways of dealing with them, and devices making publics speak and be taught about technological development – in short, technologies of democracy.

Consequently, scholarly engagement in the problematization of nanotechnology is inherently tied with the making of nanotechnology itself. The forms of engagement can then be described as "interferences", an expression used by John Law in order to point to the many connections between the description work and the activities of the actors themselves, and the performativity of social science[1]. For Law, focusing on "interferences" directs the attention to the contingency and particularities of the situations at stake. The previous descriptions are indeed forms of "interference", which highlight the importance of the intervention in problematization processes. The interferences in the previous chapters are the situations where I made problematizations visible, interacted with the actors themselves, intervened in the ontological construction of nanotechnology, and, eventually, displaced my own position. Indeed, as much as I contributed to the evolutions of the situations I examined, my own research trajectory was also transformed by the interferences I had with the actors I was studying. For example, my examination of the production of standards defining nano substances and products eventually led me to participate in the nano-responsible project. And, perhaps more importantly, my interactions with actors involved in discussions and debates about nanotechnology led me to shift my initial research interest from "public participation" in nanotechnology to the problematization of nanotechnology through technologies of democracy.

Understanding scholarly engagement in the terms of interferences prevents from taking as granted the dichotomy between "description" and "intervention". Rather, one should consider that the distance between the researcher and the objects he studies is part of the experiments at the heart of the conduct of research[2]. If one refuses, then, to ground the analysis on a static distance between the analyst and the actors, the issue is then to formulate an acceptable mode of scholarly engagement throughout the interferences with the actors. This was a practical problem for me to solve throughout the empirical work that led to the previous chapters… and to the continuous possibility for me to study and work with the actors I was interested in. At this stage, my objective is not to replicate previous empirical descriptions, but to reflect on the variety of interferences I had. The challenge is to characterize the engagement that was a condition for me to account for the problematization of nanotechnology, and

[1] Law, 2010: 278-279

[2] This means that "reflexivity" is not a satisfactory answer, as long as it is based on the distance one can construct to oneself, and forces to develop a discourse in terms of bias and self-interest. Arguably, the perspective I propose here is an active reflexivity not foreign to ethnomethodology. Cf. the infra-reflexivity Latour proposes (Latour, 1988a). For a discussion on the many meanings of "reflexivity" and a critique of the term that is grounded on ethnomethodology, see (Lynch, 2000).

reflect on the political value of this form of research practice. I ground this exploration on the works of the American pragmatists.

Evolving distances

In *Reconstruction in philosophy*, Dewey develops the analogy between the natural sciences and the human sciences. He argues that the natural sciences have learned to go beyond the hierarchy that privileges "contemplative knowledge" over "practical knowledge", particularly as the scientific revolution demonstrated that we gain knowledge of nature through our interventions in the natural world[1]. Similarly, Dewey considers that it is through experiential action that human sciences can hope to gain relevant knowledge of the social. Dewey argues in favor of an experimental ethics that refuses general perspectives based on theoretical certainties. Instead, he advocates an ethics in "which the needs and conditions, the obstacles and resources, of situations are scrutinized in detail"[2], an ethics about which research is about methodologies and generating "effective methods of inquiry"[3]. These methods produce knowledge about the world, as well as enable researchers to deal with situations that are potentially problematic for scholars and non-scholars alike. Thus, Dewey refuses the dualist perspective that separates a supposedly theoretical position from a politically relevant one, as it is through the intervention of the object under study that an "amelioration" of the current situation can be reached.

Paul Rabinow rightly insists on the instrumental character of Deweyan intervention, expected to occur when a situation "needs" it[4]. Accordingly, I do not follow a "Deweyan" approach that would contend that interferences are to occur to answer "needs"[5]. Yet Dewey's contribution has a major interest, in that it attracts the attention to the notion of "experience", which for Dewey encompasses both intellectual reflection and practical intervention. To convey this connectedness between reflection and action, he describes, following William James, experience as "double-barreled" in that "it recognizes in its primary integrity no division between act and material, subject and object, but contains them both in an unanalyzed totality"[6]. Accordingly, Dewey's experimental ethics refuses rigid categorizations and *a priori* dichotomies (subject/object, insider/outsider, description/intervention). For Dewey, philosophical

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[1] Dewey, 1920: 28-53
[2] Dewey, 1920: 174
[3] Dewey, 1920: 170
[4] Action research is based on such a pre-requisite (see an example in an action-research textbook in (McNiff and Whitehead, 2002: 71-84). Some variations of action-research contend that the "needs" may evolve throughout the interactions with the researchers (Greenwood et al., 1993).
[5] Nor do I follow Dewey's social analysis of the evolution of science, opposing "theory" to "applications", the former being mastered by the dominant class and the latter by the dominated (Dewey, 1920).
[6] Dewey, 1958: 8. Dewey derives his description of experience as "double-barreled" from James (1976: 7).

intervention is thus best understood as an experimental process rather than as a mobilization of a set of ready-made instruments.

The previous chapters have focused on different types of interventions, and have described different forms of relationships between the actors and myself. Dewey's experimental ethics is thus of a particular interest in order to account for the type of research ethics I had to experiment when working with and studying nanotechnology actors. It implies that there is no absolute "ethics" to which the scholar (and, for that matter, any other actor) could unproblematically conform independently of the particularities of local situations. As James aptly put it:

> *ethical science, just like physical science, and instead of being deducible all at once from abstract principles, must simply bide its time, and be ready to revise its conclusions from day to day.*[1]

While the conclusions "ethical science" produces can be more or less stable, these are always "liable to modification in the course of future experience"[2]. This implies that the type of intervention the social scientist negotiates has to be put on trial and made more robust each time he or she constructs his or her trajectory with other actors. From this perspective neither the type of relationship, nor the distance he or she might be led to maintain with actors, is a given, but has to be experimented with in order to acquire stabilization. This is a major difference with the radical activists I described in the previous chapter. For them, what matters is the distance from which they can draw a critique of nanotechnology. My exploration of nanotechnology shares some of their hypotheses (notably the understanding of nanotechnology as a global arrangement in search of stabilization). But it has led me to experiment with a large variety of distances. This was a condition for the description of nanotechnology[3].

Such a process supposes that it is both possible and necessary to experiment, that the researcher accepts to put him- or herself at risk, and is creative enough in the conduct of his or her empirical research[4]. This requires specific competences, and is not necessarily a collaborative or harmonious enterprise. In fact, it may well agonize relations between actors (temporarily or even more permanently), for instance when the analyst distances himself from a certain kind of participation (as in the OECD example) or refutes commitments that other actors confer upon him (as it happened in the Vivagora

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[1] James, 1897: 208

[2] James, 1897: vii

[3] Consequently, if I am not willing to criticize PMO because of their "un-democratic" manners, I would be more inclined to critique the quality of their descriptions of nanotechnology.

[4] Creativity is an explicit condition for Dewey's ethics based on the "dramatic rehearsal" that moral deliberation would be (Dewey, 1996). "Deliberation" is not a category I used in this discussion. The trials we encountered in the previous chapters have indeed involved various sorts of exchanges of arguments and forms of relationships with the actors.

example). The outcomes of the interactions with the actors are in all cases the results of situations of trials. At the OECD, my propositions resulted in the affirmation of the boundaries on which the work of the international organization is based. Each of the interactions with members of Vivagora was a test on the form of mutual engagement that we could have [1].

Engagement with ontologies

The process by which one stabilizes research configurations that are at the same time engagement with the actors is "experimental". This differs from certain calls for reflexivity that are grounded on the detachment of the analyst from himself/herself and his/her actions, in order to identify underlying presuppositions and values. Rather, research engagement in nanotechnology leads the analyst to construct values and types of relationships with the actors, under modalities that are not given beforehand but need to be experimented with throughout the research process. Within this process, the researcher does not seek to isolate punctual decisions in order to weigh the pros and cons of a given form of engagement, but to account for the continuous production of particular forms of arrangements between objects, futures, concerns and publics. This means that the responsibility of the researcher – far from being diluted within an approach that would be satisfied with "whatever works" – extends to the relationships he or she constructs with the actors, thereby holding both epistemological (about the quality of the sociological description) and ethical (about the stability of the interactions with the actors) dimensions, and depending on learning processes[2].

The reference to classical pragmatism that I propose, for that matter, is strongly influenced by STS, and differs from other readings highlighting pluralist perspectives. Hilary Putnam, for instance, refers to Dewey in order to point to the situated objectivity of ethics, "as opposed to an 'absolute' answer to 'perspective- independent' questions"[3]. Putnam's pluralist argument leads him to argue for an ethics "without ontology", that is, an ethics that would not refer to a stable and unquestionable Being[4]. He is then caught in the problem of relativism, since he wants to retain the objectivity of moral judgment, and the "fundamental values of liberty, autonomy and respects for persons"[5]. Putnam solves this problem by considering that objectivity, as in mathematics, is obtained within systems of language. One can thus be

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[1] See also for other examples and comments: (Callon and Rabeharisoa, 2004; Vikkelsø, 2007). The engagement defines a role for the actors involved, which might not be accepted. Cf. (Callon, 1999) for a discussion of the successive "attachments" and "detachments" of the researcher throughout his or her trajectory.

[2] Refering in particular to *Democracy and Education* (Dewey, 2005), Guillaume Garreta explains that moral is, for Dewey, part of a learning process for the development of the self. This is the reason why moral is ultimately an educational undertaking in the Deweyan perspective (Garreta, 2007).

[3] Putnam, 1989: 25

[4] Putnam, 2004

[5] Alexander, 1993: 376

"objective without object", and there is no need for a reference to an outside world to sustain ethics' objectivity ("If I am asked to explain how ethical knowledge is possible at all in "absolute" terms, I have no answer"[1]). Then the objectivity is that of the situation within particular language games (in mathematics), or in "practical reasoning" (in ethics)[2]. The equivalent of "language games" are thus "frames" or "habits" that define values and acceptable reasoning. A recent book entitled *Pragmatist Ethics* suggests a similar reading of Dewey: the varieties of "frames" and "habits" would determine moral reasoning[3]. A pragmatist ethicist would recognize this variety and locate his own habits. As these approaches do not interrogate stabilization processes, they tend to solidify the "frames" in which human actions are supposed to take place. They might well be "frames" and "habits", but, as we saw, they are part of what is tested and put on trial through the research work, they are outcomes of processes to be studied rather than explanatory resources. The pluralist reading of pragmatism also separates ontology from the reflection about values. It leaves intact the very existence of material objects, future programs, public concerns, and public[4]. Putnam refuses the object in ethics' objectivity for fear that it would lead to a universal claim about ethics, hence his "ethics without Ontology". But there is no need to climb directly up to the grand level of Ontology. We saw that there are many ontologies at play in the laboratory as in standardization and regulatory arenas, that they might be more or less stable, and that their characteristics are potentially open to collective exploration. An experimental engagement proposes an ethics *with ontologies* and, as such, is concerned with the analytical exploration of ontological processes, at the same time as it interrogates the interventions of the researcher in stabilization processes.

Engaged reconstruction

This approach does not provide definite answers as to whether or not one should engage with the actors involved. But it pays close attention to the local situations of trial for the analyst's engagement. The next research steps could then consist in delving further into in the exploration of the multiplicity of problematizations. There could be two ways of doing that. One would be to concentrate on some of the sites I studied, and describe at further length the micro-processes that led to the expression of the

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[1] Putnam, 1989: 22
[2] Putnam, 2004: 72
[3] Fesmire, 2003
[4] For an example of a pluralist reading of James that could also be said to be "without ontology", see (Ferguson, 2007).

variety of problematizations in each of the sites. A second one would be to multiply the forms of interferences[1].

Choosing one approach or the other, the natural conclusion could well be that "reality is multiple", that various problematizations of nanotechnology are proposed, and that, consequently, "decisions" and "choices" are all situated, and distributed in heterogeneous processes. This is not a position that I find satisfactory, for both analytical and political reasons[2]. First, what would be gained in terms of the quality of fine-grain description would prevent from displaying regularities and the re-stabilizations of dominant technologies of democracy at the expense of others. Second, my experimental engagement in the problematization of nanotechnology has also been an engagement in the connection among sites of problematization – something I observed the actors doing, and was directly involved in[3]. Understanding nanotechnology as a macro assemblage of objects, futures, concerns and publics required a work of reconstruction among various sites where problematizations were made explicit. If one sticks to the claim of multiplicity and complexity, one risks losing the possibility to account for the global character of nanotechnology, and, eventually, to describe the production of democratic orders.

Once this point is accepted, the objective is then to conduct reconstruction. Connecting sites of problematization is a way of doing so. This is what I did throughout the dissertation by linking plants producing carbon nanotubes to standardization offices, nanotechnology exhibits in science centers and science policy offices, or participatory attempts and government concerns for the responsible management of nanotechnology. The other option is to look at sites (such as standardization bodies, chapter 4 and 5) where the actors themselves draw links and connections. Thus, the engagement of the analyst and his or her original trajectory is a way toward the gradual reconstruction of problematizations.

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[1] Thus, Marcus insists on the possibility offered by a multi-site ethnography for the multiplicity of the forms of intervention of the social scientist, who can then engage in "activism", but "activism quite specific and circumstantial to the conditions of doing multi-sited research itself. It is a playing out in practice of the feminist slogan of the political ad personal, but in this case it is the political as synonymous wih the professional persona and, within the latter, what used to be discussed in a clinical way as the methodological" (Marcus, 1995: 113). Marcus goes on by providing the example of an anthropologist studying AIDS, who is, in turn, "an AIDS volunteer at one site, a medical student at another, and a corporate trainee at a third". Similarly, van Oudheusden and myself saw the political value of an "experimental normativity" in the multiplicity of forms of intervention, and the specificity of the academic role in the possibility of shifting from site to site, and to experiment a variety of positions (Laurent and van Oudheusden, forthcoming). In this chapter, I want to connect this interest in the multiplicity of modes of intervention with the need for reconstruction in order to display and critique the problematizations of nanotechnology.

[2] This is, however, Law's approach, as he develops his critique of "constitutionalism". Law criticizes the assumption that "there is indeed a common world or collective within which we live and need to live well in together". He contends that "in practice the world is irredeemably messy" (Law, 2010: 273) and that "ordering is partial, incomplete, always more or less local, more or less implicit, and therefore more or less disconcerting" (Law, 2010: 279). I am much willing to follow Law in his critique of overarching criteria evaluating normative principles for a democratic order. But I am also interested in accounting for the regularities I have encountered. In turn, this also leads to rethinking the type of democratic normativity that can be proposed. This will be discussed at the end of this chapter.

[3] When, for instance, I argued for the examination of nano silver in the Nanoforum. Another example is the connection I helped maintain between Vivagora and ICTA.

Reconstruction can now be envisioned as part of the analytical and engagement work. This follows directly from the concerns of the American pragmatists, particularly William James. In accounting for the construction of reality, James' perspective focuses on individual choices[1]. But it is not difficult to pursue the perspective James offered, by directing the attention to the performative role of social science, both at the local level of intervention, and, through the circulations and connections the social scientist performs, at that of global ordering processes. Understood as such, the ethical issue of the researcher is less the questions raised in punctual situations: what to do with actor X, facing situation Y? (speaking in his name in an institutional arena? Providing "advice" to decision-makers?) than the whole process of research inquiry, which engages the analyst and the other actors[2]. For it is through this inquiry that the researcher can participate in experiments with technologies of democracy, display the cracks and gaps in their replications, and make explicit alternative problematizations. Rather than an aesthetic approach that could eliminate the responsibility of the researcher toward the actors he is engaged with (or subsume it to a mysterious aesthetic criterion)[3], the experimental approach I proposed is concerned with the display of problematizations of nanotechnology, of which the analyst is just one component. Consequently, it renders the question of research choices more complicated: rather than discriminating among rigid possibilities when answering punctual questions (like "do I maintain an analytical distance or do I engage?"), the research trajectory aimed to make visible the work needed to stabilize certain realities, and the places where displacements can occur[4]. The choice of reconstruction

[1] See the *Will to Believe* (James, 1897), and Stengers' comments on James' ethics (Stengers, 2007).
[2] Thus, Marcus considers, speaking of the anthropologist of AIDS, that: "politically committed though she is at the start of her research, ethnographer though she is throughout it, the identity or persona that gives a certain unity to her movement through such disjointed space is the circumstancial activism involved in working in such a variety of sites". (Marcus, 1995: 113) The "circumstancial activism" of the ethnographer can indeed ensure the "unity" of the research work, but certainly not the only one. As the ethnographer of problematizations of nanotechnology engages in the making of technologies of democracy, his or her trajectory is also made of responses to the particularities of the issue at stake.
[3] The recourse to aesthetics, as a criterion in the self-development of the analyst is not satisfactory to account for the variety of distances to be experimented. Focusing solely on the personal development of the analyst forces us to detach the process of analysis from the work of the actors. Richard Rorty's "liberal ironist" is an example of such a position. See (Rorty, 1989), particularly part II, about irony and "self-creation". The link between ethics and aesthetics can be drawn differently though. Fourcault's account of the Ancient Greek ethics is one example. Although I am not attempting to develop it here, the reading of pragmatism through the STS lens could lead to a practical aesthetics as much as it has allowed me to craft a practical ethics.
[4] Stengers' comments on James' ethics are particularly helpful for that matter. Stengers explains the difference between a pragmatist approach that seeks to make visible the production of the real and the alternatives, and for whom the reduction of a problem to a local choice is always an a posteriori reconstruction, and the utilitarian approach (Stengers, 2007). One could use Anne Marie Mol's "ontological politics" to point to the type of engagement at stake here:
"If the term 'ontology' is combined with that of 'politics' then this suggests that the conditions of possibility are not given. That reality does not precede the mundane practices in which we interact with it, but is rather shaped within these practices. So the term politics works to underline this active mode, this process of shaping, and the fact that its character is both open and contested." (Mol, 1999: 75)

now means that I can describe connections among the sites I described. But as outcomes of my research engagement with the actors I studied/worked with, the reconstructions I propose in the following section do not draw a neutral landscape of diverse positions lying passively close to each other. Rather, they will offer elements to refine the description of research engagement in nanotechnology.

"Ontological politics" is indeed at play in all the sites where nano substances and products are defined, publics are manufactured, concerns take shape, and programs are crafted. But this expression is for me only useful if it allows me to reconstruct problematizations.

Section 2. Four problematizations of nanotechnology

Technologies of democracy. Circulations, experiments, demonstrations

Following up on the previous analysis, I describe in this section four problematizations reconstructed from the sites I explored. I base the descriptions on the components of nanotechnology (objects, futures, concerns, publics), and the operations involving technologies of democracy. Thus, I illustrate democratic orders enacted with nanotechnology, that is, modes of making problematizations explicit, and of managing the tension between their multiplicity and their synthetic reconstruction.

Throughout the previous chapters, the roles of technologies of democracy in the operations of problematization have been explicit. In particular, I have described experiments involving technologies of democracy, and their mobilization as demonstration devices. STS is useful to account for experiments and demonstrations. Indeed, it has shown that experiments are central components of scientific activities based on complex arrangements comprising literary, material and social elements[1], which make their replications – an important part of scientific work - a difficult task[2], and that demonstrations are both technical enterprises requiring sophisticated competences[3] and political acts allocating roles to potential witnesses and demonstrators[4]. Experiments and demonstrations are central activities involving technologies of democracy, and the operations of problematization can be described in these terms. This does not mean that these operations adopt the same formats and serve the same objectives. The four problematizations that I synthesize below thus allow me to contrast different articulations of experiments and demonstrations involving technologies of democracy.

American expert nanotechnology

Expertise for nanotechnology

When the National Nanotechnology Initiative (NNI) was created in the late 1990s, its integration in the making of American science was manifest. Nanotechnology was "the next frontier", announced as early as 1959 by physicist and Nobel Prize Richard Feynman, the "next industrial revolution", for which

[1] Shapin and Schaffer, 1985
[2] Collins, 1975; Collins, 2004. More recently, STS scholars have focused on economy and on the various types of experiments that perform economic orders (Muniesa and Callon, 2007).
[3] The conduct of demonstrations in experimental settings has been analyzed by the Social Studies of Knowledge. For an example in non-experimental science, see (Rosental, 2008).
[4] Barry, 1999

society had to be prepared. The value of the new technology was to be demonstrated for members of the Congress to fund the initiative and for the "general public" to accept it and provide students, workers, and consumers. One would be tempted to see the connection with past science policy programs in the U.S., from the Apollo project to Vannevar Bush's vision of science as an "endless frontier" [1]. But nanotechnology is a particular case. It is not meant to be a government-driven program aimed toward the realization of a single objective (like the Apollo or the Human Genome Project). Nor does it follow a linear, science-based model that would contend that funding basic science is a sufficient condition for the development of applied research, and, eventually, social progress[2]. The NNI is best described as a program that operationalizes in research management instruments long-term objectives, research organization plans, and understandings of the historical development of science and technology. It associates numerous federal agencies, and brings together fundamental and applied science for the development of nanotechnology. Nanotechnology objects and futures have caused vivid controversies between industrialists and proponents of visions of nanotechnology based on the anticipation of self-replicating molecular machines (cf. chapter 1). Eventually, the instruments of the NNI were able to connect both, while making nanotechnology a vast program gathering a large number of projects. For instance, Roco's four generations of nanomaterials connected current practices, industrial applications and long-term developments. It allowed the NNI to avoid the long-term and scary visions of Drexler while also situating nanotechnology in the continuation of Nobel Prize's prophecies, within the history of scientific discoveries.

Yet nanotechnology also caused concerns to be dealt with by public actors. The proponents of nanotechnology in the American science policy landscape soon advocated the management of risks and ethical issues through specific expert work, and the integration of "public input" in nanotechnology programs. As the example of nano silver illustrates (cf. chapter 4), the way of dealing with these issues is, in many respects, defined within the American expertise system in federal agencies. Legal conflicts occur on the qualification of substances (as "new pesticide" or "known material" in the case of nano silver), and the legal arena is the terrain on which arguments are presented and opposed to each other, and administrative choices are challenged. The opposition between the International Center for Technology Assessment (ICTA) and the silver industries is characteristic of such dynamics. The legal opposition causes constant calls for "sound science", for the "objectivity" that "special interests" would have lost. It is at this point that institutions such as the Woodrow Wilson Center intervene: by claiming to defend "no special interest", the Project on Emerging Nanotechnologies voices a concern for "more science" in toxicology and eco-toxicology. The importance of the management of nanotechnology concerns by the

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[1] The famous report written by Vannevar Bush, *Science. The endless frontier*, advocated federal support for basic research.

[2] This is known as the linear model. Benoît Godin has studied the evolution of the linear model, and its stabilization in indicators and stabilization instruments (Godin, 2006).

mobilization of science was heralded soon in the making of nanotechnology. It had implications for the making of nanotechnology publics as well. The "good expertise" that the Woodrow Wilson advocated was indeed not limited to science: by measuring public perceptions and informing "the public" through the channel of science museums, the Center could also claim that it represented nanotechnology's publics as well as nanotechnology for the public – the overall objective being that public expectations and concerns were known, while the public was also transformed into responsible citizens, knowledgeable voters, and informed consumers. Hence, as the legal confrontation of stakeholders fosters calls for "sound science", a "general public" made of individuals to be informed, and of concerns to be represented can be opposed to a public of stakeholders arguing for their interests.

Nanotechnology is problematized, in the American sites, through the dynamics between legal oppositions and "sound science", the operationalization of imaginaries of progress and development through science policy programs, and the mobilization of publics being either stakeholders arguing for their interests, or "general publics" to be informed. This problematization of nanotechnology echoes, in many respects, the dynamics of the regulation of science in the United States[1]. It requires demonstrations of the quality of the expertise being mobilized, and of the scientific value of the stakeholders' positions. This process was described in chapter 4 about silver nanoparticles, and in chapter 6 about expertise in ethics[2]. It enacts boundaries between expertise and the stakeholders' interests, and between the expertise in ethics and toxicology and the technical development of substances.

This implies discussions about the funding of the "good expertise". Thus, numerous organizations called for the integration of more federal funding for environmental, health and safety (EHS) research during the discussions that led to the re-authorization of the National Nanotechnology Initiative by Congress in 2009[3]. But mobilizing the "good expertise" to answer nanotechnology concerns is not only a problem of research funding. It also requires that the expertise be identified. Thus, successive congressional reports interrogated the quality of the reporting of EHS activities in nanotechnology programs, and, by 2008, asked for a better monitoring, identification and quantification of EHS research[4]. A specific area of expertise was needed, and it was to be visible enough for policy-makers to mobilize, evaluate and control it.

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[1] This has been described at length by Sheila Jasanoff (1990, 1992, 2002, 2005).

[2] Recall that by integrating "ethics" into the sphere of expertise, bioethics became a component of science policy that was expected to provide argumentative resources managed by experts in the making of science policy (chapter 6, section 1).

[3] The Woodrow Wilson Center and the ICTA were among them. The Environmental Defense fund was also particularly active. See (Hess, 2010) for a detailed account on the evolution of the funding of EHS research for nano substances and products within the NNI.

[4] United States Government Accountability Office, 2008, *Nanotechnology. Better Guidance Is Needed to Ensure Accurate Reporting of Federal Research Focused on Environmental, Health, and Safety Risks*, Washington DC, GAO.

Restabilizing boundaries

The call for expertise for nanotechnology faces difficulties. Expertise in ethics, either under its liberal or conservative formats, is bound to "wait and see", possibly claiming that it will "catch up" with scientific development. Ensuring that the risks of nanotechnology are taken care of faces the uncertainty regarding the characterization of nano substances and the identification of nano products. Ontological ethics and "safety by design" (chapter 6) attempt to answer the destabilization effects of nanotechnology. "Safety by design" and ontological ethics are not based on boundary-making. In these approaches, the construction of material objects is tightly linked with that of concerns. Toxicology and material science are supposed to work together in the construction of materials that are "safe by design". Concerns appear as the outcome of collective exploration, that of scientists and "embedded humanists" in the laboratory, or that of deliberative processes. But it is more complicated to make such alternative approaches visible in the process of expertise production. They would require, for instance, new scientometrics methods able to make "safety by design" projects measurable[1]. For social science, the construction of a small-scale experiment at the Center for Nanotechnology in Society (CNS) described in chapter 6 can be seen as a demonstration of the scientific quality of an approach that does not separate science from society, but can nonetheless differentiate its expert work from public decision-making. The CNS experiment is a way through which a problematization of nanotechnology aiming not to reproduce the science/social science or expert/lay boundaries can be operationalized in devices that produce acceptable demonstrations in the American science policy scene.

Nanotechnology is also an opportunity to experiment with deliberative techniques, in science museums where "public engagement" became an imperative (chapter 2), and as a component of "real-time technology assessment" (chapter 6). Like safety by design, these initiatives could question the boundaries between expertise and social interests. As ontological ethics, they are integrated into a social scientific experiment at CNS. For science museums interested in fostering public deliberation about nanotechnology, the uncertainty surrounding the objectives of deliberation is dealt with through the transformation of deliberation into an expertise managed by museum staff, and addressed to individual citizens expected to learn about a new scientific field. Thus, the stabilization of the boundaries on which the American problematization of nanotechnology is based required the transformation of initiatives that could have destabilized these very boundaries.

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[1] Existing scientometrics in nanotechnology differentiates "toxicology" fields from other domains of scientific activities (Porter et al., 2008).

Experimental French nanotechnology

Experiments

In France, nanotechnology causes deep interrogations for public actors. French administrative officials consider nanotechnology as a specific set of materials, objects, and concerns, and advance that changes are needed in the conduct of science policy. For them, the problems of nanotechnology require different approaches than other technological domains. Understood as such, nanotechnology becomes an opportunity for the experiments of numerous technologies of democracy. The debate organized by the National Commission for Public Debate (CNDP, chapter 7) is certainly the most visible example. Others comprise the Nanoforum (chapter 7) and the nano-responsible norm (chapter 5), within which civil servants, industrialists and members of NGOs attempt to craft ad hoc devices for the examination of nanotechnology's objects and issues, for the determination of its futures, and the making of its publics. Experiments take various formats: in some cases, existing technologies of democracy (such as the *conférence de citoyens* or the CNDP public debate) are replicated on nanotechnology. The demonstration of the value of the stabilized procedure on yet another topic is then at stake. In other cases, the experiment is that of a new mechanism, like the nano-responsible norm. In this latter case, it is even used to define the position of the country in international arenas (chapter 5). In all cases, the experiments in the French landscape are not limited to laboratory, small-scale projects. They imply that new categories of objects are tested. *Substances à l'état nanoparticulaire* for instance, is a category that emerged from the *Grenelle de l'Environnement*, was questioned by many, and had to be defined. The experiments also attempt to produce new publics. This is the case in science museums, where debating citizens and visitors participate in the making of exhibits (chapter 2), as in attempts such as consensus conferences, the CNDP debate, the nanoforum and the nano-responsible norm.

Therefore, the stabilization of technologies of democracy in France problematizes nanotechnology as a collection of objects that have to be contained (as A*** did, chapter 4), or constructed in a safe manner (as the nano-responsible norm attempts to do), of futures that need to be collectively discussed, of publics to be involved, of concerns to be made manageable in the public administration as they emerge. Throughout these operations, nanotechnology becomes a problem of democracy ("a problem of governance", as many people in the French administration would say), a problem of organization of expertise and democratic life, a problem of making new objects for public actions – in short, a problem for the construction of technologies of democracy.

This interest for the "new ways of doing technology policy" stem from earlier experiments. CNDP was created in 1995 and its missions were extended in 2002 to "general options", thereby making it possible to discuss within the public debate format the construction of public policy programs. The

Grenelle de l'Environnement was heralded, right after the election of Nicolas Sarkozy in 2007, as a turning point in the public management of the environment. The "five party decision" was conceived as a central model for consensual and pluralist decision-making.

Recalling these episodes does not mean that one needs to look for historical causes for the problematization of nanotechnology as a political experiment. It is rather a sign of the questions that were asked, and of the state of un-definition of many questions and problems: what role is CNDP expected to play? What to do with the bizarre outcomes of the *Grenelle* process (*substances à l'état nanoparticulaire*, requirement of a national debate)? How to involve civil society actors in the making of nanotechnology policy? How to manage the uncertain existence of potentially risky substances and products, and the growing concerns of the French public? These questions are asked by the French actors involved in the government of nanotechnology by the experimentation of real scale technologies of democracy – "experimentations" meaning that the fate of their outcomes is uncertain, and the demonstrations they are supposed to perform are not stabilized. This means that the civil servants involved are permanently raising questions about their positions, the objectives and modalities of public policy actions regarding nanotechnology.

Consider for instance the case of two civil servants I have been studying/interacting with over the past five years[1]. Arila P is a civil servant at the *Direction Générale de la Santé* (DGS), in charge of nanotechnology and a member of the French delegations to international organizations. At DGS, Arila was involved in the discussions about nanotechnology at an early stage. She argued for the specificity of nano substances and products in regulation, for the need to do risk-benefit analysis in order to introduce new nano products on the market, and was at the origin of the nano-responsible norm (chap. 5). Having to defend the public administration's position in front of industrialists, she multiplied her contacts with civil society organizations, which became important partners in the projects she was involved in (cf. chapter 7 for the case of Vivagora). Louis T was detached from the *Commissariat à l'Energie Atomique* (CEA) to work for the ministry of industry, at the general direction of companies (*Direction Générale des Entreprises*), in a department specialized in the manufacturing sector. He was a representative of the ministry of industry in the planning committee of the Nanoforum, and participated in the nano-responsible norm. Throughout the meetings of the Nanoforum planning committee, he became more and more vocal in advancing that "the administration cannot do technology policy the same way". Originally skeptical about the nano-responsible norm, he eventually endorsed its objective of "management of uncertainty", to the point that he became one of the most outspoken proponents of this device.

So the experimental process has consequences for the work of civil servants and administrators. In such a process, civil society actors such as Vivagora can also attempt to propose forms of action meant

[1] Quotes are excerpts from fieldwork notebooks.

to produce problems and publics, at the price of permanent uncertainty about the identity of the mobilization (cf. chapter 7). For the researcher, this means that his or her position is also uncertain, and, as I described in the previous chapters, put on trial.

Demonstrations

What are the criteria that evaluate the success of these experiments? I encountered different situations throughout the dissertation. In some cases (museums, citizen conference, CNDP), the demonstration is that of the possibility for the citizen to act in the governance of technology. This requires investments, infrastructure, and definitions of what "to act" means. Related to this are demonstrations that nanotechnology is being taken care of, that is, that its concerns are made explicit and addressed (in the Nanoforum), or that the industrial products are developed in a responsible manner (according to the nano-responsible norm). A last level of demonstration to perform is for the international actors to see that the French position is being produced (cf. chapter 5). It is at this level that reconstruction among the various experiments is required.

But the experimental situation makes demonstrations inherently uncertain. As many examples throughout the dissertation have shown, many technologies of democracy in France are unstable. For some actors, such uncertainty requires solidification using known methods, among which risk-benefit analysis, public perception studies, and communication plans meant to explain to an unreliable public what the concerns are and how they are taken care of. Consider for instance an initiative undertaken by CEA, called "Nanosmile". Developed as part of a European project, Nanosmile is an online training device meant to describe the approach to be taken in order to "apprehend potential risks and benefits of nanomaterials in order to contribute to Science & Society dialogue"[1]. For the proponents of Nanosmile, the technologies of democracy to be mobilized are based on the representations of scientific fact and economic imperatives, of public concerns and ethical issues. When such representations are correct, it is then possible to define nanotechnology as a program of economic development, and a collection of separate objects that can be evaluated if questions of risk and safety are asked. Futures are to be defined according to the logic of economic growth, public-private partnerships, and for the sake of continuous development. Publics are to be informed, known, and evaluated. Concerns need to be dealt with in a scientific manner, by the mobilization of scientists, ethicists, and toxicologists.

These approaches to the problems of nanotechnology are often directly adopted by the proponents of French nanotechnology programs. But they are not frontally opposed to the experimental

[1] The original version of the website separated the "subjective perceptions" from the "objective risks" to be mastered by "good practices". I described the tool in (Laurent, 2010a: 85). The graphic description of the project based on the dichotomies I criticized then has disappeared from the most recent version of the website (www.nanosmile.org, accessed April 2, 2011).

problematization of nanotechnology. All these approaches belong to an experimental state, in which some actors reproduce practices they are used to and add measures and evaluations of public concerns, as well as expertise about risks and ethics (like the Grenoble officials in chapter 7), while others propose original devices. Hence, the situation is that of a state of uncertainty in which the mobilization of existing techniques faces difficulty, but the experimentation of new ways of acting has not solidified other modes of action. This implies that a single technology of democracy can be used for a diversity of objectives. The CNDP device, for instance, was mobilized for nanotechnology as a result of the *Grenelle* process, with the objective to simultaneously help perform risk-benefit analysis of nanotechnology, inform the public, or interrogate the relevance of risk-benefit analysis itself.

This also implies that the state of experiment does not question the development of nanotechnology. On the contrary, it tends to involve as many actors as possible in it. This is well recognized by PMO, who proposes a critique of this "no exteriority model" based on spectacular demonstrations. The challenge for PMO is then to maintain the distance with an inclusive nanotechnology program.

Integrated European nanotechnology

European nanotechnology space and European values

I described in chapter 6 the European moral space that is constructed as the operationalization of "European values" for nanotechnology is discussed. Common values are to be worked upon, as they are enacted in policy instruments expected to define the existence of nanotechnology objects, the future prospect of nanotechnology development, the management of their concerns, and the expectations of the "European public". The European values themselves and legitimate procedures of decision making accepted by industries, stakeholders and the member states are experimented throughout these processes: the construction of the European political space is at stake with the construction of European nanotechnology policy.

European technologies of democracy of a different kind than the two previous cases can be identified here through these processes. They are experimental, but not small-scale experiments as in the U.S.. They are not based on the replication or experimentation of situated technologies of democracy (whether participatory democracy instruments or industrial norms) as in France. Rather, they are experiments in the making that contributes to the stabilization of European values, publics and legitimacy. Chapters 3 and 5 described the refusal of "public understanding of science" in favor of a "scientific understanding of the public" of a still undefined nature. But the construction of European nanotechnology is not limited to the probing of stakeholders' and citizens' expectations and concerns. It is also about stabilizing an original democratic formation. Processes of negotiations are meant to ensure the stability of the pluralist union, of a common market with safe and standardized products, and, more generally, of the European political project. This translates in the very making of science policy and regulatory instruments, as well as in confrontations within European institutions, particularly between the European Commission and the European Parliament.

Commentators have spoken of an "emerging governance landscape" to designate the set of public and private initiatives aimed to govern nanotechnology by the integration of ethics research in public programs, the participation of publics in nanotechnology policy-making, and the development of various voluntary approaches, such as codes of conducts[1]. The European case is indeed an example of an "emerging governance landscape", but what makes it analytically interesting is not that it is "emerging", nor that it is "governance" (as opposed to centralized forms of government). What makes it specific, as compared to the American and French examples, is that the problematization of nanotechnology in Europe is a manifestation of an original democratic formation, which needs to "harmonize" among sovereign member states, while also creating common publics, imaginaries, concerns, and building a shared understanding of what legitimacy means at the European level. We can follow Andrew Barry and see the harmonization project…

… both as a way of imagining and of reordering European space, as well as a technical process directed at establishing this space as a governable entity.[2]

The instruments of nanotechnology policy-making at the European level are the vehicles through which nanotechnology can be made "a governable entity", while stabilizing a European political space based on the Lisbon strategy. Harmonization enacts the subsidiarity principle within a European strategy based on innovation, competitiveness, and democratic inclusion. For nanotechnology, it means that the concerns of the European public have to be understood, that a common "code of conduct" is inscribed in nanotechnology policy programs, that long-term objectives such as "human enhancement" are not accepted in the ethics review of project, that safety measures are required within European research projects, and that "nanomaterials" are defined "for policy purpose". As conducted by the Commission, the harmonization project is a way not to introduce new regulation for nanotechnology, yet to manage objects, futures and concerns through dispersed modes of intervention, in the making of research projects, in the crafting of science policy programs, and through multiple public consultations. It is

[1] cf. Kearnes and Rip, 2009; Kearnes, 2010
[2] Barry, 1993: 316

understood differently by the European Parliament, which attempts to introduce specific regulation for nanotechnology.

Technologies of democracy – codes of conduct, ethics reviews, public consultation devices - are constitutive of nanotechnology in the European problematization. They have to be crafted as the various elements of European nanotechnology are being constructed. Objects and concerns of nanotechnology are discussed simultaneously when the European institutions attempt to define nanomaterials. The futures and concerns of nanotechnology are addressed in consultation processes and codes of conducts, while instruments are mobilized in science museums and ELSA projects in order to make the European public speak. These technologies construct nanotechnology policy programs and the legitimacy of European decision-making. As such, the making of nanotechnology policy is itself a technology of democracy that invents political legitimacy through the (contested) stabilization of regulation-making processes, common values operationalized in policy instruments, and a European research and innovation system able to compete with international players.

European experiments

The meaning of "experiment" in this case is close to the work of political theorists interested in "experimental governance", described as a set of governing processes aimed not to constraint the individual entities, while ensuring the efficiency of the whole system through instruments such as benchmarking and coordination devices. Commentators in this stream of work have indeed described the European political space in these terms, using as an example the Open Method of Coordination, through which the European institutions determine broad policy objectives and implement a set of instruments (guidelines, benchmarks, etc.) for member states to reach these objectives on a voluntary basis[1]. But I am less interested in this very instrument than in the general logic of the problematization of nanotechnology in the European Union, as a science policy about which common values should be shared while leaving room for national divergences within the subsidiarity principle.

Consequently, I do not take for granted claims for "efficiency", or "better democracy", when speaking about the experiments that are at the heart of the making of European nanotechnology. The form of experimentalism that the European Union produces with nanotechnology is one particular democratic format, based on the multiplicity of sites of experiments of European values and concerns,

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[1] See (Trubeck and Trubeck, 2005) for a discussion of the experimentalist perspective on the construction of European social policy. See (Szyszczak, 2005) for a description of the open method of coordination as an instrument in "experimental governance", in a perspective defined by Sabel and Zeibel (2003). The nanotechnology Action Plan explicitly refers to the open method of coordination as a way of making member states follow the Lisbon strategy: "in line with the subsidiarity principle, the Commission considers the 'Open Method of Coordination' to be an appropriate way to proceed with the use of information exchange, indicators, and guidelines".

publics and imaginaries. It requires that demonstrations be conducted in order to show that issues are taken care of in ways that enact the European values. Critiques from the European Parliament and NGOs can be found here as controversies occur about the operationalization of the European principles, and, eventually, on the principles themselves (cf. chapter 6). The extension of the principle of subsidiarity and the boundary between "general principles" and "mandatory requirements" are contested, as are the definition of the existence of materials and substances, the control of the future development, and the extent to which publics (and which ones) need to be listened to.

Experiments in this case are not a stage before the solidification of European values and processes of decision-making, but a constitutive part of Europe as an original political entity. The "European experiment" that the *Converging Technologies for European Knowledge Society* report proposed[1] is an appropriate expression. Not because Europe would be the place where science and society would finally come together and produce, at last, a democratic technology policy. But because the making of European nanotechnology policy is an experiment in the making of the European political space, which entails difficulties, solidifications of collective objectives (like competitiveness and innovation), and controversies about the operationalization of common principles and values (like inclusion and safety).

International nanotechnology

International order

Nanotechnology is in many respects an international entity. Science policy officials compare the performances of national programs against one another. Concerns and people circulate, international alliances of NGOs are set up, nanotechnology substances and products are distributed across the world. The need for an international cooperation for nanotechnology was heralded soon in science policy spheres, as a way of providing international common ground for the definition of nano substances and products, a shared perspective on the health risks of nano substances and products, and eventually a global market of standardized and safe goods[2]. Consequently, nanotechnology projects were launched at ISO and OECD.

Since international expertise and standardization intervened at an early stage in the development of its objects and programs, nanotechnology appears particularly interesting to illustrate the production of "international order", that is, the international construction of public problems and ways of dealing

[1] It was later restated by CTEKS's main author (Nordmann, 2009).
[2] Kearnes and Rip describe as an aspect of the responsible development discourse "the way it operates internationally as a tool for the development of global consensus and strategy" (Kearnes and Rip, 2009).

with them. For the actors involved in the making of international standards and expertise, nanotechnology was quite specific in this respect, being a set of loosely connected objects and programs, with no specific industrial domain able to hold these components together. As seen in the examples considered in the previous chapters, the dynamics of international work had important consequences for the making of international nanotechnology. First, both ISO and OECD follow a process expected to be "based on science". That international work is "based on science" means that international expertise or standardization initiatives are not expected to cross the line between expertise and national sovereignty. Distinguishing "science" from "policy" is thus a central element of the making of international standards and expertise. It is at stake in the separation at OECD between the Working Party on Nanotechnology (WPN) and the Working Party on Manufactured Nanomaterials (WPMN), and in the very practice of these working groups. At ISO, it implies that (toxicological) property-based definitions of nanomaterials are eliminated in order not to develop standards that would hint at potential regulation. Maintaining the science/policy dichotomy is tied with organizational considerations: at ISO and OECD, the internal organization contributes to enacting the separations between expertise and national decisions, between scientific expertise and the expertise on policy.

The "science" on which the international expertise and standards are supposed to be based is made of heterogeneous considerations. Recall for instance, the mixture of science policy logic, communication imperatives, and technical considerations that had to be mobilized so that the 100nm size limit could hold at ISO TC229 (chapter 4). Similarly, the choices of the OECD reference materials were linked to a number of considerations, either technical, economic or relative to national strategies. But as the examples described in chapters 3, 4, and 5 show, the examination and definition of the objects of nanotechnology in international arenas remain separated from that of the futures, concerns, and public of nanotechnology.

The international problematization of nanotechnology also considered "policy" as a topic of interest. Because of the impossibility to transform the making of nanotechnology futures into an object of international discussion (as it would cross the line between "international expertise" and "national sovereignty"), the "policy issues" looked at in international arenas, mostly within OECD WPN, can at best compile national initiatives, and produce representations of objects, publics and issues the components of which are discussed elsewhere. At OECD WPN, the common policy initiatives that are discussed, within a general agreement for "responsible innovation", comprise "statistical frameworks", evaluations of benefits, and public engagement work. Of course, gathering data through questionnaire and producing guidelines are not neutral choices. As the 100nm 'science-based" criteria for the definition of nanomaterials, public engagement as it is stabilized at WPN is not expected to connect international expertise with the management of nanotechnology public concerns (chapter 3). This implies that "public engagement" is to be carefully distinguished from the actual making of nanotechnology substances, products and programs.

Purification devices

Technologies of democracy based on international negotiations for standard and expertise making are experimented at ISO and OECD. Nanotechnology forces to craft standards at an early stage in the development of an entire scientific and technical field. As nano substances and products are of an uncertain nature, nanotechnology challenges the capacity of the OECD to provide guidelines for the management of chemicals: the choice of reference nanomaterials at OECD WPMN is a way for the international organization to still provide guidelines while avoiding the problem of definition. These experiments have to demonstrate that they ensure the international operationalization of the "responsible development of nanotechnology", while taking care of the constraints of international negotiation – namely that OECD expertise and ISO technical standards do not extend to national policy choices.

This international problematization of nanotechnology has effects. It solidifies definitions of nanotechnology that do not connect the identification of substances, the development of public policy programs or industrial strategies, and the constructions of public concerns and mobilization of publics. It does so at the price of the elimination of alternative constructions. Indeed, the uncertainties about the technical characterization of objects, and about the expectations and concerns of publics offer room to propose approaches meant to define substances according to toxicological properties (at ISO), or to propose devices expected to initiate the collective management of uncertainty (at OECD). Yet the processes of standard writing operate as purification devices, thanks to which propositions are crafted in order to stabilize the international order, and alternatives are rejected, or transformed till they fit with the constraints of the international arenas. Hence, propositions that threaten to destabilize the science/policy boundaries by connecting definitions of nano-ness to regulatory choices (as in Europe), or expertise about the public to perspectives about collective decision-making (as in France) are eliminated through the processes of standard writing. The international definition of "nano", or the separation between "policy expertise" and "scientific expertise" can then be re-stabilized. Chapters 3 and 4 provided examples of such processes of stabilization of the international order.

Four problematizations of nanotechnology

These four cases are illustrations of the variety of problematizations of nanotechnology. The synthetic table below presents the four problematizations of nanotechnology I described: they are four ways of assembling nanotechnology as a set of objects, futures, concerns and publics. For each of them, I list the technologies of democracy on which it is based, and the experiments and demonstration that I have analyzed.

	Problematizations of Nanotechnology	**Technologies of democracy**	**Experiments and demonstrations**
U.S.	Nanotechnology to be dealt with through the appropriate expertise	Stakeholder negotiations, recourse to sound science, RTTA	Social scientific experiment, public engagement experiments in science museums. Demonstration of the value of the expertise
France	Nanotechnology as an opportunity to explore the collective governance of technology.	Replications of participatory instruments (conference de citoyens, CNDP), experimental devices (Nanoforum, nano-responsible norm, participatory exhibits)	Experimenting devices for the making of French nanotechnology policy and the integration of its publics. Demonstrations that policy-making is dealing with uncertainty. Counter-demonstrations by PMO.
Europe	Nanotechnology as enacted by operationalizing European values	Science policy instruments	Real-time, permanent state of experiment, Demonstration of the operationalization of shared values
International	Nanotechnology as an object for international collaboration	Standard making, construction of international expertise	Experiment in the making of a new category at an early stage, demonstration of the maintenance of existing boundaries

Table 1: Four problematizations of nanotechnology

The description I propose here is not exhaustive. These four problematizations of nanotechnology are stabilized at the price of the exclusion and/or transformation of others: deliberative and "safe by design" approaches in the US are transformed into a social scientific experiment or expertise of museum staffs; PMO seeks to distance itself from the French experimental problematization; the international problematization needs to evacuate propositions that do not fit in the international arenas. Yet this description does offer a synthetic vision of different entanglements of the political dimensions of nanotechnology, namely the production of material objects, the planning of decisions about the future, the identification of public concerns, and the integration of publics.

Throughout the previous chapters, it appears that technologies of democracy associate material and cognitive elements for the production of public objectivity and legitimacy. They are the instruments through which political theory gains empirical strength. As they enact public problems and leave more or less room for alternative approaches, they offer a window in the description of nanotechnology as they produce, connect, and circulate nanotechnology objects, futures, concerns and publics.

Thus, I analyzed the construction of nanotechnology objects as connected to policy initiatives (as in the examples of the SCENIHR's definition of nanomaterials or the French nano-responsible norm, where objects and futures are brought together in a single definition expected to accommodate existing and future objects) or categorized as separate from futures, concerns and publics (as in the cases of ISO and OECD). I considered nanotechnology futures through instruments more or less integrated in the making of nanotechnology publics, issues, and objects, and which, in some cases, are meant to produce future substance, products and publics (nano-responsible norm) or are meant to represent public concerns (as for the scientific understanding of the public in Europe). Nanotechnology concerns are defined as problems of expertise (US), or of collective constructions (Europe), they are opportunities for experimenting (France), or standardizing at an early stage (ISO). In some cases, they are separated in "scientific" and "political" issues (OECD), in others, they are brought in the very making of nanotechnology policy (Europe). Eventually, every technology of democracy produces publics and associates them with the other components of nanotechnology. The dynamics of stakeholder negotiation in the American regulatory area defines publics according to the particular interests they defend, while the experiments of RTTA or in science museums construct small-scale publics about whom an expertise can be built. The French publics are experimental, contested, and their connections with the making of nanotechnology objects and programs are being explored. In response, PMO's public is made of individual citizens criticizing nanotechnology at a distance. In Europe, the mobilization of the public is a central component of nanotechnology policy, which enacts a European political space where legitimacy is to be stabilized. At the international level, nanotechnology's publics are dealt with through the production of international expertise at OECD.

The analysis therefore forces us to avoid considering nanotechnology "objects", "futures", "concerns", and "publics" as unproblematic categories. They are produced in various ways, associated (or not) through different types of connections. Questions such as "how publics make up their minds about nanotechnology"[1], "how best to involve the public?", "how best to define nano substances for effective policy-making?", or "how to deal with nanotechnology concerns?" are thus displaced. They cannot be

[1] For an example see (Scheufele and Lewenstein, 2005), in which the authors study through a telephone survey "how people make decisions about emerging technologies" and conclude, somewhat unsurprisingly, that "cognitive shortcuts or heuristics – often provided by mass media – are currently a key factor in influencing how the public thinks about nanotechnology and about its risks and benefits, and in determining the level of support among the public for further funding for research in this area".

accepted at face value since answering them can only occur within particular problematizations of nanotechnology.

"Zones" of problematization. Spatial extension.

Two of the four problematizations I described follow the geographical boundaries of nation states. Europe is an interesting case, since its boundaries have appeared permeable, as we saw in the case of the labeling project at the European Committee for Standardization (CEN) (chapter 5). Its modes of action are diverse, "networked" (chapter 6), and rely on a variety of devices expected to produce the European nanomaterials (chapter 5), European responsible futures (chapter 6), and "European publics" (chapter 2). Eventually, the international problematization is not the result of the addition of national ones, but an original political construction with specific constraints. It does not follow geographic boundaries, and is defined by the standardized standards and tools it produces.

A table such as that of the four problematizations above proposes an international comparison. But this tentative international comparison is not an addition of studies undertaken in ready-made geographic scales and spaces. Rather, it is an exploration of the making of these spatial categories. Following different trajectories can thus shed light on the geographic extension of problematizations, and on the constant interplay among them. The constructions of the European space, of the international space of standardized nanomaterials, and of national positions are indeed processes that result in the production of zones characterized by common definitions of nano substances and products, and forms of collective organization. They can be described as "technological zones", which Andrew Barry defines as

> *Space(s) within which differences between technical practices, procedures or forms have been reduced, or common standards have been established.*[1]

The "common standards", in the perspective I propose, are those of technologies of democracy. Hence, zones of problematization are not necessarily as stabilized as Barry's technological zones. They can be more or less solidified, according to the infrastructures, the extent of the circulations, the expertise that ensures their replication. The technologies of democracy mobilized in international arenas are well stabilized, and managed to deal with nanotechnology while reproducing boundaries between international expertise or standards and national policy choices (at the price of the exclusion of alternatives). In France, nanotechnology is an opportunity to introduce changes in the replication of

[1] Barry, 2006: 239

technologies of democracy (such as the CNDP debate), or experiment new ones. Eventually, the standardization of the European technologies of democracy is based on the operationalization of the European principles they ensure.

Barry uses the notion of technological zones in order to draw a geographic approach that does not stick to the territories of nation-states:

Unlike the territories of nation-states and empires, technological zones cannot be marked on a map, yet they do have limits.[1]

Using the cases encountered in the previous chapters, one can think of many potential zones of problematization that do not follow the boundaries of the nation state. The transatlantic connections between ICTA, EEB and Vivagora, for instance, could pave the way for the description of an international mobilization on nanotechnology[2]. The concern for the making of technology policy based on "real-time" or "constructive technology assessment" sparks experiments in the U.S. and Europe based, for instance, on scenario building. International standards for nanomaterials define territories that extend beyond the nation-state. The construction of the European zones is not defined by national boundaries, nor, for that matter, by purely geographic boundaries. But the circulation and standardization of technologies of democracy also encountered national boundaries, and this section has made it clear that national problematizations are well stabilized with nanotechnology. Accordingly, a similar technology can be replicated in different ways in the two countries (cf. chapter 3 for the example of the consensus conference), and the experimentations and demonstrations of technologies of democracy vary in France and in the U.S.

At any case, whether or not zones of problematization are more "trans-national" than "national" is not the most interesting question. Suffice it to say that the analysis of technologies of democracy and their stabilizations may describe a variety of zones, which encounters geographical boundaries in different ways[3]. Accordingly, relationships between zones of problematizations can have various forms. They might coexist and complement each other (as in the case of ISO and OECD definitions of nanomaterials; or the American and French versions of the consensus conference). They might confront each other in negotiation arenas (such as ISO or OECD, where national delegations confront their

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[1] *Ibid.*

[2] The previous chapters only glanced at this aspect of the mobilization on nanotechnology. Vivagora is represented at EEB and invited senior ICTA members to talk in Paris in front of members of the organization.

[3] Some of these spaces could probably be described, in Law' and Mol's terms as "regions, networks and fluids" (Law and Mol, 1994). Law and Mol use these categories to describe different states of stabilization, some of which ("fluids") allowing variations in techniques and practices. Andrew Lakoff also mobilizes the reference to fluidity through the concept of "liquidity" (Lakoff, 2005). I am less interested here in categorizing types of spaces than in pointing to the analytical interest of spatial analysis in order to account for the dynamics of problematization and display the potential sites and modalities of research engagement.

positions). They can be inserted in one another, when technologies of democracy are being stabilized, and thus contested (as in the example of CEN described in chapter 5). Thus, the boundaries of zones of problematization should not be conceived as stable, since the zones, as they interact in various ways with each other may be recomposed. One can then conceive of a geography of problematizations, which would describe their extension, their stabilization in national or trans-national formations, and the relationships among them. I undertook part of this task in the previous chapters, by showing, for instance, how the European space attempts to stabilize its boundaries by defining nano products (chapter 5), or how national constructions of nanotechnology were dealt with in international arenas (chapters 3 and 4, about the French propositions).

When speaking of zones of problematizations, it is important to insist on the fact that using problematizations does not lead me to describe a structured social space, in which some strata would be more solidified than others, and thereby determine them. It is less in terms of successive determinations (of problematizations of broader extensions containing each others) that I want to use problematizations, and more in terms of superposition and joint existences. Thus, the international definition of the problem of nanotechnology as that of "responsible innovation" is less a "general problematization" that would contain and determine national problematizations, than an original political formation, based on specific instruments (among which the 100nm size limit, the OECD reference materials, and the WPN policy expertise). As such, one cannot say that there are "French" or "American" variations within an international problematization characterized by "responsible innovation". Rather, all are described as different problematizations interacting with each other.

This does not mean that the discourse of "responsible development of nanotechnology" has no existence. "Responsible innovation" might well be a new trend for the governance of innovation in nanotechnology (as, probably, in other technological domains), centered on the need to commercialize nanotechnology applications while minimizing their risks[1]. The analysis of the problematization of nanotechnology incites us to question the making of responsible innovation. It considers "responsible innovation" neither as a ready-made category for normative use ("we should do nanotechnology responsibly") nor as an analytical endpoint ("nanotechnology is framed as a stake in the responsible development of technology"). Rather, the expression is an incentive to analyze the instruments that construct the responsible development of nanotechnology, and the forms of representation of, public administration about, and mobilization on nanotechnology that they imply.

Thus, the descriptions of problematization have sought to describe the various arrangements that, in different contexts and situations, attempt to stabilize the "responsible development of nanotechnology". We can follow Arie Rip when, in describing the "de facto agenda" of nanotechnology, he notices the entanglement between "innovation, promises, firms' strategies, public concerns,

[1] See (Kearnes and Rip, 2009).

government responses and attempts at risk regulation"[1]. What I proposed in the previous chapters are illustrations of these entanglements. The overall "responsible innovation" can then be broken down, in order to shed light on several democratic constructions, modes of organizing science and society, and stabilizations of political legitimacy and national sovereignty. Research engagement is then to be characterized further. It is not about comparing empirical observations to an "ideal of responsibility". Nor is it to display at a distance the landscape of the instruments of responsibility. Thus, the next section locates the experimental engagement I discussed above, and explores the consequences for the type of critique it proposes.

[1] (Rip and van Amerom, 2010), see also (Rip, 2006a), about "de facto governance".

Section 3. A realist critique of nanotechnology

At this stage, the reconstructed problematizations that I proposed are the outcomes of the experimental engagement I described in section 1. These outcomes are not stable spaces, but zones to be stabilized. The next step is now to identify the form of critique this research process offers. Discussing stabilization processes of nanotechnology and its problematizations, this section locates research engagement at the very heart of the operation of problematization. This offers a path for rethinking the public character of problematizations, and eventually the potential democratization of nanotechnology.

Stabilizations

<u>*Rethinking the novelty of nanotechnology*</u>

The description of the problematizations of nanotechnology forces us not to reduce the analysis to mere claims of multiplicity and circulations. Problematizing nanotechnology indeed relies on the circulation of objects, people and concerns. Carbon nanotubes are produced in France, integrated in solid matrixes in the U.S., and discussed in international arenas; ethicists travel from the United States to Europe; concerns for public engagement move from European to American science museums. But the permanent circulations can only provide a partial account of the production of nanotechnology. For the problematization of nanotechnology also reproduces modes of organizing collective discussions and oppositions[1].

The problematization of nanotechnology in the United States re-enacts the American adversarial system, while it also forces us to interrogate the integration of concerns for deliberation (done, as said before, through the production of an expertise on the topic). The problematization of nanotechnology in France provided illustrations of conflict about the role and rationality of the French citizen. In Grenoble, PMO and the local officials argue about the rational citizen's objectivity. The former advocates the at-a-distance position of the individual, anonymous and critical citizen able to locate the game of interests. For the latter, the rationality of experts is the best basis for the citizen to be enlightened about the logic of decision-making processes. The experimental situation reconfigures citizenship, as it explores the possibility of a production of citizens associated with that of concerns and

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[1] This nuances propositions such as those of Law and Urry, who contend that "'social reality' has altered" since "the phenomena (…) of the social are less about territorial boundaries and states and more about connection and flow" (Law and Urry, 2004).

products. In Europe, nanotechnology is an opportunity to pursue the Lisbon strategy and the European political space, interrogate the production of the democratic order of the Union, while pursuing the objectives of economic competitiveness and technological innovation. Eventually, the international problematization reproduces the concern for national sovereignty while developing the long-term objectives of global market building.

As they connect the production of democratic legitimacy and scientific knowledge, the problematizations of nanotechnology can be described in the terms of Sheila Jasanoff's "civic epistemologies". The category is all the more useful as it prevents from using "frames" which would determine the ways in which nanotechnology is taken care of. Indeed, the analysis I proposed does not describe nanotechnology facing existing institutions, or existing processes of problem definition[1]. The "novelty" of nanotechnology is perpetually negotiated, and used as a resource by its proponents or questioned. In the US as well as in Europe, novelty was at the heart of nanotechnology policy. As discussed in chapter 1, it implied the construction of a history of science that presented the succession of discoveries leading to the mastering of the atomic scale. It was contested when the American National Nanotechnology Initiative was created (chapter 1), and, during discussions about the nature of nano products such as nano silver (in the U.S., chapter 4) or throughout the discussions about the definitions of nanomaterials (in Europe, chapter 5). Constructing "new standards" for a new market, and re-thinking the categorization of chemicals so that existing substances become "nano" or not were permanent concerns in the standardization organizations we encountered. Consequently, the language of the "new" entity facing existing modes of problematization cannot account for the constitution of nanotechnology.

This, however, does not mean that there is no temporal analysis to perform. But whether nanotechnology is "new" or not matters less than how it is stabilized. Nanotechnology is not interesting because it is new but because it shifts, displaces, questions, might re-solidify or destabilize democratic orders. Accordingly, the study of problematization that I undertook suggests an approach that does not seek to identify the "novelty" of nanotechnology, but explores the trajectories of its problematizations. Describing these trajectories means analyzing the replications of technologies of democracy, the stabilization of the expertise about them, the reformulation of the demonstrations they are supposed to perform, the transformation of the problems they are expected to address, and the re-definition of objects on which they are supposed to work. This approach is not interested in determining the origin of destabilization, or the first locus of the apparition of a new problematization. It describes trials and displacements, gradual stabilization and recombinations, re-definitions of questions and re-qualifications

[1] For Dewey, problematization is a matter of novelty, as it occurs whenever a situation has "needs", that is, faces issues not dealt with by existing arrangements (Rabinow, 2003). STS work interested in issue politics tends to reproduce this binary opposition between "new" issues opposed to "old" institutions (Marres, 2007).

of the range of acceptable solutions. Hence, the sites where nanotechnology is problematized are not places where "private concerns" become "public problems"[1], where "new issues" encounter "old institutions", or where "a new assessment regime" is being crafted[2]. They are places where processes of problematizations are re-stabilized or displaced throughout the construction of nanotechnology.

Processes of stabilization

Consequently, instead of identifying "frames" that nanotechnology would encounter, I have described processes of stabilization. Stabilization can take various forms. In the U.S., the making of RTTA as an experiment in social science, or the transformation of deliberation as a form of expertise of science museums in the US, are processes through which problematization of nanotechnology based on the coproduction of material objects and publics is integrated in the making of American expert nanotechnology. Stabilization can also occur through the replication of technologies of democracy mastered by experts. These experts circulate technologies of democracy and make sure they manage to overcome the trials they face when they are applied to new topics. In this second process, encountered as I described the replication of the consensus conference or the CNDP debate, stabilization depends on the investments made to ensure that the expertise about technologies of democracy is stable, and that technologies of democracy do not "stick" to the topic on which they are mobilized. The real-scale experimentation of European technologies of democracy is a fourth process of stabilization, through which the maintenance of the boundary between "values" and constraining regulations is ensured, and the European moral space eventually harmonized. Eventually, standardization arenas provide a last example of stabilization process, through which international standards are written in such a way that they do not threaten the international organization of collective discussions. As described in chapter 4 about the production of the 1-100nm size limit for the definition of nanomaterials at ISO, each word of the documents released is questioned, each formulation is contested, the material identity of substances and products is explored, and its stability in the international arenas tested. The stabilization work

[1] This is an important difference with approaches focusing on trajectories connecting "private concerns" with "public problems". As seen throughout the previous chapters, this does not account for the mobilization of civil society organizations on nanotechnology: ICTA used nano–silver as the easiest target to push for the regulation of nano substances, and Vivagora grounded its mobilization on the construction of publics and problems. This, however, does not mean that there are no constraints of generalization for the making of arguments expected to convince others (see examples in the previous chapter about PMO and its attempts to transform spectators).

[2] The "new assessment regime" of nanotechnology is the title of a recently edited volume (Kaiser et al., 2010), which contends that nanotechnology is a case for the development of new political, ethical and epistemological approaches, characterized respectively by the trend toward the "democratization of science and technology", the concern for "responsibility and accountability of science in society", and the shift "from knowledge to innovation". The analysis provided in the previous chapters could be described as an illustration of this "new assessment regime". Yet this category is not very helpful to describe varieties in the stabilization of nanotechnology and processes of problematization. It can at best serve as a starting point for the analysis. But I do not want to take for granted the "novelty" of the "assessment regime" (see below for a discussion of the novelty issue).

requires a constant investment able to maintain the possibility of international agreement, and the boundaries between international expertise and national decision-making processes.

In all these cases, stabilization processes are the ways through which problematizations are enacted. They are the costly and controversial processes through which nanotechnology can be constituted as an assemblage of objects, futures, concerns and publics. They are the means through which institutions (among which the nation-State) can solidify and act as coherent entities. Accordingly, the modes of action of these institutions (including the scope and instruments of the State's internal actions as well as its manifestations in international arenas) now appear as components of problematizations.

Public spaces

Sites of problematization

By highlighting the perpetual displacements, the micro-trials in the stabilization processes, and the loci where alternative problematizations are voiced, and in some cases eliminated, the analysis is inserted in the very making of (de)stabilization processes. For example, it interrogates the democratic argument the European Commission mobilizes with the "scientific understanding of the public", and the consequence of its definition of European values for the (non) regulation of nano substances and products. It makes the analyst read the opposition between the European Commission and the European Parliament as controversies about scientific expertise and democratic legitimacy. Thus, the analysis I propose introduces controversies in the operations of stabilization. This implies that the most interesting sites for the analysis are those where oppositions are made explicit, where zones confront each other, and where the trajectories of problematization are displaced.[1]. They are the sites where technologies of democracy are used to conduct demonstrations and experiments, where they are replicated and contested. In these sites, both the empirical analysis performed by the researcher and the critique of the involved actors occur. The sites of problematization are simultaneously the places where actors define problems and possible solutions, and the places for the analyst to describe. They are the places where the interferences between the analyst and his or her fieldwork occur.

It is tempting to identify sites of problematization with "public arenas", understood as "places for debate, polemics, controversies, witnessing, expertise and deliberation where public problems gradually

[1] Cf. Barry's proposition to conduct the analysis: "in the middle of events, at times and places where the discrepancies between the public statements of international organizations, multinational corporations and NGOs and the complexity of social forms become most apparent, and when the direction of change is uncertain and contested" (Barry, 2006: 244).

emerge"[1]. The expression is interesting, as long as it allows the description to account for two important points. First, the examples considered throughout the dissertation prevent from considering sites as passive scenes, on which problematization of nanotechnology would be stabilized or destabilized. Sites cannot be considered as a stable background for problematizations to be made explicit. Material elements of the sites shape the actualization of problematization, facilitate stabilization or leave room for destabilization. Consider for instance the public meeting of the French national debate on nanotechnology. The separation that the organizers maintained between the invited speakers and the public in two different rooms, and the eventual closure of the debate, were part of the problematization of nanotechnology they propose. Hence, sites are not *a priori* distinct from the agencements that problematize, and their natures and rules can be contested. They are part and parcel of the processes of problematization. Second, the notion of site of problematization is only defined by the visibility of problematization processes, and not by known rules or social situations. In these sites, operations of problematization (experimentation and demonstration) are public, in that the analyst or the actors themselves can make the problematization processes visible[2].

Public zones of problematization

The next step is to pursue the public dimension of problematizations at the level of zones. The public dimension of the zones of problematization is then the outcome of the work of the actors involved, but also of that of the social scientist. Indeed, the reconnection across the sites of problematization renders visible the problematizations of nanotechnology and the investments they need to be maintained. Consequently, the geography of problematization of nanotechnology suggests to rethink the location of the "public space", in ways that do not separate the procedures and instruments meant to organize public discussion, and the content of public discussion itself, that is, the objects, the instruments that construct futures, the components of collective concerns, and the publics of nanotechnology. The "public spaces" that emerge from the analysis are less Habermassian "spaces for

[1] (Cefaï et Pasquier, 2003: 24). The notion of public arena is used by Hilgartner and Bosk (1988) in order to describe the trajectory of "social problems", in a perspective that owes much to the sociology of public problems (see chapter 1). Hilgartner and Bosk focus on "institutional arenas", which are "environments in which social problems compete for attention and growth". Arenas thus appear as places determined by social characteristics, which influence the evolutions of public problems. Re-mobilizing the concept, some authors downplay the determinist character, but still insist on the "pre-established rules" defining public arenas. For Joly and Marris, "each arena is characterized by its own logic of selection of problems, by resources, symbolic references and a specific grammar" (Joly et Marris, 2002, my translation; see also Cefaï, 1996). Rather than insisting on these perspectives, I am more inclined to read political science works using the concept of public arenas as an invitation to consider them as the physical extension of "problematic situations". One can read Gusfield as such (see Gusfield, 1981; Cefaï, 2009).

[2] In using "demonstration" as a concept that allows the analyst to bring together scientific demonstration and political engagement, Andrew Barry also insists on the homophony between "sites" and "sights" in order to point to the places where demonstrations are made publicly visible (Barry, 1999; 2001).

reasoned communicative exchange"[1] than what emerges from the reconstruction work. Thus, the four problematizations of nanotechnology I examined are spaces for the collective discussion of nanotechnology. They are not the only possible ones, but are always to be contested and challenged by others. The reconnections engaged by the analyst and the actors link, for instance, "safety by design" and the nano-responsible norm, or Vivagora's interventions in the Nanoforum and ICTA's legal actions, and thereby offer ways for the construction of new possibilities of engagement, and alternative problematizations of nanotechnology. Thus, the reconnections performed by the analyst and the actors display "counter publics" and eventually "counter public spaces". This offers a direction for a research engagement that would be interested in "giving voice" to counter publics. But as seen in the previous chapter with the example of Vivagora, "giving voice" for the actors of nanotechnology is not a straightforward process. That the distance with actors is always to be experimented with renders more complicated the type of critique that can be proposed. The next paragraph explores the form of critique that is then possible to propose.

A performative analysis of democracy

Democratic ideals

Speaking of "counter publics" and "counter public spaces" echoes critiques of Habermas's concept of the public sphere. For instance, Nancy Fraser proposed a critique of "actually existing democracy" based on the analysis of "minority public spheres"[2]. For her, the role of a "critical theory of actually existing democracy" is to display the ways in which "social inequality taints deliberation within publics" (1), "publics are differentially empowered or segmented" (2), "the labeling of some issues and interests as 'private' limits the range of problems" (3), and "the overly weak character of some public spheres (…) denudes 'public opinion' of practical force" (4). One can now read this critique in the terms of the analysis of problematization of nanotechnology. The analysis of the deliberation procedures conducted in chapter 3 displayed the constraints introduced by the organizers, and thus the differential treatment that participants received (cf. (1)). In some cases (such as the European nanotechnology policy), "public opinion" is mobilized within a program of development of nanotechnology. In others (as in the U.S.), it is a "deliberating public" expected to be educated. There are indeed "different publics", with a variety of roles (cf. (2)). I have shown how technologies of democracy define objects, futures, concerns and publics variously connected, and at the price of the exclusion of alternative constructions

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[1] Habermas, 2004: 2.
[2] Fraser, 1990

(cf. (3)). In all cases, the "practical force" of public opinion (cf. (4)) is the outcome of a controversial collective work.

One could then be tempted to follow Fraser's account by differentiating an ideal of democracy and its concrete realization. Scholarly engagement would then be about displaying this discrepancy, and possibly offering a path towards its reduction. This approach is common. It has sparked considerable reflections on the part of political theorists[1]. In the case of nanotechnology, some commentators have proposed to grade the "social robustness" of governance and participatory initiatives using Gibbons' "mode 2" of knowledge production. They consider that participatory initiatives in nanotechnology

> *only partially meet aspects of social robustness, and that the governance and deliberative turn in science and technology policy has not led, so far, to greater democracy and responsibility in nanoscience and nanotechnology development.* [2]

In this approach, a "democratic ideal" (known by the analyst) of "deliberation" and "responsibility" is confronted to the empirical analysis.

But separating democratic "ideals" from "actual practices" raises difficulties. A first one is that criteria such as "pluralism", "deliberation" or "robustness" are explicit parts of the problematization of nanotechnology. They are advocated by social scientists invited to give their opinions, and operationalized in the various technologies of democracy that I described in the previous chapters. They are inscribed in controversial and diverse technologies of democracy, and, consequently, enact different democratic constructions[3]. Thus, they cannot easily be considered as exterior principles according to which one could evaluate democratic arrangements or propose new ones. Rather, it would contribute to further solidify choices already made by the actors themselves. This, however, would not prevent a

[1] The literature in political theory discussing the questions of the "democratic ideal" and its concrete possibilities is immense, and I will not attempt to discuss it in detail. Robert Dahl's *Democracy and its critics* (Dahl, 1989) is a classical example. See (Sintomer, 1999) for a discussion of the democratic theory of Weber (impossible democracy) and Habermas (deliberation as the possibility to realize democracy). Scholars interested in deliberation stress that "opinions" are not given, but to be crafted, and eventually to overcome the tension between pluralism and collective action (Bohman, 2004; Dryzek and Niemeyer, 2006; Manin, 1987; Talisse, 2003, 2004). It is then particularly important to analyze the mechanism of opinion formation, reflect on the potential distortions of the "deliberative ideal" (Blondiaux, 2007), and explore the ways in which one can "improve the public sphere" and "improve the quality of civic engagement and public deliberation" (Fung, 2003: 340; cf. the examples discussed in chapter 3). In the field of science studies, Collins' and Evans' "third wave of science studies" can be read in these terms, as it is built on a separation between the "descriptive" work of expertise study, and the "normative" work of helping define who, whether "lay" or not, is to contribute to the public process of expertise construction (Collins and Evans, 2003; see for critical comments Jasanoff, 2003a; Rip, 2003; Wynne, 2003b). This latter approach would face obvious practical difficulties in the case of nanotechnology: who are the experts in nanotechnology? How to define what would be the appropriate "lay expertise" in the making of future products or ethical choices?

[2] See (Kurath, 2009). Kurath's paper has provoked some discussions about the validity of such criteria, and the empirical and normative strength of mode 2 in the first place (Rip, 2010).

[3] The same would hold true for Robert Dahl's components of the democratic ideal, particularly the "enlightened understanding", of which STS research shows the controversial charge (Dahl, 1989).

distinction between the "ideal" of democracy known by the analyst and the empirical examination. But it would force the researcher to define *ex ante* a "truer" version of "deliberation" or "responsibility" against which he or she could evaluate the observed empirical constructions.

The second difficulty is more fundamental. Separating the "ideal" from the "realization" would imply a discrepancy between "descriptive" and "normative" approaches[1], between the analysis of the world "as it is" and the reflection on the world "as it should be". As I hypothesized in chapter 1, explored in chapters 2 to 7, and discussed in the first section of this chapter, the dichotomy between the "descriptive" and the "normative" was precisely what I had to leave aside when engaging with the actors I was studying. Experimenting the forms of exteriority with nanotechnology was part and parcel of my research work. I was "describing", and I was also testing my commitment for the pluralist construction of nanotechnology. The experimental engagement that I discussed in the first section of this chapter allowed me to account not only for the situations in which I was directly engaged with the actors of the nanotechnology world, but also for those in which I was describing at the distance. In all cases, not separating *ex ante* a "democratic ideal" from its "empirical realization" was a condition for the analysis of the problematization of nanotechnology.

Eventually, this dichotomy would separate the reflection on democratic theory from the construction of the problematic entities themselves. It would isolate the "ideal" of democracy, which would be independent of the issues at stake. Yet I have not attempted to describe "perspectives" of a certain reality, and arguing for the defense of their pluralism or the possibility of their deliberative construction. Rather, I have been interested in the making of nanotechnology itself. As I have made it clear throughout the dissertation, problematizing nanotechnology means both constituting nanotechnology as an assemblage of objects, futures, concerns and publics, and organizing democratic life. If there is an "ideal" to isolate, then it has to be the outcome of the work of actors able to move it around and apply it to different issues (cf. the study of the replication of technologies of democracy in chapter 3). Similarly, the normative charge of the analysis of problematization is part and parcel of the research process itself.

A realist critique

The focus on the problematization of nanotechnology means that the "critique of actually existing democracy" that I propose is not interested in confronting an "ideal" with its empirical realization.

[1] Commentators of deliberation procedures call for "bridges" between the two perspectives, in order to analyze, for instance, the "effects of the 'deliberative norm' for collective decision-making or participants' behaviors" (Blondiaux, 2005). This, however, still separates the "normative" from the "descriptive".

Rather, it is a realist form of critique[1] that considers the making of democracy as a performative action, through the problematization of nanotechnology[2]. I did not confront a theory of democracy opposed to its empirical translation, but explored the practical manifestations of democracy with nanotechnology. In chapter 1, I considered that "democracy" consisted in the organization of oppositions and definitions of collective problems. This resulted from the observation of the intermingled political dimension of nanotechnology. This hypothesis has grounded my focus on problematization and helped me define technologies of democracy. It has allowed me to describe the modalities of the assemblage of nanotechnology through experiments and demonstrations involving technologies of democracy, and led me to characterize my research engagement as "experimental". The initial hypothesis can now be refined: after the previous discussions, it appears that democracy is at stake in the sites where problematizations of nanotechnology are crafted and stabilized. This approach reintroduces conflicts in the very making of both nanotechnology and democracy – conflicts over the modes of problematization, which the actors are conducting, and in which I participate. This pursues the path opened by the American pragmatists and examined in the first section of this chapter. The interest of STS for the reading of this body of literature is clear, since it provides the methodological tool for the analysis of the actual making of realities, instead of focusing on "perspectives" of an unquestioned reality, at the same time as it allows the analyst to account for the construction of and controversies about technologies of democracy. This means that the pragmatist pluralism is less an undifferentiated call for "multiplicity"[3] than an invitation to examine the practical making of a democratic order and the successive trials it needs to pass in order to stabilize. As such, the approach I propose participates in the construction of public spaces, is attached to the actors, and interferes with the stabilization of nanotechnology.

The type of interference can now be clarified. The problematizations of nanotechnology are permanently caught in a tension between stabilization and destabilization, between their re-enactment and their displacements. They are more or less stabilized, more or less open to alternative formations. The interferences of the analyst are then related to the degree of stabilization of problematizations. They

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[1] The expression is used by Latour, as he insists on the need for a form of critique that insists on "care" and "protection" rather than identifying hidden causalities in order to deconstruct reality (Latour, 2004b: 232).

[2] This follows a perspective opened by the ANT school of STS. Latour's *Politics of Nature* (2004a), as Callon', Lascoumes' and Barthe's *Acting in an uncertain world* (2009), proposes to do the "description of the world" in the same stream of scholarly activity as the "prescription about it". The propositions for the organization of democracy originate from the experiments conducted by the actors themselves, to which the analyst contributes throughout his scholarly work. This is not surprising from authors who spoke decades earlier about the performativity of the sociologist's activities (Callon and Latour, 1981). I am not attempting here, however, to isolate "due process", or evaluation criteria (as both *Politics of Nature* and *Acting in an uncertain world* do) in order to propose more democratic methods for the construction of the common world. This would face the very difficulties I discussed above. Nanotechnology requires a different approach to democratization.

[3] Political theorists commenting on James' "deep pluralism" have tended to make it an anti-statism (Ferguson, 2007), while others have argued that pluralism, by imposing an overarching "principle", was anti-pragmatic (Talisse, 2003). The STS reading of pragmatism allows me not to be caught in the dichotomy between the "normative" and the "descriptive", and thus not to propose an undifferentiated principle of pluralism.

display the investments needed to enact those that are well stabilized, they bring back in them alternative problematizations and thereby enlarge the cracks that occur through their re-enactment. But the interferences of the analyst also contribute to stabilizing problematizations that do not rely on robust infrastructures by accounting for them and participating in the explorations on which they are based.

These forms of intervention are performed throughout the course of the research trajectory. They are not given from the start, but evolve according to the particularities of the empirical fieldwork. They can only be performed by the sociologist, as he or she is the only one able to connect a variety of sites, to intervene in the cracks of stabilized problematizations and stabilize others by accounting for the experiments on which they are based. This means that the sociologist may shift his or her relationships with the actors he or she studies / works with, according to the necessities of empirical work and through the trials in which he or she is engaged. Hence, when a problematization gets too stabilized, there is an analytical and political impetus to display the investments it requires and the alternatives it eliminates. By highlighting the trials in which the analyst is caught as he or she interferes with problematization processes, experimental engagement prevents from considering in different terms the destabilization and stabilization effects of the analyst's interferences. Rather, experimental engagement grounds a realist critique of democracy, attached to the actual making of technical and political realities[1].

This research engagement cannot propose overarching criteria or meta procedural rules supposed to guide the production of the common world. It is nonetheless possible to speak of the "democratization" of nanotechnology, as long as it is not considered different from the conduct of analytical work, but as an outcome of a research engagement that displays the processes of stabilization and the investments they require, and adds reality to the alternative constructions of nanotechnology[2]. "Democratization" then points to the activities that publicize the problematizations of nanotechnology, and helps realize alternative constructions of objects, futures, concerns and publics. It designates the processes that ensure a variety in the problematizations of nanotechnology so that those relying on powerful infrastructure are critiqued, and the others can gain strength. This is not a simple call for "pluralism" since it is grounded on the situations of trials technologies of democracy need to face (and which produce asymmetries among them). Nor is it a mere invitation for "innovations in politics" that

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[1] Consequently, it has no reason to be caught in a dichotomy between the description of the practices of the actors themselves and the exterior critique of democracy. See for an example in political theory (Labelle, 2003), which is a comment of this constant oscillation in Lefort's political philosophy.

[2] This follows up on and complexifies Andy Stirling's opposition between processes that "open up" and "close down" (Stirling, 2008). It does not attempt to evaluate participatory instruments according to their possibility for "opening up" or "closing down", but insists on the variety of modes of closure, the investments they require, and the possibility for displacements. It points to the need to leave room for uncertain objects and social groups (Jasanoff, 2003b), and to introduce diversity in stabilization processes (Rip, 2000b).

would produce "surprises" in otherwise well-known existing political constructions[1]: rather, it intervenes in destabilization *and* stabilization processes, and thus perform original arrangements as well as it illuminates the infrastructures on which "unsurprising" existing institutions rely. Eventually, it is not a "constitutionalist" proposition that would "lose contingency"[2], because it is tied to the making of nanotechnology itself. Indeed, by exploring the machinery of technologies of democracy and the assemblages of objects, futures, concerns and publics they construct, one is led to highlight the investments necessary for problematizations to take shape and the trials that democratic orders need to pass. In this perspective, the normative position on democracy is not separated from the epistemological position of the analyst. Indeed, interfering in stabilization and destabilization processes is a condition for the sociological work to be performed, and thus to account for nanotechnology. And this is how the sociologist participates in the democratization of nanotechnology.

[1] This is Emilie Gomart and Maarten Hajer's reading of the STS approach to the study of politics (Gomart and Hajer, 2003).
[2] Cf. John Law's critical perspective on "constitutionalism" (Law, 2010).

Conclusion

This chapter has examined research engagement with the problematization of nanotechnology. Starting from the variety of relationships I had with the actors I studied/worked with, it argued that the description of nanotechnology required an experimental engagement in which exteriority is negotiated and takes various forms. I have then chosen not to pursue the micro descriptions of the multiplicity of distances and modes of problematizations, but to reconstruct problematizations of nanotechnology. I have identified four problematizations of nanotechnology, two of them (American and international) based on the maintenance of boundaries, and two others exploratory (whether in the sense of the construction of the European democratic order, or in that of the real scale and uncertain French experiments). These problematizations do not provide rigid frames that would determine the public treatment of nanotechnology. Rather, they are spatial formations to be stabilized. The description of the processes of stabilization has allowed me to locate research engagement: it is inserted in the very processes of re-enactment of the modes of problematization. Eventually, this means that the research engagement also leads to "democratization" in so far as it participates in the construction of public spaces, and adds reality for potential alternatives. By contrast, restating the general question about "how best to engage the public" would take for granted a particular organization of democracy, and stabilizes a problematization of nanotechnology without making the processes of stabilization visible. Instead, the engagement in the problematization of nanotechnology displays the mechanisms that produce democratic orders and leaves room for their potential recombinations. This exploration implies that questions of research ethics and political engagement are two sides of the same coin. In both cases, what is at stake is the description that is provided as an analytical outcome. In both cases, what matters the most are also questions of democratization.

CONCLUSION

Conclusion

Democratic problems

Nanotechnology raises problems for democracy, as much as it makes it necessary to consider democracy itself as a problem. The previous chapters have described processes that define the problems of nanotechnology and the range of acceptable solutions, and, by the same token, stabilize assemblages of objects, futures, concerns and publics. Considering democracy as the form of organization that makes problems explicit, and manages the proliferation of the ways of dealing with them, the analysis of the problematizations of nanotechnology that I have proposed has allowed me to jointly explore the making of nanotechnology's problems and that of democratic order. Through empirical examples in France, the United States and the European Union, I have described various heterogeneous devices meant to problematize nanotechnology. I called these devices "technologies of democracy" and explored the operations in which they are involved, particularly various forms of experimentation and public demonstration. Chapter 1 demonstrated that this empirical and theoretical approach is a way of accounting for the making of nanotechnology as a global entity made of objects, futures, concerns and publics.

Part 1 described processes of stabilization of technologies of democracy meant to represent nanotechnology. Chapter 2 focused on science museums, and showed that experiments with nanotechnology in French, European and American museums proposed three different democratic arrangements. French museums enact a model of integration of the visitor in the construction of representations of nanotechnology and its accompanying debate. European museums have been gradually involved in a shift of the communication policy from "public understanding of science" to the "scientific understanding of the public". American museums integrate the concern for deliberation through the production of a dedicated expertise, which could then be applied to other domains than nanotechnology. Chapter 3 described some processes of construction and use of expertise about technologies of democracy. It analyzed operations of replication of consensus conference devices, and the trials they had to face when being applied to nanotechnology. The chapter then described the construction of "policy expertise" at OECD Working Party on Nanotechnology, especially about technologies of democracy meant to ensure "public engagement in nanotechnology". The stabilization of the separation between technologies of democracy and nanotechnology was at stake in all the cases considered in this chapter, where nanotechnology was problematized in ways that disconnected the making of publics from that of objects and programs.

Part 2 of the dissertation analyzed technologies of democracy meant to draw boundaries across objects and programs in order to produce nanotechnology as an entity able to be managed by public and private actors. Contrary to the technologies of democracy examined in part 1, those analyzed in part 2 were crafted for the explicit objectives of constructing objects and programs. Chapter 4 described the ontological uncertainty about nano substances and displayed the connections between the production of substances and the making of programs of development. While the problem of the existence of nano substances can be avoided in some cases at the price of material and discursive containment, it is dealt with by legal oppositions over the existence or non existence of nano substances in the U.S., and by the recourse to a 1-100nm size criterion in international arenas. This size criterion appears as the only way for participants in international discussions to ensure a consensus. Chapter 5 followed up on these descriptions by focusing on the construction of nano products in standardization and regulatory arenas. It contrasted three definitions of nano products at the International Standardization Organization (ISO), within the European institutions, and within a French "nano-responsible" project led at the French Association for Standardization. The international "science-based" nanomaterials, the European nanomaterials "for regulatory purposes" and the French "responsible" nanomaterials are produced, respectively, through processes of international consensus making, stakeholders' negotiations, and collective internalization of industrial externalities. Chapter 6 described the production of "responsible futures" for nanotechnology, and the forms of ethics expertise on which it is based. It contrasted the mobilization of ethics as objective expertise in the U.S., and the integration of ethics in the making of responsible nanotechnology programs within the European institutions. The construction of responsible futures for nanotechnology compelled some actors to displace the problematization of nanotechnology. I described American attempts for a "real-time technology assessment", and the ways it could be integrated into the American science policy landscape.

Part 3 examined social and scholarly engagement with nanotechnology, and thereby discussed the question of exteriority to technologies of democracy, on the part of the actors who attempt to critique them. "Critique" was, in this part, an operation undertaken by actors and by the social scientist. Chapter 7 showed that anti-nanotechnology activists based their critique of nanotechnology on the construction of a distance from which they attempted to reveal questionable connections among scientists, industrialists, policy-makers and members of civil society organizations. By contrast, the example of a French civil society organization called Vivagora allowed me to describe another form of engagement with nanotechnology. In this latter case, the distance to nanotechnology is not an *a priori* but the outcome of an experimental process, through which Vivagora hopes to intervene in the construction of nanotechnology objects, futures, concerns and publics. Chapter 8 followed up on this last case by reflecting on my own engagement in the study of the problematization of nanotechnology. The many forms of distance to the actors I studied were conditions to account for the problematization of nanotechnology. The experimental engagement they suggest gave me the possibility to reconstruct four problematizations of nanotechnology out of the empirical situations encountered throughout the dissertation. Eventually, the discussion of the modalities of interferences within both these problematizations and the alternatives to them led me to characterize the outcome of this dissertation as a realist form of critique, which is inserted in the operations that stabilize and destabilize problematizations. “Democratization”, in this tentative approach, designates the construction of new possibilities for making oppositions explicit. This implies both operations of reconstruction of public spaces, and of insertion in the cracks opened during the stabilization of problematizations. Speaking of “democratization” in these terms holds a normative charge. But as I argued in chapter 8, the normative dimension is not separated from the research process aiming to account for the problematizations of nanotechnology. As such, the proposition about “democratization” is an answer to the initial question of the dissertation, about the making of democracy with nanotechnology.

Empirical analysis of democracy

Nanotechnology has offered illustrations of the connections between questions of science studies and questions of political science. The dissertation is situated in the continuity of science studies in so far as it explores the construction of material objects, of science policy programs, of concerns and publics through the analysis of experiments and demonstrations involving expert-based instruments. It pursues the interest of science studies for the construction of laboratory objects or scientific knowledge in proposing an analysis of macro, un-stabilized, and uncertain entities. The descriptions of the making of material entities can then be extended to the analysis of the infrastructures that stabilize macro problems. Thereby, the dissertation has examined important questions of political science. The three parts of the dissertation examined trials for the making of political operations with nanotechnology. They discussed traditional problems of political science through the lenses of technologies of democracy. Part 1 analyzed the problem of the representation of public problems and their publics through that of the replication of and expertise about technologies of democracy. Part 2 considered the problem of the collective management of public problems through the study of the ontological work performed by technologies of democracy. Part 3 described phenomena of social mobilization about nanotechnology through the analysis of the construction of exteriority toward technologies of democracy. The main outcomes of the dissertation are not only detailed descriptions of problematizations of nanotechnology drawing distinctions out of an undifferentiated call for the “responsible development of nanotechnology”, but also empirically-based reflections on contemporary displacements and controversies related to the conduct of democratic life. Throughout the dissertation, three pressing democratic issues have regularly been at stake: political legitimacy, national sovereignty, and citizenship.

Legitimacy

The institutions of democracy are expected to ground the legitimacy of public decisions. In cases like nanotechnology where these infrastructures are on trial (and accepted as such by the actors themselves), and where the objects, futures, concerns and publics are uncertain, legitimacy is not a ready-made category but a costly outcome to reach, possibly through innovative channels. The case of nanotechnology engages distributed decisions, which relate to the funding and organization of scientific research, and the definition and treatment of public problems. These decisions are crafted by nation-states, but also in arenas like standardization institutions and European bodies that propose other forms of representation of public and private interests. In all cases, the objects themselves, whether present or future, are part of what is to be represented and decided about. Thus, nanotechnology is a case where the concern of political science for legitimate political decisions and the interest of science studies for the representation of socio-technical hybrids cannot be differentiated.

The technologies of democracy we encountered in the previous chapters are channels through which legitimacy is constituted. That they are often subject to controversies, and need, in all cases, investments to be stabilized shows that legitimacy requires work to be enacted – which may leave room for reconfigurations. The various cases we encountered offer contrasted situations for that matter. Whereas the American nanotechnology program re-stabilizes a form of legitimacy based on the delegation to experts, French public actors enter an uncertain territory, in which the bases of legitimate public decisions are not given. In both cases, a "deliberative imperative"[1] is used in different fashions. Integrated in expert knowledge in the U.S., it is translated in the organization of multiple devices with uncertain outcomes in France. Europe is yet another case, in which the legitimacy of decisions is based on the operationalization of the principle of subsidiarity and the mobilization of technologies of democracy able to represent the "European public". In this latter case, the formation of a political entity grounded on specific channels of legitimacy is at stake.

Sovereignty

As problematizing nanotechnology means defining the objectives for national development in the global race for funding, scientific publications and economic growth, and the instruments through which the administration may act, each problematization of nanotechnology that I described defines the scope of the role of the State, what it should and should not do. Thus, the question of sovereignty is rendered visible by controversies and discussions about the problematization of nanotechnology.

[1] Blondiaux and Sintomer, 2002

Problematizing nanotechnology means putting in place internal administrative infrastructures, for instance reporting mechanisms of industrial activities, or mechanisms for the regulation of scientific work in laboratories (e.g. through codes of conduct or the ethical review of projects). These infrastructures are a necessary condition for nation-states to act, and for supra-national political entities (like the European Union) to subsist[1]. The other aspect of sovereignty is the definition of and the confrontation between national positions. In the examples analyzed in this dissertation, national positions are to be defined regarding the development of nanotechnology substances, products and programs, the definition of public concerns and the methods for the engagement of publics. International arenas are sites where these positions are discussed, and where the boundaries of supra national entities like the European Union have to resist. Describing negotiations in these arenas has offered a path toward an analysis of international relations that does not separate the construction of national positions from that of the components of nanotechnology. At stake at ISO and OECD, for instance, is the definition of an international expertise separated from sovereign national decisions, but which implies that national delegations define positions that can be antagonistic to each other. Accordingly, delegations articulate national initiatives meant to problematize nanotechnology and the definition of positions to argue for in international arenas.

Within the analysis of the problematization of nanotechnology, the State does not appear as a stable actor determining from an exterior position the evolution of public problems. Neither does it become a permanently fluid entity with neither consistence nor specific forms of action, which would not be worth a sociological analysis. National states and supra-national organizations are indeed important social actors with empirically traceable effects. But they are also formations in need for stabilization[2]. Experimenting and demonstrating with technologies of democracy are ways of doing so, as they enact the State's modes of action. The analyses proposed in the dissertation have refused the stability of pre-given technologies of democracy that would define once and for all the scope and forms of the activities of the State. Rather, nanotechnology has shown that the modalities of the action of the State can be controversial. This dynamics differs from one state to another (and the American and French situations are contrasted for that matter). It is also likely to differ from one technological domain to the next[3]. This redefinition of the analysis of the State can merely be alluded to here. But it would be worth pursuing these explorations at further length, in order to question the composition of technologies of democracy performed by (and thereby enacting) the State. This would require more

[1] The examples considered in this dissertation have dealt either with nation-states or with supranational entities. Therefore, I am not discussing the concept of the "Nation" as a notion different from that of the "State".

[2] This approach echoes the problem of the "limits of the State" (Mitchell, 1991). It considers the State as an entity in the making, submitted to trials, and neither an overarching Leviathan nor an uncertain object not worth sociological analysis (cf. Linhardt, 2008).

[3] In France, the case of nuclear waste displays other technologies of democracy tied to the technological characteristics of nuclear waste themselves (Barthe, 2006; 2009).

systematic transversal examinations of different scientific domains, and the analysis of the circulation of administrative actors and technologies of democracy from one domain to the next.

Citizenship

Nanotechnology's publics are an inherent part of the construction of the field: the operations that constitute substances, products and responsible futures explicitly define modes of intervention for publics, and publics are specifically targeted in devices meant to represent nanotechnology for them. The discussions of scientific developments and research programs in public arenas have shaped what Alan Irwin calls a "scientific citizenship"[1]. Calls to "engage publics" in science propose modalities of citizenship as they define roles and identities, acceptable forms of interventions and (often limited) possibilities of re-orientation of technical progress. In that sense, the problematizations of nanotechnology are also explorations of scientific citizenship. They connect the fabrication of publics with that of legitimacy and sovereignty, in ways that reproduce previous arrangements or displace them. In the U.S., the deliberating citizen, the empowered citizen, and the informed citizen, whom we encountered in science communication arenas (chapter 2), participatory devices (chapter 3), and legal actions (chapter 4), are not unfamiliar figures of the American polity[2]. In the French situation of uncertainty about the objectives of initiatives such as the Grenelle de l'Environnement and the CNDP debate on nanotechnologies, the experimental situation redefines the modalities of citizenship. In Grenoble, the opposition between the local administration and the anti-nanotechnology activists can be read as an opposition to the rationality expected to ground both legitimate public decisions[3] and the exercise of citizenship[4]. The European case is that of the attempted construction of a common sense of belonging to a polity. That the definition and operationalization of European "values" are so important in the process of the definition of European futures is revelatory of a situation in which an "imagined community" is tentatively crafted (not without difficulties, as seen in chapter 6)[5]. In all these situations, technologies of democracy enact citizens with specific roles and supposed to intervene in specific problems. The descriptions of technologies of democracy have led me to explore the possibility to detach the construction of citizenship from that of public problems. This is what liberal democracy has

[1] See (Irwin, 2001).
[2] Cf. for instance (Manin, 1997; Schudson, 1998).
[3] Ted Porter's analysis of quantitative technico-economic analysis as instruments for the construction of the legitimacy of public decisions is an historical account of the importance of rationality in the making of the French public decisions (Porter, 1991).
[4] Cf. the model of the dual delegation described in (Callon et al., 2009).
[5] At the international level, the construction of publics follows the line of the plurality of national polity (chapter 3). But the connections between activists in Europe and the United States (PMO and the ETC group; ICTA and Vivagora) might be a sign of the constitution of a global mobilization (see Jasanoff, 2006 on the example of biotechnology).

managed to do with the voting system, and which is questioned on complex issues where the problems to solve "stick" to the devices that produce citizenship.

These explorations build on STS by adding empirical strength to political theory, and, perhaps more importantly, revealing the processes through which diverse forms of inclusion in public life are constructed[1]. This suggests further examining the processes that solidify citizenship. At this point again the role of the State as the organizer of the diversity of technology of democracy would probably appear. How are forms of consistent national citizenships grounded? Nanotechnology has illustrated the importance of the basis for the construction of consistent national citizenship, and of the construction of acceptable channels expected to circulate the voice of the citizen. This reaches yet another level in the case of supranational entities, where the mediations from "the citizen" to decision-making processes function at different levels of political representativeness (e.g. through national delegations, or interest groups). These remarks suggest a program for future research, which would pursue the historical studies of the making of national citizenships by analyzing the trials they face, the innovative constructions that are attempted as scientific development produces new public issues, and the construction of non-statist forms of citizenship that might be the basis for transnational social movement, or exclude large numbers of people for the sake of the representations of some interest groups.

Perspectives

The approach proposed in this dissertation is not based on political theory, as it uses empirical examples in order to account for the making of democratic orders. Yet it does address the very same questions political theory has been interested in, such as that of the basis for the legitimacy of public decisions, that of the components of the sovereignty of the State, and that of the channels for the representation of citizens. These three categories of legitimacy, sovereignty and citizenship are inherently linked to each other, brought together in the problematizations of nanotechnology I described, and performed through the technologies of democracy I analyzed. In such processes, the nation-state appears as an important actor for the management of the diversity of technologies of democracy, while supra-national organizations propose other democratic constructions characterized by the coproduction of common values and modes of political actions (in the case of Europe) or by the separation between "international expertise" and "national policy choices" (in the case of international standardization institutions).

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[1] Cf. (Jasanoff, 2004b) for a discussion of the value of STS for the study of citizenship, especially regarding political theory.

This suggests future works to pursue the exploration of the stabilization of democratic order. First, although the sites encountered in the previous chapters have offered a detailed landscape of the problematizations of nanotechnology, one could envision pursuing the analysis in yet other places. One of them could be the organization of educational programs meant to train students and researchers in nanotechnology. These programs are explicit parts of nanotechnology initiatives. They contribute to stabilizing a discipline, connecting the production of material objects and the future perspectives of development. They are expected to integrate the concerns about nanotechnology, and produce "publics" of scientists engaged in nanotechnology, and of lay people to whom the trainees are expected to talk. Another site that could be considered for future exploration is that of the construction of users of nanotechnology products. Chapter 2 proposes some examples in the French science museums. In particular, the "participatory design" approach for the construction of prototypes could be further explored[1]. Another dimension in the production of users could be that of clinical trials for the applications of nanotechnology in medicine, as it is undertaken, for instance, at *Clinatec*, a Grenoble-based CEA laboratory developing medical applications in a non-medical context.

Second, nanotechnology is probably not the only example of large-scale and diverse political entity, bringing together objects, futures, concerns and publics. Other science policy programs could probably be described as such (although nanotechnology is probably quite unique as regards the diversity of topics and the importance of its concerns and publics). As for the emerging domains of activity, synthetic biology is probably the example closest to nanotechnology. Energy policies based on alternatives to carbon-based energy sources are another example, for which the construction of material objects, the definition of future perspectives, the identification of global concerns and the shaping of "publics" expected to transform their ways of living are likely to come closely together.

But the empirical approach for the study of democracy that I have undertaken here has no reason to be limited to emerging technological domains. A third path for the continuation of this research would be to consider how non-scientific entities are problematized, and open paths for democratization. For instance, educational or pension policies are based on powerful statistical tools; they operationalize prospective visions for future economic and social developments; they define collective concerns and shape individual and collective roles for publics. They engage national policy-making, and mobilize an international space of expertise and democratic actions (particularly within the European Union). They are grounded on diverse expertise and collective discussion mechanisms. They might be interesting domains to undertake a realist critique, attentive to the stabilization processes and the possibilities for alternatives, that would be both epistemological (on the construction of statistical data and economic models for instance) and political (on the organization of collective decision-making).

[1] I discussed this approach alongside other examples of technologies of democracy in (Laurent, 2011).

In this dissertation, my approach has been to develop methodological and theoretical instruments in order to account for the problematization of nanotechnology. Is it then possible to use these methods and concepts – and first of all, the notion of technologies of democracy - in other domains? This question directly echoes what many of the actors we encountered attempted: specialists of participatory procedures tried to stabilize their instruments and replicate them; officials in international organizations and standardization institutions tried to maintain the boundaries (between "technical" and "political" expertise; between "international expertise" and "national sovereignty") on which their organizations were based; activists attempted to develop a radical critique of nanotechnology as they had done for nuclear energy or other technological domains. This does not invalidate the possibility to isolate, for instance, the notion of "technologies of democracy" from the case of nanotechnology in order to use it to describe other fieldworks. But it forces us to understand such a move as a risky operation, during which the analytical instruments might have to be redefined. In any case, what would matter for the future explorations following the direction I attempted to open in this dissertation would be the construction of democratic orders, and the perspectives for democratization. The analysis of the problematizations of nanotechnology now appears as an invitation to make democracy the object of an empirical and realist critical theory.

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Democracies on trial. Assembling nanotechnology and its problems

ABSTRACT: The dissertation analyzes nanotechnology as a macro political entity comprising objects, futures, concerns and publics, and examines sites where it is *problematized.* Focusing on operations defining public problems and ways of dealing with them, the analysis of the problematizations of nanotechnology is a path for the description of both the assemblage of nanotechnology and the enactement of democratic order. The study of the problematization of nanotechnology is conducted through the analysis of experiments and demonstrations involving *technologies of democracy*, using fieldwork in France, the United States, and international organizations. The dissertation considers successively some operations of replication and stabilization of technologies of democracy separated from nanotechnology, processes using technologies of democracy to define the "nano" existence of objects and the "responsibility" of nanotechnology futures, and examples of social and scholarly engagement in the critique of technologies of democracy. Thereby, processes of representation of, public management of and social mobilization about nanotechnology are examined. Different problematizations of nanotechnology can then be reconstructed. The dissertation discusses four of them, and uses the empirical work in order to propose a realist critique of nanotechnology.

Keywords: Nanotechnology, democracy, technologies of democracy, problematization

Démocraties à l'épreuve. Assembler les nanotechnologies et leurs problèmes

RESUME : La thèse analyse les nanotechnologies comme une entité politique comprenant des objets, des futurs, des problèmes et des publics, let examine des sites où cette entité est *problématisée*. En se penchant sur les opérations définissant les problèmes publics et les façons de les traiter, l'analyse des problématisations des nanotechnologies permet de décrire à la fois l'assemblage des nanotechnologies et la construction de l'ordre démocratique. L'étude des problématisations des nanotechnologies est menée via l'analyse d'expériences et de démonstrations impliquant des *technologies de démocratie*, sur la base d'enquêtes de terrain menées en France, aux Etats-Unis et dans des organisations internationales. La thèse considère successivement des opérations de réplication et de stabilisation de technologies de démocratie séparées des nanotechnologies, des processus utilisant des technologies de démocratie pour la définition de l'existence « nano » de substances et de produits et de la « responsabilité » des programmes de développement, et des exemples d'engagement de mouvements sociaux et du chercheur lui-même dans la critique des technologies de démocratie. Ceci permet d'étudier des exemples de représentation des nanotechnologies, d'administration publique à leur propos, et de mobilisation sociale à leur égard. Différentes problématisations peuvent alors être reconstruites. La thèse s'intéresse à quatre d'entre elles, et s'appuie sur le travail empirique pour proposer une critique réaliste des nanotechnologies.

Mots clefs : Nanotechnologies, démocratie, technologies de démocratie, problématisation

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