universität wien

MASTERARBEIT

Titel der Masterarbeit

MAKING FUTURES PUBLIC

On the Modalities and Intricacies of Qualitative Social Science Nano Research

Verfasser

Gernot Rieder, Bakk. phil.

angestrebter akademischer Grad

Master of Arts (MA)

Wien, 2013

Studienkennzahl lt. Studienblatt:	A 066 906
Studienrichtung lt. Studienblatt:	Master Science-Technology-Society
Betreuerin:	Univ. Prof. Dr. Ulrike Felt

ABSTRACT

Nanoscience and -technology has been referred to as one of the most important technoscientifc breakthrough areas of the 21st century, residing in a post-normal state of uncertainty that is subject to both utopian dreams and dystopian nightmares. Considered a field of great economic potential, policymakers have been keen to ensure its social acceptability early on, calling for responsible and sustainable R&D based on democratic principles and public participation. However, such discursive shifts towards a more inclusive governance of technoscientific innovation have been undermined by deeply entrenched but conceptually questionable policy framings such as the deficit model or the risk paradigm. As a result, public 'engagement' initiatives have all too often taken the form of unidirectional, expert-led information dissemination exercises, more prone to 'downstream'-dominated rather than 'upstream'-oriented modes of future deliberation.

Against this background, this thesis investigates the resources and knowledges, the conditions, competences, and skills needed to carry out qualitative social science research in the field of new and emerging (nano)technologies, asking, "What does it take to conduct upstream public engagement research that challenges established modes of governing, that seeks to introduce alternative concepts and perspectives, and that promotes bottom-up forms of public participation, (re)conceptualizing lay citizens as 'carriers' of expertise who ought to have a say in a more deliberative governance of technoscientific innovation?"

Tackling this question on empirical grounds, the thesis conducts in-depth examinations of three Nano-related upstream engagement-oriented research projects – i.e. the Arizona-based NanoFutures project, the Durham-coordinated DEEPEN project, and the Bergen-led TECHNOLIFE project – providing thick descriptions of selected key areas of interest.

In terms of data analysis, the study follows an inductive *grounded theory approach* as well as recent calls for *comparative analysis*, but also draws on more specific theoretical frameworks such as work on the *geographies of science*, the notion of *technopolitical cultures*, research on *epistemic cultures/communities*, or the concept of *technologies of imagination*.

The thesis concludes that in order to successfully conduct upstream public engagement research, a broad repertoire of discursive, cultural, epistemological and methodological resources is required, which (a) marks the emergence of a new type of researcher who is increasingly compelled to look beyond the confines of the academic ivory tower, and (b) lends substance to the argument that a paradigmatic shift from government to governance has not yet occurred, but is still subject to ongoing negotiations.

ZUSAMMENFASSUNG

Das Gebiet der Nanotechnologie und Nanowissenschaft gilt als eines der vielversprechendsten Forschungsfelder des 21. Jahrhunderts. Ob seiner schwer einzuschätzenden Entwicklung fungiert der Bereich sowohl als Träger großer Hoffnungen als auch als Hintergrund anhaltender Ängste und Bedenken. In Anbetracht des großen ökonomischen Potentials haben sich politische EntscheidungsträgerInnen bereits früh darum bemüht gezeigt, die soziale Akzeptanz des Feldes durch eine verantwortungsvolle und nachhaltige Forschungs- und Innovationspolitik sicherzustellen. Die Einhaltung demokratischer Grundsätze und der Einsatz von BürgerInnenbeteiligungsverfahren gelten erklärtermaßen als elementare Bestandteile einer solchen „Governance"-Programmatik. Ein genauerer Blick offenbart jedoch, dass diese auf integrative technowissenschaftliche Entscheidungsfindungsverfahren abzielende Rhetorik durch fest etablierte Vorannahmen wie etwa das „Defizit-Modell" oder das „Risiko-Paradigma" unterminiert wird, was zur Folge hat, dass öffentliche Partizipationsinitiativen oftmals zu unidirektionalen, expertenzentrierten Wissensvermittlungsübungen degradiert werden, wodurch die Wissens-, Interpretations- und Erfahrungshorizonte der teilnehmenden „Laien-BürgerInnen" ins Hintertreffen geraten.

Vor diesem Hintergrund geht die vorliegende Arbeit der Frage nach, unter welchen Umständen und strukturellen Bedingungen es möglich ist, qualitative, bürgerzentrierte Sozialforschung im Bereich neuer und aufstrebender (Nano)Technologien durchzuführen. Welche Ressourcen, Kenntnisse und Kapazitäten sind erforderlich, um Forschung zu betreiben, die die Systematik alteingesessener Regierungsmethoden in Frage stellt, und die alternative Konzepte der technopolitischen Entscheidungsfindung zu implementieren sucht, bei denen BürgerInnen nicht mehr als passive, mit Information zu füllende Gefäße, sondern als TrägerInnen von potentiell wertvoller Expertise verstanden werden?

Die Arbeit gründet auf einer eingehenden empirischen Untersuchung dreier Forschungsprojekte, die sich mit BürgerInnenvisionen bezüglich potentieller Nano-basierter Zukunftsszenarien auseinandergesetzt haben. Bei diesen Projekten handelt es sich um das in Arizona situierte NanoFutures-Projekt, das von Durham aus koordinierte DEEPEN-Projekt, und das in Bergen angesiedelte TECHNOLIFE-Projekt.

Die Auswertung des Datenmaterials orientiert sich an einem induktiven Grounded Theory-Ansatz und aktuellen Aufrufen zu vergleichender Forschung. Ferner knüpft die empirische Analyse an Konzepte wie *Geographies of Science*, *Technopolitical Cultures*, *Epistemic Cultures/Communities* und *Technologies of Imagination* an.

Die Studie kommt zu dem Schluss, dass für eine erfolgreiche Durchführung von bürgerzentrierter Wissenschafts- und Technikforschung eine Vielzahl von diskursiven,

kulturellen, epistemischen und methodologischen Ressourcen notwendig sind. Ein Befund, der einerseits das Aufkommen eines WissenschaftlerInnentypus aufzeigt, welcher sich nicht mehr in den akademischen Elfenbeinturm zurückzuziehen vermag, und der andererseits das Argument untermauert, dass der Übergang zu verstärkt partizipativen Regierungs- und Entscheidungsfindungsverfahren noch keineswegs als abgeschlossen erachtet werden kann, sondern ständigen Aus- und Neuverhandlungsprozessen unterliegt.

Table of Contents

0. Acknowledgments

Writing this thesis has been a highly rewarding and enjoyable experience, but also a quite demanding and challenging one. There are a number of people whom I would like to thank for their help and encouragement along the way.

First and foremost, I would like to thank my thesis advisor, Professor Ulrike Felt, for her continuous support, dedicated mentorship, and intellectual guidance, as well as for the opportunity to write this thesis in the context of the research project "Making Futures Present: On the Co-Production of Nano and Society in the Austrian Context". My sincerest gratitude goes to the Austrian Science Fund (FWF) for supporting this research through a scholarship, and to the Department of Science and Technology Studies, University of Vienna, for helping with travel and conference expenses as well as for providing a highly stimulating intellectual environment that serves as a magnet for many wonderful researchers and people.

My special thanks go to my project colleagues Simone Schumann and Claudia Schwarz, also known as the microscopic multiple Nini&Nano, with whom I had the great pleasure of sharing an office, attending conferences, and enjoying a number of culinary excursions. Thank you both for your motivation, inspiration, and conviviality. I am also indebted to Michael Strassnig, who provided valuable input at the early stages of the project, to Stefanie Schürz and Thomas Völker, who read and commented on versions of this thesis, as well as to Thomas Eder and Martin Schwarz, who made use of their well-honed language skills and kindly acted as proofreaders. Thank you all for your time and effort.

Finally, I would like to extend my thanks to the researchers and scholars who made themselves available to my questions and quibbles. Without your gracious support, your expertise and insight, none of this would have been possible.

This thesis is dedicated to my parents for their patience and generosity, but most of all for their unconditional love and unwavering support. The following pages are for you.
Thank you.

1. Introduction and Framings

Recently, claims have been made that one defining quality of our current moment was the thinking and living towards the future (Adams et al. 2009), marking a certain *state of anticipation* that asks societal actors in general and the sciences in particular to get hold of matters of uncertainty by fostering the continuous assessment of the 'not yet'. This *colonization of the future* (Brown and Michael 2003) entails the notion that envisioned sociotechnical configurations might indeed be regarded as valuable analytical objects in that they open up a horizon of possible pathways, thereby allowing for the active engagement with what has largely been considered beyond reach.

Arguably, this call for anticipation has been particularly strong within the vicinity of nanotechnology: As scholars have suggested (Kaiser et al. 2010), for nanotechnology, the proliferation of foresight rationales has been so pervasive that it would be best to speak of an entire *assessment regime* which is supposed to reassure the social acceptability of novel Nano[1]-enabled technologies. In that, one can observe the emergence of new modes of governance, marked not only by a heightened concern for specific sociotechnical futures but also by a policy language that calls for a more "responsible" (EC 2004b), "sustainable" (EC 2008a), and socially "inclusive" (ibid.) governance of (nano)science and technology.

However, a closer look into the very same policy documents indicates that this rhetorical commitment to a more open, transparent, and reflexive governance culture is just that, a mere rhetoric that is neither specified on a conceptual level nor indicative of any practical implications, thus bearing little impact on the realities and politics of current S&T governance practice. Moreover, the alleged shift towards more integrative forms of innovation governance appears to be counteracted by a number of ideas and concepts that are still very much rooted in traditional, centralized modes of governing (e.g. see Felt et al. 2007). Thus, rather than a homogeneous, internally consistent narrative, current R&D policy guidelines appear to convey an uneven, at times even conflicting vision of prevailing governance principles.

Social science and humanities scholars have criticized this contradictory state of affairs, calling, on the one hand, for a thorough reconceptualization of 'buzz' terms such as "responsibility" or "sustainability" (e.g. see Davies et al. 2009), and, on the other hand, for a profound reevaluation of key policy concepts such as the "deficit model" (e.g. see Irwin and Wynne 1996) or the so-called "risk paradigm" (e.g. see Giddens 1999; Guston 2010b).

[1] Throughout this thesis, I shall use "Nano" as an umbrella term for "nanotechnology and nanoscience".

Furthermore, bridging the gap from theory to practice, researchers have carried out public engagement exercises meant to demonstrate how a more participatory, deliberative governance culture might actually look like.

This thesis will investigate three Nano-related 'upstream' public engagement-oriented research projects, asking for the resources, knowledges, and skills that are needed to carry out this particular type of qualitative social science research in the field of new and emerging (nano)technologies.

1.1. Towards a Politics of Anticipation

As stated, attempts have been made to frame the current state of affairs as one defined by a certain thrust for anticipation, a turn towards the future that asks societal actors to take hold of the 'not yet' (Adams et al. 2009). As Barbara Adam (2005) has pointed out, this concentration on the future as a realm to be conquered is not an entirely new phenomenon but one that has – closely linked to political, industrial, and academic currents – recurred frequently throughout history. Yet, as Brown and Michael (2003) following Giddens (1999) have argued, contemporary culture is marked by a much more intense future-orientation than ever before, chiefly driven by a political prioritization of objectives such as the compliance with precautionary requirements, the strive for sustainability, the preservation or increase of innovatory power, as well as the securing of a competitive edge. Thus, the continuous invocation of the future has become an important political resource, a rhetorical tool that plays a key role in the governance of the present. As a direct consequence, this emphasis on the future has spawned new relationships between government institutions, industry, and academia, in particular with regard to the governance of emerging technologies (Barben et al. 2008).

However, in order to gain a better understanding of the proclaimed call for anticipation, it seems pertinent to investigate the concrete meaning of the term in some more detail. As we shall see, anticipation as a concept is more complex than the mere acknowledgement that prospective realms have gained in importance as a potential perspective to be taken into account. Indeed, the term entails a set of notions and ideas that may not be evident from a cursory glance but are nevertheless crucial in determining the expression's scope and meaning:

For starters, an anticipatory stance does not simply imply just any way of dealing with the future but, indeed, a fairly specific one. As Adams, Murphy, and Clarke have

suggested, anticipation "is not just a reaction, but a way of actively orienting oneself temporally" (Adams et al. 2009, 247). This temporal orientation then "demands action" (ibid., 255), is concerned with the "management of the future" (ibid., 259), and eventually even enables the "production of possible futures" (ibid., 248). In that sense, anticipatory modes conceptualize the future *not as an inevitable given but as something that can be negotiated and prepared for*. Consequently, anticipation can be understood as the "palpable sense that things could be all right if we leverage new spaces of opportunity, reconfiguring the 'possible'" (ibid., 246). Historically, such a take on the future nicely ties into what Brown and Michael (2003) have described as the "substitution of divine agency by human agency", as a result of which "the future was […] no longer a mere continuation of the past but became increasingly a consequence of actions in the present" (Adam 2005, 3), giving rise to an imagination where the future is not pictured as being "unveiled" but "steered", not merely "interpreted" but "changed", not "foreseen" but "shaped" (ibid. 3-4). Actors participating in this type of future engagement are "future makers" (ibid., 14) insofar as they are inevitably involved in an abduction-based[2] creation of "present futures" and "future presents" (ibid., 2, 9), in a realm were fact and ideas are no longer seen as two mutually exclusive dimensions but as complementary expressions of an "immaterial future real" (ibid., 11), quite similar to the combinatory sphere between "fact" and "fetish" that Latour (1999) has proposed to label "factish".

Second, and building upon the preceding point, anticipation should not be mistaken as speculation, even though both activities exhibit similarities in their common thrust towards the future. Rather, anticipation can be understood *as the performative resource that ultimately lends speculation the authority to act in the present* (Adams et al. 2009, 249). Thus, unlike speculation, anticipation features a telescoping of temporal possibilities, once again emphasizing the activity's potential for interference and reflective (re-)alignment. As Adams and others have put it: "Anticipation is not just betting on the future; it is a moral economy in which the future sets the conditions of possibility for action in the present, in which the future is inhabited in the present." (ibid., 249)

Third, even though anticipatory work is often advocated as a countermeasure to heightened levels of uncertainty[3], it, as a forward-looking condition, *can never fully take hold of the unknown*. The future as a prospective realm that has not yet materialized must always remain uncertain to a certain degree. Consequently, it cannot be the objective of

[2] In this context, the notion of abduction delineates a continuous shifting between the past, the present, and the future (see Adams et al. 2009, 253).
[3] For a thorough account on the rise of uncertainty, please consider Nowotny and co-authors (2001).

anticipation to overcome and eradicate uncertainty but, quite on the contrary, to assume an active position, seeking to turn uncertainty into a tolerable, manageable, and, first and foremost, governable inescapability. Also, as anticipatory work always resides within the boundaries of uncertainty, its visions of future developments remain contestable and actionable, thereby mitigating the concept's normative potential (ibid., 256).

Fourth and finally, anticipation is *not exclusively an individual but also a collective undertaking*. On the one hand, anticipatory modes of future assessment can only prosper in sociocultural settings where the notion that the future is shape- and negotiable serves as a dominant narrative. In a society where the future is being imagined as an unchallengeable datum, i.e. as fate or destiny, anticipation would probably appear as a pointless endeavor. Hence, anticipation is collective in that it has to fit to and be carried by particular systems of belief, i.e. specific compatible future rationales. On the other hand, however, anticipatory work is also collective in the sense that the appeal to engage in this type of future assessment might become compulsory. In essence, this is what Adams, Murphy, and Clarke have described as the emergence of "anticipatory regimes" (ibid., 248), signifying a set of prescriptions that determine how the future should be evaluated and handled in the presence. Within such regimes, an anticipatory take on life is no longer voluntary but mandatory; anticipation can no longer be considered an option but an obligatory requirement, rhetorically enforced as a "moral imperative" (ibid., 254). In that sense, the notion of anticipatory regimes accentuates that questions of how a society positions itself towards the future are always closely linked to matters of power, which might eventually translate into very tangible social, political, and economical outcomes.

The considerations adduced thus far elucidate why anticipatory modes of future assessment have become a favored counseling tool across different domains of political decision making. Most fundamentally, since within an anticipatory framework the future is not envisioned as a given but as something that can be changed and acted upon, policymakers do not have to settle for a passive, knee-jerk legislation but can set proactive incentives to steer developments in the desired direction. In that sense, an anticipatory perspective allows authorities not only to respond to future prospects, but furthermore enables them to create possible trajectories into the future (see Adams et al. 2009, 248). Such a setup, however, bears certain risks. As Adams and others have put it:

> "Anticipation authorizes pre-emptive actions in the present forced by a purported urgency in the future, legitimating, destroying, removing and/or eradicating now in the name of an anticipated

> future danger. Here violence is justified not only as defense, offense, or tactic, but also as preparedness … anticipating a crime yet to happen." (ibid., 256)

Without wanting to bestir a similarly dystopic vision, it seems advisable to keep in mind that anticipatory logics can function as a rhetoric tool of considerable power, a power that can be used – and misused – to attain certain objectives. As the quote indicates, authorities may justify present actions by appealing to future presents, thus making use of a powerful – and difficult to challenge – discursive strategy that uses the 'not yet' as a means of defining the necessities of the here and now. However, what is interesting in that regard is not only the discursive practice as such, but furthermore the ways in which these anticipated futures have been constructed. Put differently, the recognition that anticipated futures may serve as a critical resource in a fundamentally political "economy of power" (Foucault 1982) prompts us to consider how these futures have been fabricated in the first place. In that sense, questions such as "Which kinds of futures are being produced?", "How, by whom and based on what kind of knowledge?" do not constitute a mere intellectual pastime but are central to a more profound understanding of contemporary modes of governance and decision making. The thesis at hand will address such *politics of anticipation*, and it will do so with regard to a very specific context – that is, the anticipation and governance of technoscientific futures with particular focus on nanoscience and nanotechnology.

1.2. Anticipating Nano

As argued in the introduction, the call for anticipation has been particularly strong within the vicinity of nanotechnology, a so-called 'emerging technology' that ever since the late 20th century has gained considerable momentum in stimulating the imagination of modern civilizations. Being the buzzword *de jour* (Mekel 2006), Nano visions have covered the full spectrum from utopian dreams to apocalyptic nightmares (McGrail 2010), from hopes of "leading to the next industrial revolution" (National Science and Technology Council 2000) to dystopic 'grey goo' scenarios (Drexler 1986). Thus, nanotechnology has been subjected to extreme positive and negative hyperbole (Mekel 2006; Toumey 2004), making it a technology that is far from settled or uncontested (McGrail 2010).

Another heated debate has erupted around the question of how nanotechnology as a concept could be unanimously defined. In practice, several distinct approaches seem to coexist: Originally, the term was coined in a 1974 conference deliverable of Norio Taniguchi (1974), in which Taniguchi referred to "nano-technology" as the ability to engineer materials

precisely at the scale of nanometers. This definition, although usually slightly broadened in scope and repeated with different wording, still remains the most common to date. Accordingly, Ramsden contends that "nanotechnology is […] defined as the design and fabrication of materials, devices and systems with control at nanometre dimensions" (Ramsden 2005, 3). Another generally accepted way to specify the concept of nanotechnology would be by referring to its properties. As materials' properties – e.g. melting point, fluorescence, electrical conductivity, magnetic permeability, chemical reactivity – change significantly at very small scales[4], scholars have sought to identify nanotechnology as the "new science and technology that takes advantage of properties operating at the nanoscale" (Peterson 2004, 10). Apart from these two manufacture and property-related definitions, others have hinted at nanotechnology's use as an umbrella term that unites a host of distinct practices and fields of application under a common label (Rip and Voss 2009; Schmidt 2004). As McGrail puts it, "nanotechnology can most simply be considered a collective term for the myriad research, engineering and technology development activities focused on the application of a diverse, expanding set of techniques for manipulating physical and biological materials" (McGrail 2010, 23). And Robinson contends that "unlike previous high-technology waves induced by biotechnology and genomics, nanotechnology covers diverse fields of science and engineering with very different dynamics […]." (Robinson 2010, 5) Such definitions emphasize that the term "nanotechnology" as it is used today does not merely serve as an enclosing technical denominator, but furthermore as an attestation of the science policy goal to find a "fundamental technology", a "root and core technology" (Schmidt 2004) that "attracts investment and protects ongoing research" (Rip and Voss 2009). Thus, the term continues to be used mainly for the "rhetoric and resource-mobilization force it has" (Robinson 2010, 5). Finally, attempts have been made to think nanotechnology in terms of its potential impact on current societal configurations, per chance lastingly altering how humans perceive and interact with their environment (see Crow and Sarewitz 2001; Roco and Bainbridge 2001). For instance, Barben and others have argued that "nanotechnology constitutes an emerging set of science-based technologies with the collective capacity to remake social, economic, and technological landscapes" (Barben et al. 2008, pp. 979). And whilst such a conceptualization may not hold as a sound technical description, it certainly has value in

[4] United States National Nanotechnology Initiative (unspecified) *What's So Special about the Nanoscale?* Online available at: http://www.nano.gov/nanotech-101/special (all links verified on July 10, 2013).

pointing towards the hopes and expectations that accompany nanotechnology as a field that is still largely considered an emerging one (see Kaiser et al. 2010; Kearnes et al. 2006).

All in all, nanotechnology presents itself as a concept that seems unclear and vague in several respects: It is usually defined in fairly broad terms, covering much but specifying little; it cuts across a broad range of disciplines and cannot be reduced to a limited set of application areas; it remains in constant flux and changes through research and interaction with other fields; it is subjected to a myriad of promises and expectations while the pathway to realization remains nebulous; it is envisioned as an emerging future technology but has already infiltrated the shelves of local supermarkets. Nanotechnology can thus be conceived as a technoscientific field whose future prospects are fundamentally uncertain and give way to speculation. It represents "post-normal science", a domain where traditional methodologies and strategies of problem solving have largely become ineffective (see Barben et al. 2008; Funtowicz and Ravetz, 1993).

As might be expected, such states of uncertainty may pose major challenges to policymakers and eventually necessitate legislative reorientation and novel forms of governance. As a result, ever since the early 2000s, one could observe what Kaiser and co-authors (2010) have coined the "rise of an assessment regime", delineating a state of affairs where assessment practices are no longer "ornamental to technology development" but have indeed become an "integral and active part of emerging NST[5]" (Kaiser et al. 2010, XII-XIV). This "intensification and diversification of different assessment rationales and approaches" (ibid. 2010, XII) falls into what Adams and others have called "actuarial saturation", a condition where the "sciences of the actual are displaced by speculative forecast" (Adams et al. 2009, 246), i.e. where one can witness a redistribution of scientific resources towards the future. Thus, given the "notorious fuzziness of the concept" (Schummer 2010) and its general residence in the estate of uncertainty, nanotechnology has been subjected to revised modes of governance that aspire to 'colonize' the future (Brown and Michael 2003) by adhering to a logic of assessment, marked by various techniques of foresight and anticipation.

A central aspect of this new "landscape of governance" (Kearnes and Rip 2009) is the discursive embrace of a more "responsible" (EC 2004b), "sustainable" (EC 2008a), and "inclusive" (ibid.) governance of science and technology, i.e. one that adopts "a proactive stance and fully integrate[s] societal-considerations into the R&D process" (EC 2004b, 18), promotes "a better dialogue between researchers […] and the public" (EC 2005a, 3), and

[5] "NST" is short for "nanoscience and nanotechnology".

adheres to "ethical principles in order to ensure that R&D in nanotechnology is carried out in a responsible and transparent manner." (EC 2004b, 19) Thus, the "need to devote due attention to the societal aspects of nanotechnology" (ibid.) and "encourage a dialogue with citizens" (2005a, 3) has emerged as an often-repeated policy mantra in this context. As scholars have argued, engaging the public in the governance of science and technology has become a "gold standard" (Felt and Fochler 2008), a "consensus" (Davies et al. 2009) and "[commonplace] in contemporary public policy around science, innovation and emerging technologies." (Strassnig 2009, 7) In a European context, this commitment to public outreach and inclusion has been incorporated into a number of major policy directives, from top-level funding initiatives such as the European Commission's 6th Framework Programme for Research and Technological Development (EC 2002a), the Framework Programme 7 (EC 2007), or, more recently, Horizon 2020 (EC 2011a), over Nano-specific guideline documents such as the Commission's communication Towards a European Strategy for Nanotechnology (2004b) or the Nanoscience and Nanotechnology Action Plan (EC 2005a), to more dedicated action lines such as the Science and Society Action Plan of FP6 (EC 2001) or the Science in Society Action Plan of FP7 (EC 2009a). In comparison, in the United States, the call for public participation has not been quite as pervasive as in Europe (Sciencewise 2010); however, funding initiatives such as the 21st Century Nanotechnology Research and Development Act (U.S. Government Printing Office 2003) have explicitly called for the establishment of research programs that would "identify ethical, legal, environmental, and other appropriate societal concerns related to nanotechnology" by convening "regular and ongoing public discussions." (ibid., 117) Thus, at least at a discursive level, the idea and ideal of responsible and socially inclusive R&D has been strongly anchored in many of the pivotal policy documents of contemporary science and technology governance.

Now, while the reasons for this turn towards more integrative forms of S&T governance may be manifold and complex, at least two rather straightforward interpretations seem to apply:

First, and on a more theoretical note, the orientation of public research policy towards, well, 'the public' can be understood as a somewhat delayed reaction to what Gibbons and co-authors (1994) have called the emergence of a Mode 2 of scientific knowledge production, i.e. knowledge production that is carried out in a context of application rather than the ivory towers of academia, that is transdisciplinary rather than disciplinary, that is characterized by heterogeneity rather than homogeneity, that is heterarchical and transient rather than hierarchical and preserving its form, that is more

socially accountable and reflexive, including a greater diversity of individuals and groups across the social spectrum. (see ibid., 57) In essence, Gibbons and co-authors' argument holds that especially Western scientific cultures are confronted with such novel forms of knowledge production – that is, a "complex of ideas, methods, values, and norms" (ibid., 56) – where "the exploitation of knowledge requires participation" (ibid., 65) and is "diffused throughout society" (ibid., 58) and whose goals are no longer to simply secure commercial or economic benefits but rather to ensure social and ecological ones. In that sense, the recent policy turn towards public participation can be interpreted as an answer to practical transformations that have already changed the face of current R&D. To use a well-known dictum that captures this ongoing "co-production" (Jasanoff 2004) of science, technology, and society, one could argue that "science has itself abolished the boundary between laboratory and society." (Beck 1999, 61; also see Irwin 1995)

A second reason for the rhetorical shift towards more open, socially inclusive modes of S&T governance can be found in authorities' experiences with large-scale technoscientific controversies such as the debate over genetically modified (GM) organisms (Kearnes et al. 2006; Horlick-Jones et al. 2007), the HIV-tainted blood scandal in Japan (Barben et al. 2008; Tanaka 2005), or the European BSE crisis (Seguin 2000; 2003), three cases where public confidence in expert-based policy making was undermined and authorities were forced to rethink legislative practices. As Kearnes and co-authors (2006) have argued:

> "There are […] various ways in which the GM experience has shaped, and will continue to shape, political and regulatory debates around nanotechnologies. […] Crudely put, the GM experience represents a warning, a cautionary tale of how not to allay public concern. Avoiding nanotechnology becoming 'the next GM' is seen as critical to the public acceptability of applications in the field." (ibid., 15)

In that sense, the emphasis on public outreach and participation can be seen as an attempt to prevent that Nano-related 'grey goo' scenarios – i.e. the vision of masses of self-replicating nano-sized replicators able to consume the world and "obliterate life" (Drexler 1986, 173) – or similar concerns would cause the next 'frankenfood' or 'mad cow' debacle. As nanotechnology has emerged as an area of considerable hopes and investments[6], policymakers seem eager to ensure that potential worries are addressed early on, thereby implicitly acknowledging that technological innovation is not just a matter of unbridled opportunity but, indeed, a "matter of concern" (Latour 2003).

[6] Ever since the late 1990s, worldwide public and private expenditure in nanotechnology and nanoscience has grown rapidly (see EC 2005b). The European Commission, for instance, has invested EUR 1.4 billion in the four-year period 2003-2006, and more than 1.1 billion in the two-year period 2007-2008, with further growth expected (see EC 2009b).

Taken together, these points provide a potential answer to why institutions appear to have "become much more receptive to public engagement" (Barben et al. 2008, 983) and "even the most science-centred government report is incomplete without a section on 'public engagement'." (Irwin 2006, 300)

According to policy guidelines, the social sciences are meant to play a key role in this "reflexive governance" (Voß et al. 2006) of S&T. For instance, the Nanosciences and Nanotechnologies Action Plan states that "the integration of ethical concerns […] and social sciences into N&N R&D will help build confidence in decision-making related to the governance of N&N" (EC 2005a, 9), and the U.S.-based National Science and Technology Council has named the social sciences – together with physics, the life sciences, and engineering – as one of the "intersecting disciplines at the core of nanotechnology innovation." (NSTC 2011, 1) In a similar vein, social science and humanities scholars have diagnosed a heightened "demand for further social science input" (Kearnes et al. 2006, 75), arguing that the social sciences have been "invited in" (Rip 2006, 362) to "play a formative role in the sociotechnical context of developing nanotechnologies." (Barben et al. 2008, 983)

Throughout this section, it was argued that the current approaches to governing Nano would embrace a forward-looking, assessment and anticipation-oriented perspective that not only commits to responsible, socially inclusive and reflexive forms of R&D but furthermore sees the social sciences and the humanities as central "actors […] as well as commentators" (Kearnes et al. 2006, 77) in this policy landscape around new and emerging technologies. From a (qualitative) social science point of view, doesn't this seem like an ideal research environment, a policy-driven area of genuine curiosity and intellectual openness that allows for exploratory modes of future assessment, encourages deliberative, citizen-centered research, and is open to critical reflection and dialogue? At a cursory glance, indeed, it might. However, if one takes a closer look and considers the actual policy guidelines in more detail, certain objections might be raised.

1.3. Nano Governance Revisited

To state it bluntly, what has been outlined thus far is only part of the story. In fact, it represents a somewhat superficial reading of a process that is, on closer inspection, much more complex and ambiguous. Most importantly, while the account given above implicitly suggests that a comprehensive shift to new forms of S&T governance has already occurred and thus forms the widely accepted basis of current policy directives – i.e. what scholars have called a move from "government to governance" (e.g. Jordan et al. 2005) or, simply, the "participatory turn" (e.g. Jasanoff 2003) – a more thorough examination of some of the key policy documents on (nano)science and technology indicates that such a far-reaching paradigm shift has not yet been fully realized. Instead, the documents reveal what Irwin (2006, 298) has called an "uneasy blend of 'old' and 'new' assumptions", i.e. a "contradictory and partial [discourse]" (ibid., 303) marked by a rhetorical commitment to a more open, transparent, and reflexive governance culture paired with a number of ideas and imaginaries that are still very much rooted in traditional, centralized modes of governing. Thus, rather than a homogeneous, internally consistent narrative, current R&D policy guidelines appear to convey an uneven, at times even conflicting vision of prevailing governance principles. But what does this mean with respect to the simplified account given above?

First, even though contemporary policy documents embrace a language of anticipation, seeking, for instance, to "anticipat[e] potential environmental, health and safety impacts of N&N outcomes" (EC 2008a, 6), the particular *type of anticipation* employed does not content itself with residing in the "domain of the uncertain" (Adams et al. 2009, 256), i.e. the idea that anticipatory modes can never fully take hold of the unknown and thus cannot "achieve completion" (ibid., 257). Rather, policymakers seem eager to get rid of uncertainty altogether, arguing that "there is a growing need for scientific information and tools to help better *predict* or *detect* the potential impact of nanomaterials" (NSTC 2011, 13; emphasis GR) in an effort to "address any potential risk upfront, as early as possible, on the basis of *reliable scientific data*" (EC 2004b, 22; emphasis GR). Thus, what can be observed is a considerable push towards predictive forms of future assessment, usually realized through quantitative data analysis and underpinned by a pronounced desire to base policy decisions on 'hard' scientific facts and (seemingly) disinterested, objective statistics. In such a framework, anticipated technoscientific futures are calculated futures, i.e. futures that have been measured, quantified, and put in probabilistic terms. On a more general level, this endorsement of predictive forecasting rather than 'softer' modes of future anticipation can

be seen as a reflection of what Porter (1995) has called society's profound "trust in numbers". According to Porter, numbers, graphs, and formulas can be regarded as "strategies of communication" that are "intimately bound up with forms of community" (ibid., VIII), thus representing a particular "mentality" in which the "prestige and power of quantitative methods" (ibid.) fosters the "growing role of quantitative expertise in the making of public decisions" (ibid., 6). In that sense, the "mathematization of anticipation" (Leydesdorff 2007) can be seen as symptomatic of a broader sociopolitical trend which manifests, for instance, in what has been discussed as the rise of the "audit society" (Power 1997), the "era of big data" (Gitelman 2013), or the "mechanization of the future" ["Technisierung der Zukunft"] (Hölscher 1999), fueled by what Habermas (1987 [1969]) has famously coined society's "technocratic consciousness". Ultimately, the call for exact predictions represents a somewhat utilitarian strive for sound, positivist science, a science that is meant to uncover universal truths about 'the society', provide clear-cut recommendations, and serve as a means of legitimizing present-day policy decisions. And while such an approach to future anticipation is still proactive in the sense that it facilitates a governance that "think[s] about possible developments, challenges, impact and future needs" (EC 2004b, 11), its reliance on numbers and quantitative assessments might "[minimize] the need for intimate knowledge and personal trust" (Porter 1995, VIII), thus championing a quite narrow conception of what it actually means to be "proactive", testing for predefined categories and seeking to "ensure public awareness and confidence" (EC 2004b, 19) in a rather top-down manner, which leads to another crucial observation.

Second, even though the formal inclusion of lay citizens has become a "gold standard" (Felt and Fochler 2008) and "key element" (Davies et al. 2009) in current S&T governance, and the language of public participation and engagement is now deeply rooted in many contemporary R&D policy documents, it appears that this 'participation' is mainly seen as a way to *inform 'the public' about science* in an attempt to ensure "public trust in scientific and technological breakthroughs and provide a favourable environment for investment." (EC 2010, 12) Thus, rather than a means of giving voice to lay people's concerns and fostering 'true' upstream deliberation, public participation is often framed as an instrument of top-down appeasement, marking the fairly paternalistic outreach strategy of a downstream-oriented governance philosophy that seeks public legitimization but appreciates (lay) citizen involvement only as far as these citizens take a role as good, silent listeners. Arguably, this

one-way, 'missionary' approach is underpinned and bolstered by at least *four key imaginations*:

To begin, the push for top-down information dissemination can be seen as the logical extension of what has been dubbed the "deficit model" of the science-citizen relationship (e.g. see Irwin and Wynne 1996), that is, the assertion that "people lack information about – and thus understanding of – the purported 'true nature' of a techno-scientific development" (Felt et al. 2010, 529) and hence must be 'instructed' and 'educated' in order to develop a 'correct' understanding of what is 'really' going on. For example, in the paramount policy communication Towards a European Strategy for Nanotechnology (EC 2004b), the European Commission, referring to a Eurobarometer survey on Europeans, Science and Technology (Special Eurobarometer 2001), claims that "an opinion poll of over 16 000 individuals in 2001 indicated that nanotechnology is poorly understood", which, according to the Commission, would "demonstrate that there is an urgent need to provide information about present-day nanotechnology research and its possible applications." (EC 2004b, 19) Consequently, from such a perspective, (lay) citizens are not perceived as knowledgeable entities but as ignorant, empty vessels – a passive, chronically underinformed audience that "operate[s] in a knowledge vacuum" (Irwin 2001, 10) and finds itself in desperate need of learning the 'truth' about (techno)scientific 'facts'. Implicitly, this deficit model also entails the assumption that increased knowledge *about* science will inevitably lead to greater support *of* science and that "better [top-down, GR] communication will resolve problems of public confidence" (ibid., 7), a notion and logic that has been criticized repeatedly by science studies scholars (e.g. Wynne 1995; Felt et al. 2007).

Secondly, and in direct relation to the previous point, the strive for downstream information dissemination is furthermore boosted by what has been labeled the "high-science perspective" (Irwin et al. 1996), i.e. a firm belief *in* science as a distinctive domain of truth and thus the accreditation *of* scientific knowledge as something "privileged and legitimate" (ibid., 48), a higher form of evidence that is not only seen as categorically different from but also superior to other forms of knowing. In such an intellectual framework, science is conceived as a purely rational, logic-driven endeavour that merely 'reveals' or 'uncovers' pre-given facts, objectively reflecting a reality 'out there'. Consequently, scientific and technological progress is not so much seen as a matter of concern, i.e. as something that ought to be discussed and (critically) reflected upon, but rather as an almost sacrosanct process which is "a priori to be judged as positive" while any "public mistrust needs […] to be based on misinformation" (Fochler 2007, 40). Thus, in

essence, the high-science perspective builds upon three core conceptions: a clear separation between science and technology on the one hand and society and social values on the other (a); a glorification of scientific knowledge as *the* dominant and most highly valued form of knowing (b); the inclusion of – and thus reliance on – certain, formally recognized knowledge carriers (e.g. scientists, certified experts) rather than others (e.g. lay citizens, representatives of concerned social groups) (c). Contending lay interpretations and local knowledges are systematically eschewed in such a framework, "muted in relation to science" (Irwin and Wynne 1996, 136) and dismissed as counterproductive noise rather than appreciated as a valuable addition. Once more, the principal goal is not to facilitate a reflexive debate *on* technoscientific developments but to reassure public confidence *in* and a broad support *of* processes of technoscientific innovation.

Thirdly, even though contemporary R&D policy reports emphasize the need for "responsible" (e.g. EC 2008a) and "sustainable" (e.g. EC 2009b) development that improves people's "quality of life" (NSF 2011, 11) and takes into account the "societal challenges" (EC 2011a, 5) that may accompany processes of technoscientific innovation, they even more emphatically stress S&T's central role in "stimulating economic growth" (NSF 2006, 1), "spur[ing] prosperity" (NSF 2011, 3), and "sustaining [a] nation's competitive edge" in a "dynamic, complex, and competitive international environment." (NSF 2006, 5) Thus, in particular against the backdrop of the current economic crisis and increased global competition (see EC 2011a; 2012), the furthering of and investment in science and technology is seen as a means to "strengthen […] industry" (EC 2007, 7), "deliver jobs" (EC 2011a, 2), and "ensure long-term competiveness" (ibid., 4). In that sense, the promotion of science and technology is not conceived as an Enlightenment-schooled end in itself but rather as an important constituent of a thriving economy, an indispensable necessity within a capitalist logic where progress is equated with growth, innovation with financial prosperity, and success with global S&T leadership. With regard to public engagement, however, this also entails that any critique of technoscientific advancements does not solely represent an isolated contestation of individual technologies – e.g. GMO, nuclear power, Nano – but, indeed, poses a challenge to the modernist conception of wealth-generation through unbridled innovation at large (see Latour 1993; 2010), calling into question the quasi-dogmatic imperative of "what can be done should be done" (Huesemann and Huesemann 2011, XXIV). Hence, it should come as no surprise that policymakers demonstrate a certain preference for expert-led, top-down information dissemination, that is, public outreach activities that by their very design prevent an all too critical and deep

engagement and are often tailored to foster consensus and support rather than facilitating critical reflection, conceptualizing 'the public' as ex post "consumers" (e.g. EC 2004b; 2005a) rather than as knowledgeable actors/stakeholders who should be consulted before actual products have been developed and are readily available on the market.

Finally, whenever potential adverse implications of technoscientific innovations *are* being addressed, this is usually done within the confines of what has been called the "risk paradigm" (e.g. see Beck 1992; Giddens 1999), an assessment framework in which "'risk' is highlighted […] not just as an important element, but as *definitive* of all the issues raised in the governance of science and technology" (Felt et al. 2007, 37; emphasis as original), "seek[ing] to provide a single answer: safe or unsafe" (Stirling and Mayer 1999, 5). References to the issue of risk are legion throughout the respective policy documents. For instance, in its Nanoscience and Nanotechnologies Action Plan (EC 2005a), the European Commission argues that while "some risk is inherent" (ibid., 8) for any technology, "health, safety and environmental risks that may be associated with products and applications of N&N need to be addressed" (ibid., 3). In a similar vein, the National Science and Technology Council emphasizes the necessity of fostering "research primarily directed at understanding the environmental, health, and safety impacts of nanotechnology development and corresponding risk assessment, risk management, and methods for risk mitigation." (NSTC 2011, 30) Arguably, this focus on risk and risk alone furthers the pursuit of top-down information dissemination in several ways: For one, the prevalence of the risk paradigm bears the danger of blanking out other, equally valid concerns, such as broader ethical, legal, or social implications, as well as more fundamental questions, such as whether we as a society actually want to engage in certain technoscientific trajectories in the first place. Moreover, within this line of thinking, the issue of risk is usually discussed in a very technical manner, i.e. as something that can be measured and calculated (e.g. see NSTC 2011, 30), quantified and stored in dedicated databases (e.g. see EC 2005a, 11), as well as successfully handled through the implementation of standards and regulations (e.g. see ibid., 10). What follows is that concerns that are not expressed in such a technical language may be dismissed and (de)classified as unscientific and, hence, irrelevant. Lastly, there is a sense that even though "some risk is inherent" (ibid., 8), this risk can indeed be managed and controlled, i.e. is containable through technical or legislative 'fixes', making virtually any technology adjust- and 'tamable' to social – and socioeconomic – ends. Ultimately, this governance philosophy contributes to a R&D climate where the voluntary, permanent relinquishment of a technoscientific opportunity is usually not considered a viable option,

where even temporary moratoria are seen as "severely counter-productive" (EC 2004b, 19) and potentially harmful to the prosperous development of both society and economy, and where critical voices or calls for caution are thus more likely to be muted than being openly discussed and/or seriously considered.

In sum, it becomes apparent that policymakers' propensity towards top-down information dissemination is not just a mere coincidence but, rather, is consolidated by and represents a direct reflection of a number of core beliefs, concepts, and imaginations that are deeply ingrained in current R&D governance practice. Consequently, a fundamental shift from 'downstream' to 'upstream' modes of public participation would indeed necessitate a thorough departure from the tenets of the deficit model (a), a reappraisal of science as a social process that is not only amenable to scientific but also to public scrutiny (b), a stronger emphasis on science as a driver of responsible, socially reflexive development rather than a sheer means to economic growth and industrial prosperity (c), as well as the abandonment of the risk paradigm as the prime – or even sole – perspective of importance (d). In turn, however, this also implies that as long as such reorientations have not occurred, the call for public participation/engagement remains little more than a shallow platitude, a purely rhetorical commitment that hardly has any impact on a broader conceptual/epistemological level, let alone practical consequences that would actually make a difference to the realities and politics of current S&T governance.

A third and final objection relates to the somewhat questionable since undifferentiated claim that the social sciences and the humanities have been "invited in" to take up a "new role" and get "a better hearing" in processes pertaining to the governance of technoscientific innovation (see Rip 2006, 362). Now, while scholars have indeed diagnosed an elevated "demand for further social science input" (Kearnes et al. 2006, 75) and official policy reports repeatedly stress, for example, the necessity to "bring together resources and knowledge across different fields, technologies and disciplines, including social sciences and the humanities" (EC 2011a, 5), a closer look indicates that this very demand does not refer to just any kind of social science expertise but rather a fairly specific type. As one might expect, this 'desired' input largely corresponds to the first two points outlined above. Thus, on the one hand, there appears to be a strong interest for quantitative assessments, which is reflected in the relative prominence and significance of analytical tools like the European Commission's Eurobarometer surveys (e.g. see Special Eurobarometer 2005; 2010a), which are based on the assumption that public attitudes towards science and technology can be

determined through yes-or-no, true-or-false questions and, subsequently, accurately expressed in charts and numbers, percentages and probabilities. This push for quantifiable results is furthermore accompanied by a growing demand for clear-cut, directly applicable policy recommendations, which arguably is not always the strong suit of qualitative research that usually seeks to produce in-depth understanding rather than spreadsheets with generalized classifications, delivering ambiguous, fine-grained descriptions rather than nicely packaged, ready-made facts. On the other hand, policymakers and funding bodies also seem to have a vested interest in projects that subscribe to the logic of the deficit model, seeking to inform the public about science and technology (see for instance the BMBF-supported nanoTruck initiative[7]), that adopt an industry-friendly perspective and test products for consumer acceptance (see for example the FP7 project NanOpinion[8]), and/or that discuss potential implications in the narrow framework of risk versus benefit analysis (e.g. see the FP6 project Nanologue[9]). To be sure, none of this means that projects deviating from these objectives have no chance of getting funded – as will be shown, there are contexts where such funding is available and obtainable. However, the consistent presence of certain core beliefs suggests that particular preferences prevail, and that the current funding and governance environment is thus not equally welcoming to all kinds of research and research trajectories. Insofar, the claim that the social sciences and the humanities have been "invited in" represents a somewhat precarious generalization that requires thorough reconsideration or, at the very least, further specification, as there is indication that the 'door' is effectively more open to some approaches than it is to others.

All in all, the outline of these three areas of ambiguity should have succeeded in demonstrating that current Western S&T policy directives are indeed marked by an uneasy blend of differing, at times even conflicting assumptions, an inconsistent, partial discourse that runs through many of the pivotal policy documents. As scholars have argued, such reports read "as if two voices are struggling to be heard" (Hagendijk 2004, 46), forming an awkward intermingling in which the language of anticipation is paired with a call for

[7] Federal Ministry of Education and Research (BMBF) (2012) *nanoTruck - Meeting Place Nanoworlds*. Online available at: https://www.nanotruck.de/fileadmin/user_upload/Dokumente/nanoTruck_Brochure_en.pdf.

[8] See the NanOpinion website at http://nanopinion.eu/en and some of their video material under http://nanopinion.eu/en/about-nano.

[9] Nanologue (2006) *The future of nanotechnology: We need to talk*. The final report has been taken off the Internet but is still available at: http://web.archive.org/web/20130118093603/http://www.nanologue.net/custom/user/Downloads/Nanologue_we-need-to-talk.pdf.

predictive modes of future engagement, where the understanding that citizens' concerns should be taken seriously stands next to the belief that the public can only contribute properly if it is adequately educated and instructed, and where the social sciences and the humanities are recognized as vital contributors, but only as long as they do not stray too far from the funding agencies' core convictions. As a consequence, it should come as no surprise that representatives of the (qualitative) social sciences and the humanities have criticized some of those normative undercurrents, arguing that "technologies of data collection are inherently social and political" (Holmberg et al. 2013, 400) and thus should be treated as objects of investigation rather than as simple number-based solutions; that the "deficit model is the way that social science is itself encouraged to misconceive its own research objects, namely social actors" (Kearnes et al. 2006, 76); and that it can't be the task of science to "[deliver] a quiescent public for commercially exploitable scientific knowledge" (Wynne 2006a, 75) but, rather, to "[attempt] to draw the public into decision-making and establish a more responsive culture for innovation." (Irwin 2006, 300) However, scholars did not content themselves with challenging the politics of current S&T governance in general and those of public outreach activities in particular, but, in order to show what such a "more responsive culture" could actually look like, also sought to conceptualize their own research projects as practical counterproposals, thereby aiming for ambiguity and thick descriptions rather than yes-or-no opinion/knowledge polls, for methodologies that would give voice to lay citizens' concerns and knowledge ways rather than restricting deliberation to expert-led information dissemination, as well as for an open research climate that would remain independent of industry and government interests, allowing for the formulation of critique beyond the narrow scope of the risk paradigm. Ultimately, these projects were intended to offer a different vision of what it might mean to engage in a more "responsible" (Davies et al. 2009), "plausible" (Selin 2011), and "participatory" (TECHNOLIFE 2012) governance of science and technology, a governance culture that would take contemporary knowledge societies seriously (see Felt et al. 2007) and allow for a more upstream-directed deliberation of technoscientific futures, which, finally, brings us to the central question this thesis seeks to address.

2. Research Questions and Outline of Thesis

Throughout the previous chapter, it was argued that current S&T policy documents are marked by a number of deeply-entrenched (master) narratives – from a certain inclination towards quantitative methods over the so-called high-science perspective to a continued conceptual adherence to the risk paradigm as well as the pursuit of industry-friendly, growth-directed research in general – that run contrary to, and effectively undermine, any stated commitment for a more socially inclusive and reflexive governance culture. And while many actual research projects have readily subscribed to these normative preconceptions, there are others that have sought to tell a different story, one that thoroughly reconsiders what it might mean to aim for more responsible and sustainable development, thus openly calling into question many of the core beliefs that are still prevalent in current S&T policy making. But this 'clash' of contrasting views raises a fundamental question: If the master narratives outlined above are truly as entrenched and widespread as assumed, and if the accompanying assumptions are held by the same authorities that ultimately decide on whether a specific research project will be funded or not, how then is it possible to realize such antithetical, nonconformist research projects in the first place? Put differently: Given the current (Western) policy environment, what kind of resources, knowledges, and skills are needed to carry out qualitative social science research in the field of new and emerging technologies that is contrarian in that it challenges established governance practices, that is subversive in that it seeks to introduce alternative concepts and perspectives, and that is genuinely democratizing by promoting bottom-up forms of public participation, (re)conceptualizing lay citizens as 'carriers' of expertise who ought to have a say in a more inclusive governance of technoscientific innovation? It is this question that lies at the very heart of the thesis at hand. Thus, the following pages are intended to provide insightful commentary on the strategies and difficulties, the modalities, intricacies, and politics of upstream public engagement research in Europe and the United States. In the empirical chapter of this thesis, this research objective will be tackled by focusing and elaborating on a number of more specific sub-questions and/or areas of interest:

To begin, in section 4.1., we shall ask how qualitative public engagement initiatives that strive for complexity and ambiguity rather than clear-cut answers, for thick descriptions rather than straightforward explanations must present and communicate their research in order to enroll funding agencies' support and ensure a project's financial viability. Thus, we shall consider the kind of negotiation practices and discursive strategies necessary to obtain grants while at the same time seeking to guard a project's intellectual authenticity and

maintain its upstream orientation. As we shall come to see, the arguments presented in this section will challenge the assumption that science is only about science, making the case that in present-day research environments (social) scientists must incorporate skills and capacities that are arguably closer to those of politicians, managers, and entrepreneurs than to the classic idea(l) of the ivory-tower lab rat.

The subsequent section, i.e. section 4.2., will then focus on the geographies of scientific knowledge production (see Livingstone 2003), taking into account the particular spaces and places of upstream public engagement research. Thereby, we shall take a closer look at specific technopolitical cultures, i.e. the (nationally) distinct ways in which technological innovation, political processes, and societal values are intertwined (see Felt and Müller 2011), as well as at concrete local arrangements, i.e. the immediate research environment in which a project is situated, reflecting on how such spatial configurations may impinge on and set a frame for the planning and conduct of actual research. Ultimately, the section will contest the widely accepted idea that science is above culture, demonstrating how particular historical and geographical circumstances may condition discursive space, defining, in a conflation of location and locution, what can be said and what cannot, thereby facilitating certain types of research while impeding others.

Finally, in section 4.3., we shall focus more directly on the specificities of upstream public engagement research, examining closely the theoretical and methodological frameworks employed by scholars who engage in this particular kind of public outreach. Thus, on the one hand, we shall investigate researchers' epistemic cultures (see Knorr-Cetina 1999), i.e. their shared systems of belief, assumptions, and ideologies, as well as, on the other hand, their methodological tools which are meant to put greater emphasis on (lay) citizens' sociotechnical imaginaries. It will be the aim of this section to illustrate empirically that if the call for a more socially inclusive governance of science and technology is ever to be taken seriously, it must be accompanied by a thorough theoretical reconceptualization of the relationship between science, technology, and society, as well as by novel methodologies which should, if not downright replace, then at least serve as a significant supplement and counterbalance to traditional forms of top-town information dissemination.

All in all, the empirical investigations will seek to provide an extensive, though by no means comprehensive, overview of the resources, structures, and strategies that are necessary to conduct upstream public engagement research. What will furthermore tie the three sections together is the sense that science does not constitute a strictly formal, logic-driven phenomenon, a purely rational endeavor that inevitably progresses towards truth,

but, rather, a social activity that is situated and context-dependent, shaped by political agendas and marked by distinct epistemologies and ideologies. Thus, the subsequent explorations will draw on the intellectual heritage of some of the key texts of the sociology of scientific knowledge (SSK) (e.g. see Bloor 1976; Collins 1982) as well as the so-called laboratory studies (e.g. see Latour and Woolgar 1986 [1979]; Knorr-Cetina 1981), using their insights to give an impression of the current state of qualitative social science research in the field of nanoscience and nanotechnology. Yet, before engaging in the empirical analysis, I shall provide some more detail on the adopted research approach.

3. Material, Methods, and Theoretical Considerations

In order to provide well-grounded answers to the questions outlined above, the empirical deliberations will draw on case studies of three qualitative social science and/or humanities-based research projects that sought to facilitate upstream public engagement in and around new and emerging technologies – more specifically, nanotechnology – demonstrating in practice how a more open, egalitarian debate on issues of science and technology might actually look like. The projects examined were the Arizona-based NanoFutures project, the Durham-coordinated DEEPEN project, and the Bergen-led TECHNOLIFE project. Let us briefly consider each of them in turn:

The NanoFutures project was initiated by the NSF-funded Center for Nanotechnology in Society at the Arizona State University (CNS-ASU) and sought to develop "plausible visions of nanotechnology-enabled futures" in order to instigate deliberation on the "social implications of an emergent technology whose outcomes are not known." (Selin 2011, 723) The project consisted of three phases: A "development" phase in which project members aimed at creating a collection of "naïve product descriptions", i.e. short vignettes that would "neutrally" describe Nano-enabled products of the future that were "technically valid, accessible, and thought provoking" (Bennett 2008, 150); a "vetting" phase where selected scientists and engineers would evaluate the scenes for "plausibility, timeliness, and relevance" (Selin 2011, 728); as well as a "deliberation" phase in which the product description were shown to a broad variety of stakeholders – from social scientists over interested individuals to members of non-governmental organizations – assisting them in "develop[ing] their own visions of the future" (Bennett 2008, 154). In terms of upstream public engagement, it was the latter deliberative component that was most important, as it sought to "[create] a space of reflection" where participants could "assess and assign values to the technical scenes generated by the project." (Selin 2011, 730) To do so, the researchers set up a website featuring (a) a wiki platform that would allow users to 'flesh out' the product descriptions into full-fledged scenarios by adding "social context and complexity" (ibid. 731), and (b) a discussion forum where participants were "invited to critique the scenes and […] address issues of governance, control, ethics, religion, and cultural, economic and legal change." (ibid., 730) On a more general level, the objectives of the deliberation phase of the NanoFutures project were twofold: For one, the researchers aspired to "create clear thinking around the social implications of nanotechnology and, as such, to open the future to critical reflection." (ibid. 731) Beyond that, however, they were also interested in examining "how different communities assess plausibility", "maintain

different epistemologies", and thus have "different standards […] and different ideas about governance, ethics, and desirability." (ibid., 730-732) In that sense, even though phases one and two of the project followed a somewhat realist mode of thinking – seeking to create "neutral" product descriptions that would then be evaluated by scientists with "relevant expertise" – the NanoFutures project ultimately embraced a constructivist, (upstream) deliberation-oriented perspective, laying emphasis on (lay) citizens' narratives and encouraging a critical (re)assessment of already "vetted" technoscientific visions.

The second project under consideration was the DEEPEN[10] project, which was funded by the Sixth European Framework Programme (FP6) and coordinated by the Institute for Hazard and Risk Research (IHRR) at Durham University (UK) in collaboration with partners from Germany (Darmstadt University of Technology), the Netherlands (University of Twente), and Portugal (Centre for Social Studies at the University of Coimbra). DEEPEN was conceptualized as a three-year project and ran from October 2006 to September 2009. Beyond the overarching goal of "deepen[ing] understanding of ethical issues associated with nanotechnologies" (Davies et al. 2009, 3), the project's interests were twofold: First, on a scientific level, the DEEPEN researchers were most interested in unraveling "the 'lay ethics' and values that diverse European public use to understand and make sense of emerging nanotechnologies" (ibid., 12), i.e. to capture the "content and context of lay hopes and concerns" (ibid., 3) so as to "uncover in more detail the ways in which public responses to nanotechnology develop and are resourced." (Macnaghten et al. 2010, 17) More precisely, they sought to investigate the "deeply rooted cultural narratives" (Davies et al. 2009, 21) which "operate as storylines that enable lay publics to understand the cultural meaning of developments in nanotechnology" (ibid., 39) and provide "foundation and strength to a more broadly applicable type of imagination." (ibid., 18) In order to access these "tacit narratives" (Davies et al. 2009, 20), the researchers hosted a number of discussion groups in Portugal and the United Kingdom. The UK-based discussions – which for practical reasons[11] were more central to this thesis – involved six groups of six to eight participants, lasted approximately three hours, and included extended debate around stimulus material, i.e. posters with Nano-related images and newspapers snippets (see DEEPEN 2008), that would "[introduce] nanotechnology and the visions around it." (MacNaghten et al. 2010, 17) Upon analysis of the discussions, the researchers identified five key cultural narratives – from "be careful what you wish for" over "opening Pandora's box" to "the rich get richer and the poor

[10] The name "DEEPEN" is short for "Deepening Ethical Engagement and Participation in Emerging Nanotechnologies".
[11] Interviews were only conducted with members of the UK-based DEEPEN research team.

get poorer" (see Davies et al. 2009, 18-19) – claiming that these deeply rooted "mythic tropes" would help shed light on "laypeople's excitements and anxieties about nanotechnology", showing up the ways "in which responses to the technology are created and maintained" while fundamentally challenging the Enlightenment assumption that "technological progress will inevitably lead to social betterment" (ibid.). The second major concern of the DEEPEN team was then to translate their research findings into concrete public policy recommendations, seeking to bridge the gap between the world of science and the realm of policy making. Amongst other suggestions, the team emphasized the need for innovative methods of engagement in order to "understand the complexity of public 'attitudes'" (ibid., 21), urged a "return of 'ethical concerns' to the sphere of politics" (ibid., 37-38), as well as advised a thorough "reconfiguration" of the concept behind the notion of "responsible development" (ibid., 38-39).[12] Ultimately, such measures were supposed to support a shift of governance "from reactive [and risk-based, GR] to integrative forms of innovation management." (ibid., 27) Thus, the DEEPEN project followed an upstream agenda not only by carrying out adequately designed scientific investigations, i.e. by hosting a series of lay imagination-centered discussion groups, but also by seeking to communicate practical policy recommendations to public governance authorities.

The third and final project examined was the TECHNOLIFE[13] project, which was funded by the Seventh European Framework Programme (FP7), ran for 33 months from March 2009 to November 2011, and was hosted by the Centre for the Study of the Sciences and the Humanities at the University of Bergen in collaboration with the University of Manchester, the University of Tartu, the University of Copenhagen, Cardiff University, Lancaster University, the European Commission's Join Research Centre (JRC), the Autonomous University of Barcelona, as well as the University of Versailles Saint-Quentin-en-Yvelines. In essence, the project sought to "develop new frameworks for the early identification, characterization and deliberation upon ethical issues arising from a broad range of information and communication technologies (ICTs), including their convergence with other scientific and technological fields (such as bio-nano)." (TECHNOLIFE 2012, 3) In order to reach this objective, the research team devised a comprehensive methodology that

[12] I shall comment on some of these suggestions – and their politics – in more detail throughout the upcoming empirical sections.

[13] The abbreviation "TECHNOLIFE" derives from the project title "a *T*ransdisciplinary approach to the *E*merging *CH*allenges of *NO*vel technologies: *L*ifeworld and *I*maginaries in *F*oresight and *E*thics".

would (a) define "hot topics" in relation to specific technological fields[14] (e.g. see Delgado et al. 2011); (b) involve an online deliberative exercise in which citizens and stakeholders discuss these topics; (c) include an online voting system that allows for quantitative analysis of results; as well as (d) encompass a qualitative analysis that identifies arguments, concerns, imaginaries, and alternative frames of understanding (see TECHNOLIFE 2012, 2).
In this setup, the online discussion fora were of particular importance as they were supposed to provide a platform for "voices 'out there' wanting to be heard but not getting through the official filters" (ibid., 16), providing valuable empirical data that could eventually be used to "improve existing conceptual frameworks and procedures for implementing and representing the social needs and interests of citizens at early stages of policy-making and research." (ibid., 3) In order to stimulate debate and provide common points of reference, the research team created three 3-4 minutes long, science fiction-inspired movie clips[15], which addressed the issues of concern[16] in a "provocative" manner, hoping to serve as an "opening challenge" that would "connect and engage […] at an emotional level" (ibid., 17), sparking citizens' imagination and fostering "the generation of legitimate but excluded world-views as they assemble around emerging issues." (ibid., 16) Based on the analysis of these virtual, forum-based interactions, the TECHNOLIFE researchers formulated a number of policy recommendations that, not unlike the DEEPEN project, addressed the pivotal question of what it actually means to strive for responsible research and innovation (see ibid., 28), suggesting that in order to take a proactive stance and counteract a further alienation between citizens and government, participation and dialogue should "permeate [the] governance of science and technology at all levels" as an "inherent and integral dimension and not [as] an 'add-on' through the occasional participatory exercise." (ibid., 31) Consequently, matters of "social justice, equality and power ought to be contemplated and discussed upstream, already at early stages of R&I, not only on high moral grounds but also on realist and consequentialist terms." (ibid., 30)

The three projects outlined above were chosen for several reasons: First and foremost, they all committed to an upstream agenda – i.e. the idea that questions relating to the governance of science and technology ought to be discussed from the bottom up rather than decided from the top down – a particular quality that is crucial in the context of this thesis. Second, all three projects were – directly or indirectly (see sections 4.1.1. and

[14] Those fields were ICTs and the changing configurations of public and private; geographical imaging systems and environmental conflict; as well as converging technologies and the future of the human body (see TECHNOLIFE 2012, 2).
[15] The clips can be watched on the TECHNOLIFE website at http://technolife.no/short_movies/.
[16] See footnote 14.

4.2.2.) – funded by a major funding organization, i.e. the NSF (NanoFutures) or the European Commission (DEEPEN, TECHNOLIFE), which means that they successfully conducted upstream-oriented research under the auspices of agencies that, according to many policy documents (see chapter 1.), usually adhere to more downstream-oriented governance directives. Third, the projects were all coordinated by and/or involved the collaboration of leading research institutions (see above) and hence do not represent just any random undertaking but key research endeavors of some of the pivotal players in the field. Fourth and finally, the three projects were also chosen for pragmatic reasons, i.e. they were accessible in terms of documentation and project deliverables and the participating researchers were available and approachable during the assessment phase.

In terms of data collection/generation, the projects were approached in three distinct ways, in a combination of qualitative and quantitative research strategies:

First, in order to get a general impression of the structure, intentions, and arguments of the projects and sensitize myself to possible lines of inquiry, I performed a close reading of the projects' written output, including their key deliverables, the final reports, but also additional project-related articles that had been published in peer-reviewed journals as well as materials provided on the websites of the projects. In essence, the goal was to develop a better sense for how these projects were constructed, how they operated, their core beliefs, agendas, and imaginaries, what messages they sought to convey, as well as the assumed implications of those messages. That said, it is important to recognize that these initial assessments were not supposed to provide a comprehensive overview or in-depth analysis, but rather should be conceived as a first approximation to the researched projects' "world[s] of meanings" (Given 2008, 812) that would serve as a starting point for further investigations.

The second way of approaching the projects was by conducting a software-facilitated quantitative assessment of the textual resources mentioned above (i.e. the projects' key deliverables and journal articles as well as certain texts taken from the websites of the projects). More precisely, I (a) produced word frequency lists to filter out the keywords of the documents, (b) created word-document matrices that would allow me to perform a co-word analysis of the input material, (c) used the visualization software Pajek[17] to generate co-occurrence maps based on these datasets, and (d) employed factor analytic techniques (SPSS) to carve out the latent semantic structures of the documents under

[17] See Pajek website at http://pajek.imfm.si/doku.php.

consideration, the result of which can be considered a quantitative form of content analysis.[18] The created maps[19] were instructive in several ways, revealing not only the semantic layout of each of the projects – i.e. keywords (vertices), their relative frequency (size of vertices), as well as their position and entrenchment within the network (connections between vertices, visualized using the force-based Kamada-Kawai algorithm) – but also indicating overlaps between them, thus depicting, on the one hand, the semantic patterns that are unique to a given project while, on the other hand, also highlighting cross-project commonalities. However, while this approach might already be considered a full-fledged meaning-producing practice in itself (see Leydesdorff and Welbers 2011), in the context of this thesis, it was mainly used as input and guidance for the third and most central method of data collection, that is, a series of interviews with the respective project researchers.

As stated, interviews constituted the primary source of data for the empirical research presented in this thesis. Altogether, I conducted ten interviews with researchers from all three projects under consideration: From the CNS-ASU community (NanoFutures), I interviewed Professor David Guston (in citations abbreviated as "DG"), Principal Investigator and Director of the Center for Nanotechnology in Society; Daniel Sarewitz ("DS"), Co-Principal Investigator and Associate Director of CNS-ASU as well as Co-Leader of RTTA 3: Deliberation and Participation; Assistant Research Professor Cynthia Selin ("CS"), Leader of RTTA 3/1: Scenario Development; and Affiliated Staff Member Ira Bennett ("IB"), who was in particular involved in the "development" and "vetting" phases of the project (see above).[20] Regarding the DEEPEN project, I conducted interviews with Project Coordinator Professor Phil Macnaghten ("PM") as well as Co-Investigators Dr. Matthew Kearnes ("MK") and Dr. Sarah Davies ("SD"), all of whom were members of DEEPEN's Durham-based research group. Concerning TECHNOLIFE, I was able to arrange interviews with Dr. Kjetil Rommetveit ("KR I" and "KR II"[21]) and Dr. Ana Delgado ("AD"), who had both participated in the project as post-doc researchers. Last but not least, I interviewed Professor Arie Rip ("AR"), who had also been a member of the DEEPEN consortium (Twente research group), but with whom I

[18] For a step-by-step manual of this process, see Vlieger and Leydesdorff 2010; for a more theoretical reflection, see Leydesdorff and Welbers 2011.

[19] One such map has been included in the annex of this thesis.

[20] All listed academic titles and functions have been taken from the NanoFutures website at the time of the interviews, accessible at http://web.archive.org/web/20110813192440/http://cns.asu.edu/about/people/. The positions of some of these scholars have changed in the meanwhile, see http://cns.asu.edu/people.

[21] I interviewed Dr. Rommetveit on two consecutive days. As such an extended break between sessions might allow for processes of reflection and reconsideration in both interviewee and interviewer, the interviews are cited as separate.

primarily spoke about the history and significance of Constructive Technology Assessment (CTA) in Europe and abroad, as well as his estimates concerning the future of the Society for the Study of Nanoscience and Emerging Technologies (S.NET), in hopes of gaining a better understanding of the field, its structures and politics.

The interviews were conducted between November 2011 and July 2012, lasted between approximately thirty minutes and two hours (with an average of one hour and fifteen minutes), and were carried out in a semi-structured way, as this particular format enables researchers to focus on a predefined set of questions in a systematic and targeted manner while still maintaining a certain openness, allowing for exploratory 'probing', the acquisition of more in-depth accounts through follow-up questions, as well as the spontaneous addressing of matters of concern that seem important to the interviewee. The questionnaires used during the interviews were similar with respect to a number of overarching questions, but were also appropriated – based on the information gathered from the documentary analysis and the semantic mapping approach (see above) – to each individual project as well as to the specific function of the respective interviewee (e.g. I would not pose the exact same questions to a researcher who had mainly been engaged in scenario writing as to the director of the research institution who, presumably, was only peripherally involved in the nitty-gritty of everyday research). Most interviews were conducted face to face, which was made possible by travel grants provided by the Department of Science and Technology Studies, Vienna, with only the DEEPEN-related interviews being conducted via the voice-over-IP service Skype[22].

On a more theoretical note, the interviews might be classified as a mixture of what Bogner and Menz (2009) have labeled (a) exploratory, (b) systematizing, and (c) theory-generating expert interviews, thus simultaneously serving (a) as a way "to establish an initial orientation in a field" (ibid., 46), in this case in the field of qualitative social science Nano research; (b) as a means of "gaining access to exclusive knowledge" (ibid.), in this case with respect to the three research projects under consideration; as well as (c) as a possibility to investigate "subjective action orientations and implicit decision making maxims of experts" (ibid., 48), in this case the maxims and agendas inscribed in what I will propose to call the upstream epistemology (section 4.3.1.) and the three projects' technologies of imagination (section 4.3.2.). In that sense, the interviews functioned as potent tools of data generation, providing not only basic guidance and insight into technical details, but also shedding light

[22] Skype interviews have become increasingly common in social science research. For a brief account of this development and its practical implications, see Hanna 2012.

on the assumptions and beliefs, the imaginaries, concepts, and ideologies 'behind' NanoFutures, DEEPEN, and TECHNOLIFE.

Finally, it seems pertinent to point out that the interviews were conducted with scholars who essentially specialize in the same field as the interviewer and author of these lines – after all, the thesis at hand seeks to provide technoscience-related qualitative social science research on, well, technoscience-related qualitative social science research. This intellectual proximity facilitated the interactions in multiple ways, but also created certain difficulties: On the upside, it made it relatively easy to connect with the researchers as they had few reservations and could simply be approached at jointly attended conferences. Also, given the abundance of shared concepts and ideas, it was not difficult to establish a productive interview climate marked by mutual understanding and interest. On the downside, however, it was exactly this familiarity with the field, its key concepts and beliefs, that made it particularly challenging to resist the lure of the offered narratives and maintain analytic distance. More than once I found myself guilty of what Latour and Woolgar (1986 [1979]) have called the "dangers of going native", thus remaining silent when I should have probed deeper, accepting certain ready-made conceptions all too willingly. What helped me to alleviate some of those problems were the relatively long intervals between the interviews – sometimes up to several weeks – giving me time to (re)gain a critical perspective, carefully reflect upon certain shortcomings, and prepare for the upcoming interviews accordingly. The result of this process of continuous reassessment was that the focus of the interviews gradually shifted, from the initial, positivist idea of 'getting the details right' to a more constructivist approach that sought to capture researchers' in-depth reflections and fathom the discursive, cultural, epistemological and methodological resources that constituted the very foundations of the three projects under consideration. It will ultimately remain for the reader to decide whether this endeavor proved successful.

All in all, the three approaches to the accumulation of primary data provided a rich basis for the empirical investigations presented in this thesis. They were complemented by an extensive review of secondary data sources, including key policy documents, related scientific publications, as well as a number of deliverables from similar research projects. Which leads to a final method-related question: How were the data analyzed?

In the main, the process of data analysis was guided by the basic principles and analytic strategies of the grounded theory approach, first articulated by Glaser and Strauss (2006 [1967]). Consequently, the interview material was fully transcribed, coded using the

qualitative research software ATLAS.ti, subjected to theoretical sampling in order to collect more "pertinent data" (Charmaz 2006, 96), as well as continuously tested and reassessed, following Glaser and Strauss' "constant comparative method" (2006 [1967], 101-117). The grounded theory approach was chosen for several reasons: For starters, grounded theory asks the researcher to develop hypotheses inductively from the gathered data, thus advocating a bottom-up approach to theory generation that nicely fits the exploratory nature of this study. Moreover, the concept allows for the combination of different kinds of data – see Barney Glaser's well-known dictum "all is data" (Glaser 2001) – which is particularly relevant as the thesis at hand draws upon multiple data sources, from interviews over various project deliverables and journal articles to semantic maps. Finally, more recent work on grounded theory has stressed the need to "push grounded theorists to consider seriously the various contexts of their research focus and to portray how contextual elements 'condition' the action that is the central analytic focus" (Clarke 2005, XXXV), thus indulging the idea that in order to develop a truly 'grounded' theory of a particular phenomenon, situational and social contexts must be taken into account. The empirical investigations presented in the following chapter intend to take this call for increased situation awareness seriously, the result of which can best be seen in section 4.1., where we shall consider the intricacies of funding with respect to current policy environments, as well as in section 4.2., where the geographies of science – and their local and (trans)national politics – will be of primary interest. Ultimately, the grounded theory-informed assessments were not supposed to deliver straightforward explanations but, rather, to allow for reasonably saturated descriptive accounts based on theoretical sensitive coding and thorough immersion in the collected empirical material.

Despite the general commitment to grounded theory and inductive reasoning, the empirical investigations were also informed by more specific theoretical frameworks, which served as conceptual leitmotifs throughout the individual sections: While section 4.1. – The Intricacies of Funding or: A Game of Coin – relates to classic laboratory studies literature (e.g. Latour 1984; 1987; Latour and Woolgar 1986 [1979]) and provides a somewhat Machiavellian account of science that markedly differs from the Mertonian ethos of science (Merton 1942), section 4.2. – The Geographies of Science: On Spaces and Places – hinges upon Livingstone's (2003) account of the *geographies of scientific knowledge* as well as Felt and co-authors' notion of *technopolitical cultures* (see Felt et al. 2010; Felt and Müller 2011), highlighting the significance of space and place in the conduct of upstream engagement research. Section 4.3. – Making Futures Public: The Upstream Epistemology and

Technologies of Imagination – then draws on Knorr-Cetina's (1999) work on *epistemic cultures* and Haas' (1992) concept of *epistemic communities* as theoretical underpinnings for what I will call the upstream epistemology. The section also embraces Felt and co-authors' (2013b) notion of *technologies of imagination* as a common conceptual framework for the three projects' upstream engagement methodologies.

On a more general level, the empirical investigations were inspired by some of the pivotal texts of constructivist science studies research (e.g. Mol 2002; Law 2004), but also, and in particular, by Jasanoff's (2005) call for comparative analysis as "a means of investigating the interactions between science and politics" (ibid., 15). According to Jasanoff, comparisons among national and regional debates – in this case regarding public engagement and the governance of science and technology – allow us to "explore the links among knowledge, technology and power within contemporary industrial democracies" (ibid.), shedding light on the "civic epistemologies of modern nation states" (ibid.) and helping us to "decide which courses of action we wish to follow, as individuals or as political communities." (ibid., 14) By providing in-depth examinations of three projects situated in distinctive (techno)political cultures and focusing on both similarities and differences, the following analysis seeks to realize such a "comparative optics" (Knorr-Cetina 1999) as "a framework for seeing" (ibd., 4), offering rich accounts of the current state of affairs in S&T-related policy making. Now, without further ado, we shall commence this empirical expedition, starting off with one of the most mundane of all topics: Funding and the politics of its acquisition.

4. Empirical Investigations

4.1. The Intricacies of Funding or: A Game of Coin

As Latour and others have argued in their studies on laboratory life (Latour and Woolgar 1986 [1979]; Latour 1987), the production of scientific knowledge is an expensive undertaking. This most certainly applies to the natural sciences, where elaborate instruments enable the translation of material phenomena into numbers, graphs, and other visual representations, but also holds true for the social sciences, where, amongst other things, salaries must be paid, workshops organized, and conferences attended. To state it bluntly, without proper funding, none of the examined research projects could have unfolded the way they did; most likely, they would not have materialized at all. Hence, the first crucial pillar, the first indispensable resource when it comes to the realization of social science-moderated bottom-up engagement with technoscientific futures is the securing of monetary funds. But in a time where financial resources are said to be scarce (EC 2011a), where science is mainly seen as an engine for economic growth, international competitiveness, and an innovation-friendly marketplace (NSF 2006; 2011; EC 2007; 2011), and where publics are still all too often depicted as empty vessels in need of being informed and educated about the merits of scientific advancement (EC 2004b; NSF 2005), how can research projects that do not readily subscribe to such normative agendas hope to obtain the necessary grants for the exploration and elaboration of alternative, potentially agenda-opposing perspectives? Moreover, in an age of uncertainty, crises, and post-normal science (Funtowicz and Ravetz 1993), where there appears to be an increasing demand for social scientific expertise (United Nations Educational, Scientific and Cultural Organization 2010) preferentially served as neatly arranged recommendations best backed by quantitative survey data (Special Eurobarometer 2001; 2005; 2010a; 2010b), how can qualitative public engagement initiatives that strive for complexity and ambiguity rather than clear-cut answers, for thick descriptions rather than straightforward explanations, stand their ground and ensure their financial survival? To say it up front: It is a difficult undertaking that requires a lot of tact and tactics, prudence and persistence, as well as a general willingness to negotiate and a readiness to compromise. Following, I shall touch upon three funding-related narratives that exhibited considerable consistency across the interview data. More precisely, I will point towards the necessity of *finding an opening*, the intricacies of *maintaining intellectual authenticity*, as well as the difficulties of *ensuring continued*

existence over longer periods of time. However, before expounding on these three narratives in more detail, a brief overview of the projects' main funding conditions shall be provided.

Of the three projects considered, two received funding by the European Commission's *Framework Programme for Research and Technological Development* [23] (DEEPEN, TECHNOLIFE), whereas the other one, NanoFutures, was financed as part of a larger grant issued by the National Science Foundation (NSF). Now, while both funding agencies belong to the most potent government grant initiatives in their parts of the globe – that being Europe and the United States – they adhere to somewhat different philosophies: While Framework Programmes usually distribute funds to individual research projects that answer to specific calls[24], the NSF, ever since the late 1980s, has started to promote center-based funding by allocating considerable resources to a fairly limited number of selected research facilities (see Gaughan and Bozeman 2002). And while traditional, small-scale grants remain central to U.S. federal support of academia, the move towards larger-scale center funding has emerged as a significant trend over the course of the past two decades. The palpable differences between these two financing models are reflected in the projects at hand: Whereas DEEPEN and TECHNOLIFE were funded as stand-alone projects and received grants of EUR 894 226 for three years (DEEPEN) and EUR 809 343 for roughly two and a half years (TECHNOLIFE)[25], NanoFutures was integrated into a larger research program carried out at Arizona State University's Center for Nanotechnology in Society, which had been created in 2005 with a $6.2 million NSF grant that was eventually renewed in 2010.[26] To put this in perspective: NanoFutures was but one of four projects running in the RTTA 3 research line[27],

[23] The project DEEPEN was funded under the *6th Framework Programme*, which ran from 2002 until 2006. TECHNOLIFE was part of the *7th Framework Programme*, which started in 2007 and will continue to run until 2013, before being superseded by the *Horizon 2020* initiative in 2014.

[24] Over the course of each multi-annual Framework Programme an extensive number of calls for research proposals are being published, each related to a specific research area and budget line. For instance, the DEEPEN project was located in the research area "Ethics Research" of the budget line "Science and Society", while TECHNOLIFE was situated in the research area "Ethics and New and Emerging Fields of Science and Technology" of the program line "Science in Society" (for more information on the switch from "science *and* society" to "science *in* society" consult Sterling 2006 or EC 2009a).

[25] For the official entry of the DEEPEN project on CORDIS (Community Research and Development Information Service), see http://cordis.europa.eu/projects/rcn/84695_en.html; for TECHNOLIFE, see http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=10603514.

[26] For information on CNS-ASU, see http://cns.asu.edu/about/; a more recent bulletin on the renewal of the grant can be found at http://www.nsf.gov/news/news_summ.jsp?cntn_id=117862.

[27] "RTTA" is short for "real-time technology assessment", CNS-ASU's cardinal theoretical approach that is meant to integrate "social science and policy research with natural science and engineering

which was in turn accompanied by three other RTTA programs – RTTA 1, 2, and 4 – as well as two thematic research clusters (TRCs). Thus, while the entire CNS-ASU network is undoubtedly much larger and better funded than either DEEPEN or TECHNOLIFE were, the particular project under consideration, i.e. NanoFutures, was considerably smaller-scale than its European counterparts. However, while it would be intriguing to investigate how these different funding conditions eventually impinged on the projects' intellectual output, at this point we shall turn towards a more basic question: Considering that all three projects employed methodological frameworks that – in terms of capturing public imaginaries – went well beyond the usual opinion polls, risk versus benefit assessments, and expert-centered consensus exercises, thereby potentially calling into question some of the funding agencies' core assumptions (see above), how was it possible to obtain funding while at the same time preserving the projects' intellectual integrity? As mentioned, throughout the interviews, three narratives emerged as most prevalent. Let's consider them one by one.

4.1.1. Finding an Opening

For starters, the interviewees repeatedly referred to what might best be described as the task of *finding an opening*. In essence, this narrative suggests that against the background of the current financial crisis, in which science and scientific innovation is largely seen as a key to economic recovery, the widespread utilization of the deficit model, where uninformed publics are meant to be educated about scientific 'facts', as well as the increasing demand for policy recommendations, the funding of projects that seek to walk a different path – for example by concentrating on public imaginaries and going beyond perfunctory attempts to upstream engagement – has become ever difficult. Consequently, in order to ensure such a project's financial viability, a certain flair for funding opportunities appears to be vital. But how exactly might such an opening look like? As a matter of fact, the interview material suggests that it can take quite different forms:

At the highest level, an opening can be rooted in the policy documents of a large-scale research agenda, such as the 21st Century Nanotechnology Research and Development Act (U.S. Government Printing Office 2003), which provided the argumentative background for the CNS-ASU grant proposal (see Guston 2010a; 2010b). Among other things, the Act calls for the establishment of a "research program to identify ethical, legal, environmental,

---

investigations" for "observing, critiquing, and influencing social values as they become embedded in innovations" (Guston and Sarewitz 2002, 2).

and other appropriate societal concerns related to nanotechnology", as well as "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 […]." (ibid., 117)[28] Ultimately, such high-level policy documents might impinge on the nitty-gritty of a grant-awarding process, as their visions and directives set a course and inform decision making further down the line. For instance, with regard to the case at hand, the Act authorized the National Nanotechnology Initiative (NNI), i.e. the very initiative that now finances the CNS-ASU complex, and played a decisive role in the negotiations between the NSF and the prospective members of the CNS community. As David Guston, director of the Center for Nanotechnology in Society, puts it:

> "The Act provided the background for both NSF's request for proposals for a 'Center for Nanotechnology in Society' – which was issued in 2004 – as well as for the response to that request from Arizona State University. Indeed, ASU's proposal specifically invoked the legislation and designed its approach to address the congressional interest in public engagement with nano-scale science and engineering […]." (Guston 2010b, 432-433)

Thus, in the case of CNS-ASU in general and the NanoFutures project in particular, the congressional commitment to public engagement provided an opening, a certain space of possibility that was – at least at this scale – relatively new to the U.S. governance of emerging technologies.[29]

However, apart from such top-level research agendas, openings might also be found in concrete funding programs, such as the 7th Framework Programme's Science in Society action line, which concedes that it is "not enough to simply inform the public about scientific advances", but that "organizing the debate on scientific choices, priorities and implications for society is fundamental to research policy." (EC unspecified) Just as the research act, such a declaration constitutes an opening, an official commitment to a certain research focus. Yet, in this case, the linkage between proclaimed intent and the actual funding is much more immediate, as FP7, over its roughly seven-year duration, distributes a total of EUR 8.1 billion, whereby the Science in Society action line accounts for some EUR 330 million.[30] Hence, at least financially, the statement represents more than a mere lip service. In fact, it denotes a general preparedness to support research on the public perception of science and

[28] For a more detailed assessment of the Act and its legislative considerations, see Fisher and Mahajan (2006).

[29] For possible reasons as to why such an opening emerged in the first place, see Fisher and Mahajan (2006).

[30] For a corroboration of these numbers, see the European Commission's FP7 website at http://ec.europa.eu/research/fp7/index_en.cfm and the CORDIS Science in Society website under http://cordis.europa.eu/fp7/sis/about-sis_en.html.

technology with considerable funds. Still, a closer look into the work program's guidelines reveals traces of the Commission's usual framings, from science's function as a driver of innovation and prosperity, over a presumed lack of public understanding of science, to a continuing orientation towards risk and benefit assessments.[31] Moreover, a glance at some of the funded projects indicates that a mere declaration alone says very little about the actual quality of the research being conducted. Nevertheless, despite all intellectual limitations, the EC's Science in Society action line demarcates a funding space which endorses a type of research that is often treated as secondary and dispensable, thus representing a potential opening for alternative perspectives and out-of-the-ordinary methodologies.

Thus far, I have pointed towards openings that are either located at a very high level, i.e. embedded in government policy documents, or at a more intermediate stage, i.e. inscribed in the objectives of particular funding programs. Yet, in order to get the ruble rolling, another type of opening is needed: for a research project to really take off, it must first find a thematically suitable call for proposals. In the case of the European Framework Programmes, such calls are legion; but as individual calls are only open for a limited period of time, the call system ultimately determines when a particular research endeavor has a realistic chance of getting funded.[32] Thus, calls represent openings at a very practical level: Only if there is a thematically matching one available does it make sense to apply for funding. If there is no such call around, there simply is nothing to apply to. Hence, when it comes to matters of funding, timing is crucial. Having the 'right' project at the wrong moment might jeopardize all fund-seeking efforts.

Now, apart from such issues of timing, individual calls may look quite different. For instance, they might be formulated rather openly, thus allowing for a fair amount of intellectual and creative authenticity. Then again, calls might be drafted in a pointed and instructing manner, incorporating normative assumptions and outlining narrow paths of how the research ought to be conducted.[33] It should come as no surprise that research projects which are critical of some of the European Commission's preconceptions regarding the relationship between science and society usually prefer the former type of call to the latter. In fact, they are somewhat dependent upon the existence of such open calls, for only

[31] Examples for all three narratives can be found at the European Commission's Science in Society website under http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=1221.

[32] A list of currently open calls for the FP7 Science in Society action line can be found at http://ec.europa.eu/research/participants/portal/page/capacities#sis.

[33] For an overview of how such calls might look like, see the European Commission's Science in Society Work Programme 2013 (EC 2012).

under their aegis does it become possible to conduct the experimental and explorative research these projects favor. Consequently, both Framework projects examined for this thesis were backed by remarkably open calls, a fact the project partners seem to be well aware of. As one member of the TECHNOLIFE project stated:

> "At the same time, the call was quite open. So, in terms of what we were going to propose, I mean, it was an exceptionally open call. It was like they were saying: 'We need some good ideas. Please give us, please give us something.' So, I mean, we were a bit surprised that – and many others had been too – that because it was a quite experimental project, that this would be funded by the European Commission. But maybe it was a strike of luck." (KR, 11)

Indeed, the call this quote refers to reads like an invitation to wander into uncharted territory: It merely asks applicants to conduct research "on ethical issues for which no European or international guidelines exist" (EC 2008b, 11), proposes but does not prescribe two potential areas of interest – i.e. information and communication technologies as well as technologies in the field of security –, and makes no claim whatsoever regarding a preferred methodology. Thus, the call constitutes a plea for ideas and intellectual input rather than another case of streamlined top-down service research. Moreover, it represents an opening in that it grants intellectual freedom, allows for the creation of novel theoretical and methodological frameworks, and encourages out-of-the-box thinking. Without such calls, chances are that DEEPEN and TECHNOLIFE would never have become the projects they eventually grew into. [34]

All in all, this section has pointed out three loci where openings – and therewith funding opportunities – might occur: In government policy documents, in the work programs and guideline papers of concrete funding initiatives, as well as in the form of individual calls for research proposals. In practice, these three domains do not exist separately, but are highly interdependent: Without the dissemination of appropriate calls, high-level policy declarations would remain but mere lip service. Vice versa, without the necessary background documents, no such calls could be issued in the first place. What is most crucial to recognize, however, is that in order to secure funding, the ability to find and capitalize on such openings is absolutely vital, especially at a time where the window of opportunity for certain kinds of research has become increasingly narrow. In addition, even though all the

[34] For the original DEEPEN call, see 4.3.2.3(a) in EC (2006); for TECHNOLIFE, see SiS-2008-1.1.2.1 in EC (2008b).

projects examined in this thesis were eventually able to make the cut and obtain funding, one should not forget that for each approved project there are several that get rejected.[35]

Now, there is one final point to be made, and it is a rather crucial one: Up until this point, the impression was conveyed that funding is primarily a question of finding an opening. However, this notion of 'finding' is somewhat misleading as it suggests that funding opportunities are just 'out there' waiting to be seized. As matter of fact, they are not. Just as scientific facts, funding opportunities have to be *created*. They are not divine gifts from above, but represent the eventual result of oodles of formal and informal talks, negotiations, and networking. Let's briefly revisit the three levels of openings outlined above: Was the 21st Century Nanotechnology Research and Development Act's appeal to pay attention to the ethical, legal, and social aspects of nanotechnology a mere coincidence, serendipity in action, so to say? Was its commitment to public input and outreach work just a random concession to the social science community? No, it wasn't. It wasn't because the experiences with GM agriculture and nuclear power had made a lasting impression on U.S. policymakers (see Fisher and Mahajan 2006); because leading NSF pundits had started to point towards the potential social implications of nanotechnology early on (see Roco and Bainbridge 2001); and because social scientists had publicly cautioned authorities to initiate a nano-ethics program that was not sufficiently well integrated into research and development policy (see Winner 2003). Thus, the Act's commitment to ELSI research didn't 'just' happen. It occurred at a particular time for very particular reasons and marked the eventual outcome of a long-standing debate stirred not only but also by representatives of the social sciences and the humanities. The same holds true for the European Commission's Science in Society funding theme, as the language and imaginaries embedded in its program guidelines weren't the result of "spontaneous generation" (Aristotle 1883 [ca. 343 BC]; Latour 1989), but the product of an ongoing dialogue between members of the Commission and social science scholars. Documents such as Sterling's *From Science and Society to Science in Society* (2006), Felt and co-authors' *Taking European Knowledge Society Seriously* (2007), or the MASIS report (EC 2009a) serve as written evidence that the boundaries between the policy sphere and academia aren't quite as clear cut as one might expect. In fact, social scientists officiate as rapporteurs and expert advisors to the Commission, thus occupying a position that is not situated at the fringes of research policy, but at the very core. Of course, in the end, their influence might be limited and many of their ideas might not make it into the official program guidelines; nevertheless, there can be little doubt that those scholars do

[35] In fact, in a classical STS move, it would be interesting to take a closer look at some of those rejected projects and investigate the circumstances of their failure to get funded.

play a formative role by providing intellectual input and acting as a counterweight to some of the Commission's key assumptions. Something similar happens on the level of the individual calls for research proposals: For one, such calls are not issued by 'the European Commission', seen as an autopoietic system bereft of all human agency, but by individual people who are in constant contact with the field they are funding. Many of the Commission's employees maintain ties to representatives of the social sciences or the humanities; some of them even have a background in a related discipline – for example science and technology studies (STS) or philosophy – themselves. Thus, the stereotypical picture of politicians and bureaucrats, on the one side, and scientists, on the other, represents an oversimplification that is of little analytical value, for it paints in black and white what largely resides in shades of grey. Second, the interview material indicates that the publication of individual calls is often preceded by informal pre-application talks, wherein representatives of both sides seek to find common ground and evaluate what kind of research might be required at a certain point in time. Consequently, calls do not materialize in a vacuum, but get formulated in a social process, a dense intermingling of peoples, agendas, and specific technopolitical cultures. And even though they lack executive powers, scholars from the social sciences and humanities play an integral role in this process by actively participating in the shaping of the intellectual climate these calls derive from.

In sum, we should refrain from the idea that funding opportunities are just 'out there' waiting to be found. Rather, such openings must be created and maintained, debated, defended, and constantly (re)negotiated. This does not mean that there might not be individual projects that stumble upon suitable calls and get funded right away; however, the empirical data suggests that, in the present research environment, the adoption of a wait-and-see attitude often does not suffice. In order for funding opportunities to really open up, a lot of work, persistence, and a certain willingness to compromise is required. But the necessity to engage and bargain with the authorities actually goes much further than that. In fact, public policy counseling, the development of guideline recommendations for funding programs, as well as pre-application talks only constitute the early stages of a series of negotiations that further intensify as soon as a project proposal is being submitted. But let's see for ourselves.

4.1.2. Maintaining Intellectual Authenticity

As mentioned, funding initiatives in general – i.e. FP6, FP7, Horizon 2020 – as well as their particular action lines – i.e. the Science *and* Society action line of FP6 or the Science *in* Society work program of FP7 – are built around certain agendas, ideas, interests, imaginaries, and assumptions. These assumptions usually materialize in concrete policy documents that serve as intellectual guidelines for the respective funding schemes.[36] Before any misunderstandings arise: The assertion that funding programs are carriers of specific (political) agendas is by no means meant to imply that there is any malpractice or nefarious conspiracy at work. In particular in the case of large-scale funding initiatives, general visions and key objectives are usually communicated transparently and can be easily looked up by perusing the respective agency's online presence.[37] Nevertheless, in order to obtain funding, applicants must, in one way or another, relate to those narratives. Depending on the specificities of the particular grant program, this may involve more or less extensive concessions and compromises. Especially in the case of projects that wish to challenge predominant framings and promote alternative perspectives, the need to find common ground represents nothing less than a struggle to *maintain intellectual authenticity*. However, the empirical data suggests that in many cases the interaction between the funding agency and the grant applicant is not a one-sided, top-down arrangement, but rather a dialectic forth and back, a negotiation, in which the applicant attempts to elicit the funding agency's interest in the proposed research project, whereas the agency seeks to ensure that certain core objectives will be met. Following, I shall briefly outline some of the key strategies and tactics applicants employ in order to conduct their research without succumbing to the ideologies and rationales of governmental funding agency.

The first point largely concurs with what has been argued in the previous section: As the switch from science *and* society to science *in* society demonstrates (Sterling 2006; EC

[36] Documents detailing the key objectives of the FP6 Science and Society work program can be found under http://cordis.europa.eu/fp6/sp2_wp.htm; a breakdown of the FP7 Science in Society action line can be found under http://ec.europa.eu/research/science-society/ and in the *Science in Society Leaflet* at ftp://ftp.cordis.europa.eu/pub/fp7/sis/docs/sis_en.pdf.

[37] For instance, essentials regarding *the 6th Framework Programme for Research and Technological Development* (*FP6*) can be found under http://cordis.europa.eu/fp6/whatisfp6.htm; the key objectives of *FP7* are condensed at http://ec.europa.eu/research/fp7/pdf/fp7-inbrief_en.pdf; and the *Horizon 2020* initiative is crudely outlined at http://ec.europa.eu/research/horizon2020/index_en.cfm, and more extensively under http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0808:FIN:en:PDF. Basics regarding the *National Science Foundation* (*NSF*) have been pooled at http://www.nsf.gov/about/, and the agency's strategic plan for the years 2011 to 2016 is accessible under http://www.nsf.gov/news/strategicplan/nsfstrategicplan_2011_2016.pdf.

2009a), (social) scientists themselves are at times very much involved in the *preparation and formulation of prospective research agendas*. They do not stand idly by and let policymakers decide on their own, but actively partake in the debates and negotiations that precede the adoption of any large-scale research policy doctrine. Moreover, informal pre-application talks as well as a continuous probing for potential discursive openings appear to be the norm rather than the exception. Even before a definite project proposal has been submitted, scholars champion their interests in hopes of contributing to a funding environment that will allow them to conduct their research without having to adhere to any predefined policy directives. Moreover, as the spectrum of possible research is being defined early on, any intellectual autonomy sacrificed at this stage might be difficult to regain later. Consequently, early involvement in research-related policy making seems crucial when it comes to the task of securing and maintaining academic authenticity.

A second set of strategies concerns the actual *process of grant application*. As argued, this process can essentially be understood as a dialectic forth and back, a negotiation, in which both sides seek to attain certain objectives. But how can applicants retain their scientific integrity and ensure that their research is not being compromised by high-level policy directives? In fact, a number of tactics seem to coexist: For starters, the interview material suggests that researchers do not simply 'answer' to calls for project proposals, but perceive these calls as potential openings that can be colonized and appropriated. Thus, rather than accepting top-down instructions and subscribing to service research, scholars attempt to *enroll* funding agencies by emphasizing the value and significance of their research and, in an interesting shift of perspective, convincing them that it is in their own best interest to approve the grant application (see Callon and Law 1982). In some cases, agencies can be easily persuaded, especially when they themselves are in need of input and new ideas (see the TECHNOLIFE quote in the previous section). However, as soon as the proposed research goes beyond the scope of the usual, becoming intellectually provocative and/or methodologically explorative, things might get tricky. In such cases, multiple application attempts may be required. Let's consider the following account from a CNS-ASU researcher:

> "We responded to the first request for proposals from National Science Foundation with two very ambitious proposals where we first laid out the RTTA agenda. […] And we got slammed in the NSF competition. I think because they had no idea, they were totally not expecting what we were doing and had no idea how to deal with it. The early group that got significant funding at University South Carolina, in some ways they were much more, you know, they were more successful at explaining what they were gonna do but also more conventional in that they were talking about

> communication of risk and philosophy of technology. And we were talking about something different […]." (DS, 3)

So, even though the applicants submitted "two very ambitious proposals", they failed to enroll the NSF, presumably because they suggested a research enterprise that was, at least by U.S. standards, unconventional and unexpected. As the interviewee stresses, the NSF simply "had no idea how to deal with it" and, instead, decided to fund a project that was based on an already well-established conceptual framework. Thus, the ASU-CNS proposal did not get "slammed in the competition" because of formal mistakes or because it's arguments were logically flawed or theoretically feeble; it got rejected because it did not succeed in communicating the purpose and potential value of the envisaged research endeavour and failed to put together a convincing enough package to persuade the NSF that it was worth taking a risk and exploring new grounds. However, after their initial setback, the researchers intensified their efforts, regrouped, and, as soon as the next round of calls for proposals was issued, applied again – this time with more success:

> "So, you know, a part of the process of failing in the first effort to get money was […] getting a chance to revive and do a better job, getting more time to put together the community, […]. And also, you know, getting to make our case over a longer period of time to the National Science Foundation, to people in Congress, just to the community in general, so that when the next big competition came along we were prepared, we were prepared to meet it with a very good proposal and they were prepared to accept it 'cause they understood what we were doing." (DS, 3)

As we can see, such acts of persuasion and enrollment may take considerable time and effort: From minor formal changes, over the sharpening and refinement of individual arguments and ideas, to the formulation of entirely new research agendas or the reinforcement of the project consortium, there are many possible ways of how a grant application can be reworked and transformed into a more convincing research proposal. Yet, one particularly crucial facet of this process is the growing need to frame research in terms of its applicability, societal relevance, and contribution to policy making. The proliferation of such an "economy of promises" has been critically discussed in a number of publications (Felt et al. 2007; Jones 2008; Felt and Fochler 2012) and remains one of the most pressing matters of concern in contemporary social studies of science and science policy. Needless to say that the project outlines and key deliverables of NanoFutures, TECHNOLIFE, and DEEPEN are packed with examples of such a promissory language, regardless of whether it pertains to the cultivation of "society's ability to govern the implications of its own ingenuity" (Selin and Hudson 2010, 174), the development of methodological frameworks able "to address

ethical concerns of Europeans"[38], or the conduct of "social research […] necessary to assist future governance, regulation and public appraisal of emerging nanotechnologies" (DEEPEN 2006, 14). However, researchers seem to have found ways to adapt to the necessities of such a promissory logic without losing sight of their own scientific priorities. In fact, they employ a number of tactics that allow them to maintain their intellectual focus while at the same time satisfying the funding agencies' demand for benefit-oriented research. For instance, even if scholars are willing to integrate a strong promissory language into their proposals, their visions and aspirations may differ significantly from those of their sponsors. For example, even though all of the examined projects took interest in the relationship between science and society and promised to provide valuable insights as to the conditions under which a more constructive dialogue could be achieved, none of them would iterate the widespread notion that the proclaimed lack of public trust *in* science roots in a public misunderstanding *of* scientific facts and could hence be countered by top-down information and education initiatives. Similarly, while scholars seem reluctant to embrace the pursuit of economic growth as an end in itself, they seem less hesitant to stress the potential economic benefits of a more socially inclusive mode of innovation governance. Thus, although scholars are increasingly required to operate within a matrix of promises, they do not simply adopt the policy objectives of funding agencies – in this case the National Science Foundation and the European Commission – but tailor and adjust them according to their own needs and preferences. What further facilitates this process is the relative indeterminacy of promissory statements. While project contracts may be rife with affirmations of applicability and societal relevance, these promises are often formulated in such a vague, indefinite manner that they allow for considerable leeway as to how they might be put into practice. After all, what does it actually mean to create "social engagement around anticipatory governance of nanotechnology"[39], or to "foster a climate of ethically sensitive R&D around potential nanotechnologies" (DEEPEN 2006, 14)? For researchers, the promissory culture appears to be a challenge as well as an opportunity: While the threat of an increasing commercialization of science seems imminent, skillfully handled, promises may serve as a convenient way of meeting funding agencies' expectations, while at the same maintaining a project's intellectual authenticity. Ultimately, the ability to deal in the currency of promises

[38] See TECHNOLIFE's CORDIS entry at: http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=10603514.

[39] Quote taken from the NanoFutures website which has been withdrawn from the Web but is still available at http://web.archive.org/web/20080612181559/http://cns.asu.edu/nanofutures/.

(Felt and Fochler 2012) constitutes but one of the competencies needed to enroll and uphold a funding agency's financial support – however, a very crucial one.

Third and finally, when it comes down to *matters of research*, scientists do not simply accept top-down narratives as they are presented; instead, they challenge and contest, deconstruct and reframe them. Put in actor-network terms: Scientists do not submissively *subscribe* to what they are presented with; quite on the contrary, they *de-scribe prescriptions* only to *re-inscribe* alternative narratives (see Akrich and Latour 1992). Sometimes this process of genuine reinterpretation takes place subtly and covertly, sometimes it does so outright and in explicit terms. Consider the following extract from an interview with a DEEPEN researcher:

> "If you look at the Commission 2004 document to nanotechnology, I think even in that document, they talk about the save and efficient and responsible development of nanotechnology. And 'responsible' technically is defined in a kind of a risk framework, you know, to make sure it's safe. And, again, we wanted to *shift the terms around* and so 'reconfiguring responsibility'."
> (PM, 7; emphasis GR)

What exactly does this quote refer to? In 2004, the European Commission published a communication called *Towards a European Strategy for Nanotechnology* (EC 2004b), in which the institution stressed the need to "ensure that R&D in nanotechnology is carried out in a responsible and transparent manner." (ibid. 19) Thereby, the notion of "responsibility" was conceptualized according to what has been identified as the "risk paradigm" (see Beck 1992; Giddens 1999), indicating a heightened awareness for matters of security and safety as well as a sensitivity to the ethical, legal, and social aspects (ELSA) of new and emerging technologies. As the EC's publication states: "Nanotechnology must be developed in a safe and responsible manner. Ethical principles must be adhered to and potential health, safety or environmental risks scientifically studied […]. Societal impacts need to be examined and taken into account." (EC 2004b, 3) In sharp contrast to this perspective, in their final project report *Reconfiguring Responsibility* (Davies et al. 2009), the DEEPEN researchers argued that it was time to move beyond "the banal calculations of 'risks vs. benefits'" (ibid. 37) and turn from "reactive forms of risk governance to more integrative forms of innovation governance", where "direct public participation and deliberation is to play a formative role." (ibid. 27) Thus, while subscribing to the language of responsibility as such, they criticized that the concept was still underdeveloped and accompanied by a narrow, unimaginative theoretical framework, i.e. the risk paradigm. Consequently, they sought to promote new ways of thinking about responsibility, stressing that "if responsible development is to succeed in opening up debate on nanotechnology, it needs to be substantially rethought."

(ibid. 6) To emphasize this point: Instead of accepting the notion of responsibility as it was outlined in the EU policy papers, the DEEPEN researchers stripped the term from its framings and proposed a thorough reconceptualization, a fundamental shift in perspective, attempting nothing less than to redirect the debate on responsibility and responsible innovation, following the credo: "If you wanna know what responsibility means […], come to us." (MK, 26) To the researchers of the DEEPEN project, the notion of responsibility provided an opening, a welcomed opportunity to insert a contrarian discourse into a well-established pattern of thinking. But even more so, the term presented a chance to connect to one of the EC's central concepts (see EC 2008a), to find common ground and initiate a meaningful conversation. Ultimately, it is through strategies such as this that scholarly projects may establish their intellectual independence. After all, researchers will always be required to take up certain cues from the funding authorities. If they refuse to do so, chances are the grant will be awarded to another applicant. For example, in the case of the DEEPEN project, receiving funding under the "Ethics" line of the "Responsible Research" funding scheme (EC 2006, 10) required a genuine willingness to adopt an ethical perspective and relate to the idea of responsible research and innovation. However, once that baseline is set, scholars may start to indulge in critical thinking, scrutinize certain imaginaries, and propose fresh perspectives. As one researcher told me after the official interview had ended: "If you can't agree to a call at all, don't do it." This seems about right. Yet, if there is some workable basis, there might indeed be a chance for researchers to engage and contribute in a way that is both acknowledged by the authorities as well as gratifying to academics who seek to push beyond the boundaries of low-level service research.

All in all, this section should have provided a glimpse into the strategies and competences needed to shield a research project against funding agencies' agendas and priorities – from the readiness to intervene in high-level policy making and participate in the preparation and formulation of prospective research agendas, over the ability to evoke an agency's interest and enroll its support by buying into an economy of promises, to the intellectual capacity to deconstruct top-down framings and offer alternative perspectives. As can be seen, the pursuit of intellectual authenticity calls for a multitude of proficiencies, tact, and endurance. To some extent, Bruno Latour's *Portrait of a Biologist as a Wild Capitalist* (1984) seems to apply, as the task of obtaining funding while simultaneously ensuring autonomy sometimes bears more resemblance to Machiavellian power politics than to the traditional Mertonian ethos of science (Merton 1942). Be that as it may, our

investigations into the intricacies of funding are not yet concluded, for there remains another crucial aspect to be considered.

4.1.3. Ensuring Continued Existence

Research projects are temporarily finite and have clearly defined start and end dates. Simply put, they pop up, research is being conducted, papers are being written, findings are being communicated, and then they vanish again. Now, if science were a transcendental, disembodied sphere, the limited lifespan of research projects probably wouldn't be an issue. However, science isn't such a mystical domain but, as argued, a very practical social endeavour that involves real people, careers, and biographies. To researchers, especially pre- and postdocs, the conclusion of a research project may imply the loss of a paid position in academia and, ultimately, the departure from science (see Felt et al. 2012). But the "projectification of science" (e.g. see Vermeulen 2009) is not only challenging in terms of its social implications but also with regard to its impact on intellectual and scientific matters: First, the project format enforces a more linear scientific workflow with clearly defined questions and problems, but also the expectation that solutions are attainable and can be communicated in a set of predefined deliverables. Thus, within such an organizational framework, science is increasingly seen as a manageable, predictable process, a functionalist enterprise with a clear focus on time, cost, and output. (see Vermeulen 2009, 195-196) Second, a research project's temporal finiteness raises doubts regarding over its long-term significance. After all, the end of a project usually entails the dissolution of the research consortium, the breakup of the individual research teams, as well as the reorientation of each researcher. And even though a project's deliverables, reports, and findings might still be accessible and retrievable, the ideas and arguments ingrained in those documents are in danger of losing their immediacy if they are not being refined and developed further, presented at conferences, incorporated in new publications, and communicated to various stakeholders. Thus, in the social sciences, if a project has no afterlife, chances are its intellectual legacy will quickly dissolve into oblivion. And it is exactly for those reasons that researchers invest a great deal of time and effort seeking to ensure that there will be some follow-up even if a specific research arrangement has come to an end. The CNS-ASU community has proven particularly proficient in this respect, as they were able to obtain and renew a substantial NSF center grant that guarantees long-term financial security and serves as the pecuniary backbone for a variety of projects and activities. But the Europeans have

demonstrated a certain aptitude as well: The DEEPEN project was preceded by two other projects – the DEMOS-based Nanodialogues (see Stilgoe 2007) and the ESRC-funded Nanotechnology, Risk and Sustainability: Moving Public Engagement Upstream (Macnaghten 2007) – and TECHNOLIFE was followed by the *EPINET* project[40], which started in May 2012 and will run well into 2015. In the following, we shall take a brief look at some of the strategies researchers employ in order to *ensure continued existence* beyond the duration of an individual project. Some of those strategies have already been mentioned – i.e. in order to secure a research community's financial future, a certain knack for creating and seizing openings is as crucial as the ability to advance alternative perspectives without alienating the funding authorities – others are so apparent that they do not need lengthy elaboration – i.e. work agreements must be met, deliverables issued in time, and the pursuit of a mutually respectful and productive communicative relationship seldom seems like a bad idea. Yet, there are a number of practices that are not quite as obvious and thus warrant special attention:

For starters, researchers appear increasingly inclined to try to raise the visibility of their projects by creating more and more sophisticated websites, seeking to communicate to a wider audience what it is they are doing. However, by "websites" one should not think of single webpages embedded in some department's existing Internet presence, but of sizeable standalone platforms that provide not only information regarding the very basics of a project – i.e. a general overview including the fundamental research questions, core objectives, as well as the project partners – but also details on the applied methodology, updates on recent developments, and access to background documents and key deliverables. [41] Furthermore, such websites may play a crucial role in a project's methodological setup: For instance, the NanoFutures project homepage included a weblog and a wiki, both of which represented major elements of the envisaged public engagement exercises. Similarly, the TECHNOLIFE website contained links to the Ker-TECHNO deliberative fora, again an essential component of the project's outreach methodology. In such cases, websites are more than mere information hubs, but actually constitute a vital part of the research process. Yet, the quest for greater visibility does not end here. In fact, researchers seem to have a keen interest in promoting their activities on other platforms such as video-sharing websites and social networks. Consequently, both, the DEEPEN project and

[40] For details on the FP7 project EPINET, see http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=12853008.

[41] For examples of such websites, see the TECHNOLIFE website at http://technolife.no or the DEEPEN project homepage at http://www.geography.dur.ac.uk/projects/deepen/Home/tabid/1871/Default.aspx.

TECHNOLIFE, had their own YouTube channels, whereby the latter also maintained a Facebook fan page. And while neither the uploaded videos nor the social network presence could reach the popularity of viral videos or renowned Facebook pages, several thousand hits and a few hundred fans can hardly be dismissed as insignificant.[42] Now, all this outreach work happens for a variety of reasons: For one, researchers use the Internet as a way to connect with people, in hopes of raising awareness and encouraging them to participate in the deliberative activities. Being present on YouTube and Facebook allows them to tap into the services' large user base and, in addition, makes them more visible in search engines. Researchers may also include these online outreach activities in the project reports. TECHNOLIFE, for example, incorporated a detailed breakdown of all dissemination work into the project's final report, listing Web page 'hits', YouTube 'clicks', and Facebook 'likes' right next to conference presentations, online articles, and the presence at industry fairs (see TECHNOLIFE 2012). Thus, activities such as these might contribute to a project's perceived overall performance, attesting a certain public awareness and visibility. And it seems evident that such a testimony of successful outreach work might come in handy when a project eventually ends and the game for coin begins anew. Last but not least, the establishment of a strong online presence also serves the purpose of creating and maintaining a brand, i.e. a memorable and recognizable trademark that evokes certain associations and succeeds in building an intellectual legacy. Thereby, researcher do not hesitate to resort to a more outgoing, marketing-oriented language, e.g. by vigorously promoting "the Technolife method", or framing a project as "Europe's leading research partnership for ethical challenges posed by emerging nanotechnologies". Arguably, this change of pace in self-promotion represents a reaction to funding agencies' growing demand for more applicable, output-driven research, in an attempt to meet increased expectations by emphasizing the value and significance of the applied research approach. In sum, the quest for greater online visibility can be seen as an effort to improve the overall performance of a project: By being present on multiple platforms, reaching more people, and adopting a brand-like appearance, researchers hope to deliver a more convincing 'package' that bolsters a project's legitimacy, following the ultimate goal of enrolling funding agencies beyond the confines of an individual project.

A second strategy to secure long-term support appears to be the dissemination of different types of text, meaning the creation of deliverables that are mainly written for policymakers as opposed to papers that are rather intended for an academic audience. A

[42] As of today, TECHNOLIFE's Body & mind enhancement video clip has been watched over 4000 times on YouTube; the project's Facebook fan page currently has 327 "likes".

particularly good example for such a bifurcated publication practice is the DEEPEN project, where some key deliverables – e.g. Davies et al. (2010), Kearnes (2010), Davies (2011) – seem to be more directed towards the scientific community, whereas others – e.g. Davies et al. (2009) – are clearly meant to address government representatives and policy stakeholders. As the DEEPEN Final Report stresses, "its intended audience is those involved in policy in these [i.e. nanoscience] areas." (ibid., 1) But what exactly are the differences between these two types of documents? For one thing, reports written for a policy audience are usually characterized by a more accessible language, a general reduction of complexity, as well as a more direct way of reasoning. Moreover, they often reduce the wealth bibliographic references and employ highly structured, formatted, and visually engaging text design. Also, policy documents focus strongly on providing clear-cut recommendations, followed by succinct conclusions. As a DEEPEN researcher explained: "We did work very hard actually on the final report. The kind of smoothing down some of the complexities and making it punchy and making the language accessible and trying to be very relevant. […] Of course, we write for different audiences." (SD, 7) On the one hand, the application of such a two-tiered publication strategy appears to facilitate the preservation of a distinct scientific identity as it allows for the publication of articles that tie into the scientific discourse and grapple with the nitty-gritty of academic reasoning. On the other hand, the separate dissemination of reports geared towards policymakers enables researchers to better cater funding agencies' expectations, e.g. by "smoothing down complexities", making the language "accessible", and adding some "punchy" recommendations, thereby ensuring "relevance". Ultimately, the ability and readiness to frame one's research in different ways for different audiences appears to have become a crucial commodity in the quest for continued existence.

The third and final point expands on what has just been argued but contends that the necessity to engage with and work towards funding agencies and policymakers is in fact not limited to a project's written outputs, but extends to multiple other activities, such as the aggregation and cultivation of personal contacts, presentations before representatives of industry and government, as well as memberships in various research councils, think tanks, and advisory boards. This is particularly visible in the CNS-ASU context, where scholars frequently speak at NSF or NNI hearings, congressional caucuses, as well as various science and technology policy conferences[43], and where, with the Consortium for Science, Policy, and Outcomes, a network has been established that seeks to foster "policies to help

[43] For a comprehensive overview, see the CNS-ASU Library at http://cns.asu.edu/cns-library/.

decision makers and institutions grapple with the immense power and importance of science and technology as society charts a course for the future"[44]. However, it is also apparent in the DEEPEN case, where researchers kept monitoring the key debates and policy developments regarding upstream engagement, talked to members of the British Council as well as representatives of the EC Science and Society Directorate, and organized workshops that were supposed to tackle questions of science policy (see MK, 2; DEEPEN 2009), and with regard to TECHNOLIFE, where project members presented their work at technology fairs (see KR, 5), did not hesitate to personally approach high-level politicians (see KR II, 18), and generally appear to have maintained a productive exchange of ideas and opinions with funding authorities (see Kjølberg and Strand 2011). And while none of these activities alone would automatically guarantee prolonged financial support, chances are that all the efforts combined might eventually contribute to a project's perceived value, thus improving the odds that future grant applications of the respective research group will be regarded with favor. However, the interviews suggest that researchers reflect critically on such authorities-directed engagement practices and usually seek to maintain a certain distance. For instance, they do not wish their research to be "directly political", i.e. in the form of a legislative document, but "relevant to politics" (KR, 2), by being advisory, supportive, but also challenging and thought provoking. And even though they hope that their "research would be […] taken up by policy in some way", the conviction persists that "there are profound incommensurabilities between the way policy systems work and the way research works" (SD, 17), and that "policy structures are not set up to deal with [the] kind of ambivalence or complexity" (SD, 19) these research projects intend to produce and portray. Thus, while researchers attempt to connect to government and funding officials in order to demonstrate their research's relevance and work towards future funding opportunities, they are well aware of the limits of such an undertaking and adjust their expectations accordingly. All in all, despite all caution and potential pitfalls, the fostering of professional ties with the world of politics represents yet another vital strategy in the attempt to ensure a research community's continued existence.

This section has been selective in many ways: It did not comment much on the politics of specific funding schemes, the impact the conditions of a particular grant can have on a research project, or the (unwritten) rules of how a successful research consortium must look like. It also did not focus on matters of inter- or transdisciplinarity, the art and craft of

[44] See CSPO (2011) *About CSPO*. Online available under http://www.cspo.org/about/.

writing convincing grant proposals, or the issue of repeated rejection. However, the section did picture the quest for funding as an ongoing struggle, a continuous forth and back, a delicate negotiation. It emphasized that, in the present research environment, funding opportunities are not just 'out there' waiting to be seized, but indeed must be created and maintained, a task that asks for dedication, persistence, as well as willingness to compromise. But researchers also need to be adept in shielding their research against funding agencies' agendas and interests. To do so, they must participate in the preparation and formulation of prospective research agendas, carefully deconstruct top-down narratives, and enroll agencies to their own cause by employing a language of promises. Last but not least, the section presented a number of strategies meant to ensure a research community's continued existence – from the enhancement of a project's online visibility, over a two-tiered publication policy, to the fostering of a lively intellectual exchange between researchers on the one side, and policymakers, funding authorities, and industry representatives on the other. All in all, the discussion demonstrated that in order to receive funding, it is no longer enough to merely promise and deliver 'good' research. Instead, scholars have to show proficiency in promoting their ideas amongst high-level officials, in building research collaborations that transgress the boundaries of individual departments or institutions, in juggling a myriad of expectations and promises, and in communicating eventual findings to different audiences, thereby becoming more like politicians, managers, and entrepreneurs themselves. And it is exactly those proficiencies, those considerable skills in playing the 'game of coin' that constitute the first crucial resource in realizing a research project that seeks to capture public technoscientific imaginaries in all their complexities. Following, we shall turn towards another set of resources and ask what role spaces and places play in this quest for more upstream future deliberation.

4.2. The Geographies of Science: On Spaces and Places

As Livingstone (2003) has pointed out, "science is not above culture; it is a part of culture" (180), a human enterprise situated in time and space. Consequently, science does not "transcend […] particularities" but "discloses them", representing "a social practice grounded in concrete historical and geographical circumstances" (ibid.). Social spaces and sites, he adds, "facilitate and condition discursive space" (ibid., 7). They can "promote or restrain certain interactions" (ibid., 18), defining, in a conflation of location and locution, what can be said and what cannot, establishing what counts as a legitimate knowledge claim and what doesn't. Hence, the places and spaces of scientific knowledge production are neither neutral containers nor blank stages on which the 'real' action takes place; instead, they are constitutive of science and play into the practices of everyday research. In short, Livingstone asks us to take into account the "geographies of scientific endeavors" (ibid., 134), paying attention to the topography of specific (techno)scientific cultures and bethinking the local, regional, and national features of *science in action* (Latour 1987). And this is exactly what this section intends to do. Following, we will investigate the role particular geographies have played in the case of the examined research projects. Thereby, we shall concentrate on two distinct, albeit heavily intertwined, types of geographies, drawing on the notion of "space" to point to the *regional psychologies* (Livingstone 2003), *technopolitical cultures* (Felt et al. 2010; Felt and Müller 2011), and *sociotechnical imaginaries* (Jasanoff and Kim 2009) that may distinguish one location from another, and the notion of "place" to address the particularities of specific research contexts, their material, structural, and performative modalities, as well as the power relations inscribed in such site-specific formations (see Watts 2008; Suchman 2011). Thus, the discussion of spaces and places will attempt to shed light on both the public discourses and political debates around technoscientific issues as they manifest in distinct (national) contexts, but also on the actual sites of knowledge production, their physical and structural properties as well as their tacit rules, laws, and politics. As stated, the purpose of this endeavor will be to highlight how particular geographies may impinge on matters of research, setting (normative) standards for the kind of scientific inquiry that is deemed beneficial and appropriate, thereby encouraging certain projects while constraining others. Yet, as there is no overarching formula for how spaces and places shape science, but only individual cases and circumstances (see Livingstone 2003, 14), these investigations will neither be comprehensive nor final but exploratory and indicative of the many ways geographies might make a difference. In this respect, it is important to recognize that such geographies are not fixed

entities or hermetically sealed givens but the contingent outcomes of continuous negotiations and renegotiations (see ibid., 88). Thus, geographies have to be *performed* and *enacted* (Mol 2002); they are not stable or complete *orders* but tentative and fractional *orderings* (Thrift 1999), assembled in heterogeneous networks of human and non-human actors (Latour 2005). Overall, the section will read more like a succession of different stories rather than a dense theoretical treatise, hoping to encourage further debate on the relevance of spaces and places instead of closing it down prematurely by concentrating on but a few overarching characteristics.

4.2.1. On Spaces and Places I: Technopolitical Cultures

As mentioned, this thesis investigated three social scientific research projects that responded to the ubiquitous call for future anticipation by conducting a number of foresight activities designed to capture citizens' imaginations concerning nanotechnology and Nano-related innovations. As such, all projects incorporated public engagement/participation exercises that sought to facilitate open, unrestricted discussion and deliberation, allowing participants to gradually develop and articulate their own positions, voice concern, and contest dominant socio-economic dogmas. However, the national preconditions for such engagement settings around new and emerging technologies were somewhat different:

In England, the home of Durham University, the coordinating partner of the DEEPEN project, there exists a long-standing tradition not only of public participation *per se* (Kass 2000; Stein 2003) but also regarding an academic discussion *on* public participation, e.g. its political significance and democratic value (Irwin 1995), what it really means to do public participation and not, for instance, public communication or public consultation (Rowe and Frewer 2005), as well as concerning the concept's potential shortcomings and pitfalls (Wynne 2007). Scholars such as Brian Wynne (1992; Kearnes and Wynne 2007), Alan Irwin (2006; Irwin and Michael 2003), Mike Michael (2009; Brown and Michael 2005), Andy Stirling (2008; 2012), Phil Macnaghten (2007; Macnaghten et al. 2005), and many others, have published extensively on the subject; research at the university level is supplemented by the work of various think-tanks, research councils, and advisory boards; and the next generation of researchers has already been trained – see for example the work of Jack Stilgoe (2007; Wilsdon et al. 2005) or Sarah Davies (2011; Davies et al. 2010). Moreover, official government policy documents have recognized the importance of public outreach efforts, declaring that "society's relationship with science is in a critical phase", that "direct

dialogue with the public should move from being an optional add-on to science-based policy-making […], and should become a normal and integral part of the process", and that the UK "government should give a lead at EU and international level in fostering public dialogue on issues involving science." (House of Lords 2000) Thus, on a national level, the DEEPEN project tied into a well-established discourse both in academia and in the political arena. What it promised research-wise was not particularly new or unheard of (see DEEPEN 2006), but rather the continuation of an ongoing debate, the next step in a sequence of activities geared towards public engagement in the context of new and emerging technologies. In that sense, the DEEPEN project originated in and fed into a technopolitical culture that was already accustomed to this type of research. Yet, the project did add another dimension to the debate by not only ascertaining public views on Nano but also paying attention the cultural narratives underpinning those views, following the objective to "characterize public responses and *understand how these are resourced*." (DEEPEN 2009, 4; emphasis GR) Arguably, the opportunity to pose such questions in the first place cannot solely be attributed to the UK's tradition of public engagement, but should further be understood as a response to the experiences with BSE and GMO (Kearnes et al. 2006; Macnaghten and Guivant 2011), the uncertainties that mark the age of post-normal science (Groves 2011), as well as the perceived lack of public trust in science and science policy (Wynne 2006b). As a DEEPEN researcher recalled when reflecting upon the conditions and circumstances that accompanied the creation of the project:

> "So, we have been working with the sense that Nano was very important […]. It was important in a British context, partly because in 2003, 2004, when we started the project, you could already see the alignment of actors developing around an emerging agenda, and that felt very significant to monitor […]. And it also felt like that there was an opportunity to, you know, to engage in different style in such a scientific world. And in the UK that was obviously enabled by both the GM experience but also not just GM experience itself but a kind of a regular true response to that experience. So part of the regular true response was that we need to understand the GM experience. And so that enabled also different social science work to be funded." (MK, 3)

Thus, in a British context, the intensity of the GM controversy can be said to have functioned as an "enabling experience" that facilitated the conduct of different, more qualitative types of social science research. And while the generation of economic growth through the creation of an industry and innovation-friendly environment remain central to the UK governance of new and emerging technologies (e.g. Department for Business, Innovation and Skills 2010), in the case of Nano, the public backlash that had caused the moratorium on the production and sale of GM crops between the years 1998 and 2003 (Horlick-Jones et al. 2007) appears to have opened up a space of opportunity, marked by a partial reorientation

as to what counts as important – and thus fundworthy – research (Royal Society 2004; Wilsdon and Willis 2004). The GM debate – just as the BSE crisis, the state of uncertainty, or the perceived lack of public trust in science – did not change the rules of game; yet, it did play a role in amending them so that a few new moves became available. All in all, to a qualitative, citizen-centered project such as DEEPEN, the United Kingdom presented a fairly welcoming environment. The country's long-standing tradition in public engagement, as well as several more recent technoscientific controversies, had brought about a cultural and political space that was relatively open to the Lancaster group and their research interests. One should not forget, however, that DEEPEN was not a local research project, financed by a UK research council or think tank, but a European project, funded under the European Commission's Sixth Framework Programme, whose main objective was to contribute to the creation of a "European Research Area" (EC 2002). Hence, despite its situatedness in a distinctively British context, the DEEPEN project was also part of a transnational reality, another complex space with its own rules, objectives, and imaginaries. But what does it actually mean to conduct "European research" (EC 2004b)? And how is this tied to matters of public participation? Let us consider these questions from two contrasting perspectives:

On the one hand, there are the official policy documents of the European Commission, characterizing Europe as "25 countries with shared values and strong institutions acting together" (Commission of the European Communities 2005, 12), thus emphasizing a common identity that is regarded as an "international response to globalisation" (ibid.), as well as the basis for a "specific European approach to economic and social policies" (ibid., 4). This quest for a transnational identity became particularly apparent in the guideline documents of FP6, which stated: "Past FPs have helped to develop a culture of scientific and technological cooperation between different EU countries and they have been instrumental in achieving good research results. They have not, however, created a lasting impact on greater coherence at European level." (EC 2002a, 1) In the view of the Commission, one possible way of achieving such coherence and structuring the European Research Area was the adoption of the Science and Society Action Plan (EC 2001), which – through various initiatives – was supposed to "promote a dialogue between science and society", "bring science policies closer to citizens", and "put responsible science at the heart of policy making" (ibid., 5). And while the previous sections of this chapter already pointed towards significant differences between the interests of the European Commission and the objectives of upstream engagement projects such as DEEPEN, there can be no denial that a general commitment to public dialogue and experiments with new forms of science and

technology governance had been hard-coded – with a budget of EUR 88 million for the Science and Society action line – into FP6. As Alfred Nordmann noted when analyzing the Programme's objectives:

> "At a time when the 'European Union' is still a political experiment that might succeed or fail, research and research policy become arenas for advancing this political experiment by conducting experiments on European governance and identity – and, indeed, by suggesting that the European knowledge society is rooted in collective experimentation with emerging technologies." (Nordmann 2009, 282)

Thus, within the confines of FP6 and at least partly due to the experiences with and uncertainties of NBIC science[45], the EC saw the task of creating a European Research Area and fostering the formation of a European Knowledge Society as inextricably linked to the establishment of new science-society relationships. Through its broad commitment to public dialogue and responsible research, but more concretely via the implementation of the Science and Society action line with its specific focus on ethical assessments of new and converging technologies, the Programme provided an inviting, if not encouraging, technopolitical environment for the DEEPEN project.

On the other hand, there are the practical implications of conducting European research, meaning the need to collaborate with partners across national boundaries and form international research consortia. This requisite is part of any Framework Programme; for example, the *FP6 at a Glance* resource states: "Projects have to be transnational: Only consortia of partners from different member and associated countries can apply."[46] The EC also specifies the minimum number of project partners that need to be involved in a project proposal, as well as the type and country of origin of institutions that are eligible for application. Most importantly, however, projects must have a "European added value", which is again broadly defined as "the required transnationality of most actions". (EC 2007, 6) From such a perspective, 'Europeanness' is imagined as being achievable by bringing together partners from different parts of Europe. As one interviewee put it when asked whether there was anything special about European Framework projects as opposed to nationally funded projects: "The most significant fact about it is that it is European." (KR, 12) Yet, from a sociological point of view, this way of 'thinking Europe' poses an essentialization, a black-boxing of a complex and highly contingent process in which numerous actors do not simply constitute 'Europe' – if seen as an ontologically fixed entity – but perform and enact

[45] In fact, the GMO controversy was not limited to the UK, but stretched – to varying degrees and in different manifestations – across all over Europe, constituting a transnational phenomenon that was of great concern to European policymakers (see Horlick-Jones et al. 2007).
[46] CORIDS. *FP6 at a Glance*. Online available at: http://cordis.europa.eu/fp6/glance-print.htm.

particular versions *of* Europe. As comparative studies have emphasized (Felt 2003; Hagendijk et al. 2005), for the time being and despite all efforts to the contrary, Europe remains a highly fragmented assemblage of individual nation states and regions that feature distinct technopolitical cultures underpinned and accompanied by specific sociotechnical imaginaries. From French nuclear power (Hecht 2000) over life science policies in Britain, Germany, and the United States (Jasanoff 2005) to citizens' perceptions of biomedical technologies in Austria, France, and the Netherlands (Felt et al. 2010), scholars have shown how nations establish their own ways of governing technoscientific developments. Consequently, instead of simply defining DEEPEN as a European project, thereby suggesting that Europe is in fact just one big, homogeneous entity, one must take a closer look and ask what *kind* of Europeanness the project actually assembled. Who were the collaborating partners and how did their respective technopolitical cultures contribute to what would eventually become the DEEPEN project? We have already briefly examined the British context, which was especially significant, since it was home to Durham University, the project's coordinating institution. But what about the other participating partners? There were three of them: the Darmstadt University of Technology, Germany; the University of Twente, Netherlands; and the Centre for Social Studies at the University of Coimbra, Portugal. What attracts attention with regard to this particular research consortium is the dominance of a north-western European alliance of countries, a part of Europe that has repeatedly been depicted as particularly prone to government experiments with upstream public engagement (Hagendijk et al. 2005; Sciencewise 2010). Germany is usually not mentioned as one of the leading nations in this area – the prime examples being the UK, the Netherlands and Denmark – however, recent studies have diagnosed the "emergent nature of a public participation framework" (EIPP 2009, 10), the country has a fairly well-developed culture of citizen activism when it comes to matters of science and technology[47], and there are a various institutions in and outside of academia that conduct research *on* or are more directly involved *in* science-society relationships.[48] The Netherlands, for their part, have a strong academic tradition in science and technology studies, have well-funded research organizations such as the Rathenau Institute that has been investigating the dynamics

[47] See for example the country's strong anti-nuclear movement, public resistance against genetically modified crops, or the Stuttgart 21 protests.

[48] Within the academic realm, the Darmstadt University of Technology, the Institute of Science and Technology Studies at the University of Bielefeld, the Karlsruhe Institute for Technology Assessment and System Analysis, as well as the Aachen research cluster for Future Studies, can be viewed as examples for research at the intersection of science, technology, and society. Additionaly, non-profit organizations such as Science in Dialogue or the Science Shop Bonn have sought to enable and stimulate discussion and exchange on scientific research.

between science, technology, and society since the 1980s, are commonly referred to as the founding country of science shops (Felt et al. 2003; VA Report 2011), and have reached a level of methodological professionalization that has even enabled the transfer of specific approaches – such as constructive technology assessment (CTA) – to other countries and contexts (Schott and Rip 1997; Rip 2005). To state it bluntly, by collaborating with research institutions from these two nations, the British DEEPEN coordinators assembled what comes close to a 'dream team' of European upstream engagement, especially with regard to Nano research. If a Danish institution had been part of the consortium – for instance a group of researchers from the Copenhagen Business School – all leading nations would have been represented. By extension, this means that DEEPEN not only brought together partners that looked good on paper and fulfilled the EC's demand for transnational research, but succeeded in assembling a team of resourceful collaborators that came from public dialogue-committed national contexts and had worked on similar projects before. The impact and significance of these project partners was discernible throughout the interviews, in particular in the form of the Darmstadt community and the persona of Alfred Nordmann[49]:

> "So, […] we are going to a workshop in a university in the US, South Carolina, were Alfred Nordmann […] gave what I still consider to be a kind of foundational lecture on the significance of the nanoscale and the imagination of the nanoscale. And there was a version of his lecture, of his paper, you know, it's two papers […]. These two, […] they were very very good papers and he is a blindingly good public speaker […]. He gives a wonderful evocative but powerfully critical account of the significance of nanoscale. To me, this convinced me that this was an important topic, that there were other people in the nano world who were doing really good work. […] So, when I heard Nordmann for the first time in, I think, 2004 […], it was a revelation." (MK, 4)

Judging from this, Nordmann, a central figure of the Darmstadt technoscience community, had made an impact on prospective members of the British DEEPEN team even before the project had been conceived. By giving an "evocative" or even "revelatory" speech, he provided food for thought, making a convincing case for the significance of Nano as well as the urgent need to "mobilize social imagination" and "identify social needs" (Nordmann 2004, 113). Inputs such as these became even more relevant once the project had started, broadening its scientific scope by introducing additional perspectives:

> "You know, we had these six monthly meetings between the entire project team. And we were working with Alfred Nordmann and Arianna Ferrari and Clare Shelley-Egan, from Twente. And I think

[49] Alfred Nordmann is Professor of Philosophy and History of Science and Technoscience at Darmstadt Technical University and acted as principal investigator of the DEEPEN project's Darmstadt research group.

> the interaction with Alfred and Arianna in particular was very influential […]. But those interactions were very significant because it meant that all social science analysis was constantly being interrogated from a more philosophical perspective. And I think you see that in the project report, as well as in some of the some of the writing that we did collaboratively. […] I think that really was something that gave DEEPEN a richness that wouldn't have been there if, you know, it was just the three of us in Durham working on stuff." (SD, 5)

The crucial point is the following: DEEPEN did not just assemble any kind of Europeanness, but indeed a very particular one. Bringing together researchers from Durham, Darmstadt, and Twente, the project built upon a north-western European alliance of countries that all had, although to varying degrees, demonstrated interest in experimenting with novel forms of governance, including models of upstream public engagement. As a result, the project partners had a substantial background in this type of research, possessed a high level of theoretical and methodological proficiency, and knew how to pose questions that were both scientifically interesting as well as relevant to policymakers. And this availability of experience and proficiency made a decisive difference. It provided DEEPEN with a solid basis to start from, enhanced the project's analytical "richness" by fostering an interdisciplinary perspective, and helped in creating a research environment that was well equipped to handle any conceptual challenges that may arise in the course of such a project. The fourth project partner, the Centre for Social Studies at the University of Coimbra, added another flavor to the mix and contributed to strengthening the transnational and comparative scope of the project. However, when looking at the grant application, the individual deliverables, the final report, and the interview material, there can be no doubt that DEEPEN was predominantly the brainchild of a British-German-Dutch collaboration, a very specific transnational configuration that, for the reasons indicated above, appears to have been particularly well suited to carry out the upstream engagement research the DEEPEN project set out to deliver.

In conclusion, it can be stated that DEEPEN was realized within a set of fairly supportive technopolitical environments: In the UK, the country's long-standing tradition of public engagement as well as more recent experiences with 'mad cow disease' and genetically modified crops had brought about a climate that was receptive to the kind of bottom-up research the DEEPEN group proposed. The same applies for the European level, where the uncertainties of NBIC science and a perceived lack of public trust in science had fostered a commitment to more dialogue and responsible research, with particular focus on ethical, legal, and social aspects of new and converging technologies. Last but not least, DEEPEN was carried out by an international consortium consisting of project partners that, spurred by their own national and cultural backgrounds, all had considerable experience

with qualitative, public engagement-oriented technoscience research, thus providing a strong basis for the project's overall objectives. With the exception of some national idiosyncrasies, the story of TECHNOLIFE largely resembles that of the DEEPEN project. Hence, we shall cross the Atlantic, and briefly consider the research environments of the U.S.-based NanoFutures project.

The Sciencewise report International Comparison of Public Dialogue on Science and Technology (2010) has painted a rather grim picture of the current state of public engagement in the U.S., stating that "the United States led the world in the 1960s in terms of Technology Assessment (TA), but has since fallen behind." (ibid., 41) The report further details that despite repeated calls "for a clear commitment to public dialogue from government", the "dominance of the political system by powerful, in particular economic, interest groups […] presents a challenge to building channels for broader public input into decision-making", and that "large national research-funding agencies place more emphasis on the dissemination of knowledge than two-way communication" (ibid. 41-42). Ultimately, in its comparative account of public dialogue on science and technology, the report ranks the United States 7th out of 8 countries considered, second to last and only ahead of Japan. Others have come to similar conclusion: For instance, Macnaghten and co-authors (2010) argue that, compared to certain EU member states, "public engagement activity in the US has been more limited" (ibid., 16); Irwin (1995) attests the predominance of a "technical language" in US public hearings; and Bibel and co-authors (2004), when assessing the NSF-commissioned, highly influential 'NBIC'-report of 2002 (Roco and Bainbridge 2002), find the work to be "strongly positivistic and individualistic" with concentration on "accelerating advancement of mental, physical and overall performance" instead of "increasing the quality of life, social cohesion or on solving humankind's main challenges of access to safe water, sustainable development, peace, etc." (Bibel et al. 2004, 6) Simply put, in comparison to the European countries discussed above, the United States' investments in public participation and upstream engagement appear to lag behind, an impression confirmed by a DEEPEN researcher who has worked in academia on both sides of the Pond:

> "Europe and in particular the UK has this very distinctive history around science and technology and is much more techno-sceptical – if that's a word. And the UK, you know, had this series of controversies, public controversies, through the 90s. […] There was a sense that things had gone very wrong and something needed to be done to make the relationship between science and society better. […] I think that backdrop has meant [the] government has been forced to see public engagement and dialogue and deliberation as something that is important. And that is not really there in the US and as a result my experience with the US has just felt like being back ten or twenty

> years in Europe. So there's much less awareness of public engagements in a sense that I'm used to it, which, again, is a particular flavour of public engagement." (SD, 20)

Thus, to a social science and science communication researcher who has been trained in the UK, moving to the US felt like a throwback to another era of public engagement, at least when measured against a European standard. However, one might argue that it is not so much a matter of time, i.e. of being more or less developed, but a question of national culture and history. As the interviewee continued:

> "Also, the US has a very different kind of history of democracy – or a different idea of democracy and a different tradition of deliberation. And that really, I think, shapes the idea of what it means to participate […], and as a result structures the way that people talk about things like public engagement. So I think a traditional attitude to technology – whether there is a degree of scepticism or more optimism and enthusiasm – and also a different political history, those two things really have structured the way public engagement is imagined." (SD, 20-21)

Hence, when comparing the United States to the European Union, in particular the north-western member states mentioned above, the prevalence of a very distinct technopolitical culture becomes discernible: Public engagement in science and technology is far less prominent than in the EU, and large-scale funding initiatives, such as the EC's Science in Society action line, simply do not exist.[50] However, the absence of such a programmatic commitment to deliberative approaches to policy making does not mean that there are no opportunities at all. As mentioned in the previous section, the 21st Century Nanotechnology Research and Development Act (U.S. Government Printing Office 2003) explicitly called for the establishment of a research program that would "identify ethical, legal, environmental, and other appropriate societal concerns related to nanotechnology", as well as 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 […]." (ibid., 117) David H. Guston, Director of the Center for Nanotechnology in Society at the Arizona State University, has frequently referred to the Act as the argumentative background for CNS-ASU grant proposal (see Guston 2006; 2010a; 2010b; 2012), stating that the "proposal specifically invoked the legislation and designed its approach to address the congressional interest with public engagement with nano-scale science" (Guston 2010b, 432-433). Thus, at least in the case of Nano, there was a certain readiness to foster and fund public outreach activities. As a member of the CNS-ASU

[50] The Office of Technology Assessment (OTA), which had conducted science and technology policy research since the early 1970s, was abolished in 1995. Recent efforts to revive the institution have yet to translate into tangible actions.

community remembered when reflecting on the political climate at the time of the initial grant proposal:

> "In the late 1990s, the volume of the [Nano] hype began to rise, the standard sets of claims were being made – and I should say claims on both sides, of course –, so that it was gonna save the world, or it will be the next industrial revolution, it will solve all our energy, pollution, agriculture problems – and it would destroy the world. So […], it was a nice microcosm of exactly the sorts of discourses that go on around these things. But interestingly, there was – and maybe this suggests some progress, right, I'm willing to be slightly optimistic –, there was actually an openness on the part of research institutions to have a little bit more of a discussion at a very early upstream stage." (DS, 2)

Nevertheless, despite this relative "openness", the future CNS-ASU researchers had to struggle to get their proposal funded. Simply put, the NSF's peer reviewers "didn't understand what [they] were trying to do", "what the proposal was about", and the fact that the agency "only had [them] reviewed by three people […] suggested that they weren't serious about the proposal to begin with" (DS, 11-12). But the researchers did not give up; instead, they tried to be constructive, argued in a letter to the assistant director of the NSF that there was a problem with the agency's peer-review process, and made sure to demonstrate that they were in for the long haul (ibid., 12). Furthermore, they sought to strengthen their case by adopting a threefold strategy: First, they made sure that their proposal included "conventional social science" that the NSF "would feel comfortable with"; second, they wanted to show that they were doing "something big and different", without making the agency think "it was too strange and weird"; finally, they emphasized potential collaborations with European partners – i.e. the Lancaster/DEMOS group around Phil Macnaghten and the Dutch NanoNed consortium – hoping that such a transcontinental perspective would further improve their chances of getting funded (ibid.). Thus, in order to *enroll* the NSF, they had to work very hard, put together "a really good concept" (ibid., 13), and convince the agency of something that was genuinely new to them – something "they were totally not expecting […] and had no idea how to deal with" (ibid., 3). By comparison, the Europeans, too, needed to convince the EC's reviewers of the relevance, value, and general feasibility of their proposed project; however, they could start their argument from a different level, since much of what they were proposing had already been argued before. In contrast to the US, the notion of public engagement as a crucial part of contemporary innovation governance was already well-entrenched in their respective countries' technopolitical cultures – especially in the UK and the Netherlands – and the Science *and* Society action line of FP6 as well as the Science *in* Society work program of FP7 were, despite all conceptual limitations, potent practical commitments that research in this

domain would actually gain funding. Hence, while the European projects could build on a pre-existing structure, continuing an ongoing debate and adding a few twists here and there, the CNS-ASU community had to break through a fairly thick layer of ideological and technopolitical ice, argue for the unfamiliar, and open up a debate that – at least in this specific form – had not yet gained traction in the US. Formally, the 21st Century Nanotechnology Research and Development Act presented a rare opportunity to conduct government-funded research on the societal aspects of a major technological innovation; nevertheless, the CNS-ASU researchers had to invest a lot of work to get their foot in the door and convince the NSF of the value and worth of their upstream engagement-oriented research agenda. Which raises a final question: If the contemporary US technopolitical culture truly is less amenable to forms of public engagement in the governance of science and technology, and if, as a consequence, there is no distinct academic community that specializes in the design and conduct of bottom-up participatory approaches, how then was it possible to conceive and carry out a mammoth project such as CNS-ASU – and by extension NanoFutures – in the first place? Put differently, if one agrees that the creation of insightful engagement activities is not a trivial undertaking but one that requires skill and training as well as a certain theoretical and methodological proficiency, in the case of CNS-ASU, just where did this proficiency come from? The answer is as simple as it is telling: It got imported from the Old Continent and then adapted to American needs. Three examples shall suffice: For starters, the CNS-ASU's overarching theoretical framework, the so-called "real-time technology assessment" (RTTA)[51], draws heavily on constructive technology assessment (CTA), a specific form of technology assessment (TA), which has been developed primarily in the Netherlands (see Schot and Rip 1997; Fisher 2006). As Guston and Sarewitz (2002) emphasize: "Constructive technology assessment (CTA) is an attempt 'to broaden the design of new technologies' through '[f]eedback of TA activities into the actual technologies'. […] The real-time technology assessment […] continues on this general trajectory." (ibid., 97-98) Second, when discussing novel forms of innovation governance and the need for public engagement, CNS-ASU researchers frequently refer to the canonical writings of the European Nanoscience and Emerging Technologies (NET) community, in particular to the works of Phil Macnaghten, Alfred Nordmann, Arie Rip, and Brian Wynne (e.g. see Barben et al. 2008; Selin 2011). What is important to recognize, however, is that by doing so, they not

[51] "RTTA" is short for "real-time technology assessment" and represents the CNS-ASU's cardinal program of research. For details, see "The CNS-ASU Program" at http://web.archive.org/web/20100611042342/http://cns.asu.edu/program/research.htm as well as Guston and Sarewitz (2002).

only pay tribute to the field as such, but also relate to a very specific technopolitical culture that has for some time not been fostered in the United States. Third and finally, CNS-ASU has imported European TA and public engagement culture in a very practical manner by hiring scholars trained and educated at European research institutions. A particularly striking example for the potential impact of such person-bound knowledge transfer is NanoFutures, a project that originally featured a rather positivistic, expert-centered research approach, seeking to create "naïve" and "neutral" nanotechnology-enabled product descriptions, which would then be "vetted" for their technical validity by scientists with "relevant expertise" (see Bennett 2008; Selin 2011). However, when a researcher who had been trained in technology assessment and scenario planning at the Copenhagen Business School took charge of the project, NanoFutures was augmented by a host of deliberative exercises that allowed for a broad range of citizens to discuss, critique, and rewrite the previously vetted product scenes, raising questions as to who counts as a relevant stakeholder, what constitutes a legitimate knowledge claim, as well as calling attention to the various ethical, legal, and social implications of 'purely technical' products (see Selin 2011). Ultimately, this methodological reconceptualization broadened the project's analytic scope and gave rise to the notion of "plausibility", a concept that remains central to CNS-ASU research. And while it would be presumptuous to call NanoFutures a Danish project, it seems apparent that a slice of Royal engagement culture had indeed been infused into the project's conceptual outline.

To sum up, this section was meant to convey a feeling for the significance of spaces and places by demonstrating how different technopolitical cultures set frames for the type of research that can be conducted at a particular point in time. Drawing on the example of the DEEPEN project, it was argued that long-standing national traditions of technology assessment and public engagement, the experiences with BSE, GMO, and other technoscientific controversies, the uncertainty of post-normal NBIC science, as well as the perceived lack of public trust in science, had triggered a national (Britain), transnational (the DEEPEN research consortium), and European (FP6) research and policy environment that was accomodating to the research propositions of the DEEPEN team. By comparison, the United States presented a much less conducive technopolitical environment for public engagement research; however, the 21st Century Nanotechnology Research and Development Act was a viable opening for a persistent team of researchers to make their case and get the Center for Nanotechnology in Society funded. Now, what does all this tell us about the significance of specific technopolitical geographies? First of all, it tells us that

spaces and places are indeed relevant and give shape to the actions and performances that are embedded within them, defining what counts as a legitimate action – or, in this case, research endeavor – and what does not. Second, it reminds us that any event or action is not necessarily confined to just one particular space or place, but can be tied to multiple sociopolitical and/or technoscientific contexts, which, in turn, requires us to trace acts of translation and appropriation between and across such social, cultural, or national accumulations. Third, it indicates that spaces and places are shifting and fluid without being arbitrary or random; they form at specific moments for specific reasons. Fourth and finally, it draws attention to the fact that spaces of opportunity don't just open up but also may close down again, as exemplified by the abolition of the US Office of Technology Assessment, or, more recently, the defunding of the Danish Board of Technology by the Danish Parliament. Thus, in order to remain open, such spaces and places must be protected, defended, fostered and maintained, a finding that leads back to the previous section of this empirical part, i.e. the intricacies of funding and the 'game of coin'. Yet, science is situated not only in sociocultural environments and technopolitical contexts, but also takes place in concrete sites and locations. Hence, let's redirect our attention and take a brief look at the project's more immediate environments, i.e. the material, structural, and performative properties of their local arrangements.

4.2.2. On Spaces and Places II: Local Arrangements

When I visited Arizona for the S.NET conference in the fall of 2011, I encountered a bustling CNS-ASU community that was eager to present their projects, exchange ideas, and discuss potential research collaborations. Supported by a substantial NSF grant, the Center for Nanotechnology in Society had become home to a considerable number of scholars, working on different research projects, engaging in public outreach activities, and training a legion of students. From an academic point of view, the Center appeared to be thriving: A plethora of innovative, cutting-edge theoretical concepts were being tested; the community had published a number of well-received articles; and the Center grant had recently been renewed for an additional five years. Simply put, they knew what they were doing and they were doing it well. A few years earlier, however, at the time the Center was founded, things had been looking quite different. The community had not yet been formed, besides a general outline of RTTA (Guston and Sarewitz 2002), none of the Center's core concepts (e.g. the notion of "plausibility" (Selin 2011) or "anticipatory governance" (Guston 2010b)) had yet been formulated, and practical experience with outreach work was still limited. Interestingly, it was in these early days that the NanoFutures project was initially conceived.

When talking to researchers who had participated in NanoFutures about the early phases of the project, they repeatedly referred to the unrestrained creative freedom they enjoyed when the project first took off. According to them, there weren't any concrete conceptual directives or binding work packages, nor was there a detailed master plan that laid out how to get from A to Z. What was clear, however, was that NanoFutures was supposed to function as the "future-oriented piece in RTTA" (IB, 4), and that one would have to find a way to "elicit response from people" (ibid.), an objective that led to the creation of a set of "naïve" Nano-enabled product descriptions, best documented in Bennett (2008). When asked how the project's methodological framework had been developed, one researcher responded "organically" (IB, 5), seeking to stress that things unfolded gradually over the course of the project. Generally, there appears to have been sufficient *space* to "try a bunch of different things" (IB, 22), and to experiment with various ideas. In absence of a precise conceptual framework, concrete investigative procedures remained open to debate and could be adjusted. Thus, unfettered by a compulsive methodological corset, NanoFutures started out as an exploratory undertaking that evolved and took shape over time.

But how was this possible? Didn't the NSF seek to ensure a more tightly regimented course of action? A preliminary answer to this question would be that the project didn't

show on the agency's radar for quite some time. As one interviewee conceded: "I mean, the nice part, at least early on, is that the NSF didn't have a […] clue of what we were doing and allowed us lots of leeway to come up with." (IB, 22) But again, how was that possible? Why didn't the agency ask for a more rigorous work plan just as the European Commission does? The answer, in fact, has nothing to do with the project itself, nor with regulatory leniency, but with the funding structure of the project: Back in 2005, the NSF did not fund an individual project; rather, the agency decided to finance a greater vision, namely an entire research center assigned with the task to "increase reflexivity within the nanotechnology enterprise and to increase society's capacity to engage in anticipatory governance of nanotechnology and other emerging technologies" (Fisher et al. 2008; VI), and to use RTTA to "map the research dynamics of nanotechnology; to monitor the changing values of the public and of researchers; to engage both these groups in deliberative and participatory forums regarding nanotechnology; and to assess the influence of these activities on researchers." (NSF 2005)

In this complex programmatic structure, NanoFutures was but one piece of a larger puzzle, a project amongst many.[52] Arguably, it was this logic of center funding, the magnitude of the encompassing structure, and the relative stability of the monetary situation that allowed NanoFutures to develop as self-controlled as it did. Most importantly, however, the "experimental" nature of the project (see Selin 2011) appears to have facilitated the eventual formation of its upstream agenda. As mentioned, NanoFutures started out as an expert-centered research endeavour, and only later incorporated opportunities for citizen deliberation. If the exact layout of the project would have been specified in advance, if its structure would have been rigid and adamant, chances are it would have ended up as another top-down initiative, in concord with the NSF's goal to "inform" the "general public" about the implications of nanotechnology (see NSF 2005).

But the conditions for the development of the project were different. NanoFutures was given a chance to grow and develop into a type of project unforeseen. It can be argued that it evolved alongside the Center's own thriving expansion: As new researchers joined and the role of CNS-ASU as an institution became more clearly defined, NanoFutures changed, embracing an amended "program of action" (Latour 1994) that was significantly more oriented towards upstream engagement. From this perspective, the project's particular nature was shaped and co-produced by its immediate environment, a large-scale

[52] As stated earlier, NanoFutures was but one of four projects running in the RTTA 3 research line, which was again accompanied by three other RTTA programs – RTTA 1, 2, and 4 – as well as two thematic research clusters (TRCs).

research center that was still very much 'in the making', trying to find its techno-political calling.

Yet, the context of CNS-ASU was significant in other ways as well: Located at the College of Liberal Arts and Sciences at one of the largest public universities in the United States, the Center lies just a stone's throw away from the University's life sciences, engineering, and physics departments – from places where nanotechnology is not only debated, but employed on a daily basis. This geographical proximity proved advantageous, as it allowed for frequent informal collaborations between the Center and its natural science-based neighbors. For example, the NanoFutures team was able to vet their product descriptions locally, as they would just "pick up the phone and be like: 'Hey, this is what I've done, I need to talk about it with somebody. Can you put a couple of people together? It can be your postdocs, it can be your whole lab group.'" (IB, 5)

By facilitating such interactions, the ASU campus became a valuable resource for the CNS community and their transdisciplinary research aspirations. It is also noteworthy that these kinds of collaborations were officially endorsed by the University Administration under President Michael M. Crow – who himself has a background in science and technology policy – a clear signal that the work of the Center was perceived as a positive contribution to the climate of intellectual exchange fostered by the University. Thus, instead of just being located *at* the campus, the research CNS performed was considered a vital part *of* the University's scientific activity, a position that most certainly cannot be taken for granted. Ultimately, this level of 'embeddedness' as well as the official backing of the Center's research made for a fairly unique academic environment. As one member of the NanoFutures team stated when considering how the context of CNS-ASU affected his work:

> "I think certainly ASU as an institution allowed for things to happen that might not be possible elsewhere. Because we were able to argue for such an odd centre and get that located so centrally within the University. And the top-down directive from the President that scientists are supposed to be working with people that do these other types of things. So, I really couldn't get the blow-off […]. They might string me along but I'm not gonna get completely brushed off as uninteresting. […] So that helped." (IB, 7)

By funding CNS-ASU, the NSF decided to go big: Instead of relying on a scattergun approach and supporting a host of individual projects housed at different research institutions with relatively small funds, they concentrated their resources on a very select number of places[53]

[53] Apart from the CNS-ASU complex, the NSF created a broader nanotechnology in society network by distributing $5 million to the University of California, Santa Barbara (CNS-UCSB), $1.4 million to the University of South Carolina, $1.7 million to projects at Harvard and the University of California, Los

with the perspective of long-term funding. NanoFutures profited from this overarching structure as it allowed the project to develop incrementally as the Center slowly took shape. Thus, even though upstream public engagement in science and technology had not been as great a concern in the US as in certain European countries, the Center structure provided NanoFutures with the necessary time to catch up – theoretically, methodologically, and in terms of human resources. The NSF had initiated nothing less than a 'cold start' in technology assessment in general, and in Nano-focused TA in particular, and they were determined to invest generously in this type of research. Within the TA and emerging technologies community, there seems to be an understanding that the situation in Arizona is fairly special, not to say unique. A DEEPEN researcher compared the British to the American context in the following way:

> "You know, we were one little project in Europe. Arizona is a much more substantial, you know, this is a strategic initiative by the NSF to fund these two centers and obviously there is […] much more significant sort of research. And I am not saying that our research wasn't serious but the kind of center building that they are all engaged [in] in Arizona is much more important." (MK, 13)

Leaving aside the question of whether the research is more important or not, it is clear that the situation of the European projects was strikingly different from that of NanoFutures. Let's take a look.

I visited Bergen in February 2012, arriving from Oslo at Bergen Station after a stunning seven-hour train ride through the Norwegian mountain scenery. Bergen is a busy harbor city with a picturesque city center and a population of about 270.000. Crossing the city from my hotel on the northern outskirts to the southern city center, where most departments of the University of Bergen are located, took me about half an hour – about as long as it had taken me to traverse the ASU campus back in Arizona. My target destination was the Centre for the Study of the Sciences and the Humanities, a multidisciplinary interfaculty research institution established in 1987 that focuses on the "theory of science", defined as "'research of research within the natural sciences, within social sciences and within the humanities"[54],

---

Angeles (UCLA), as well as $20 million for a Nanoscale Informal Science Educaton Network (NISE Net) (see Guston 2007).

[54] Centre for the Study of the Sciences and the Humanities (2009) *Theory of Science*. Available at: http://web.archive.org/web/20111227171534/http://www.uib.no/svt/en/research/theory-of-science.

"the roles these different sciences play in society", as well as the "theoretical and ethical aspects and uses of such scientific research"[55].

Three years ago, researchers from this institution had been successful in obtaining a FP7 grant for their project TECHNOLIFE, which was funded for 33 months, from March 2009 to November 2011. The nature of this grant was strikingly different from that of the CNS-ASU community: While the National Science Foundation had invested considerable sums in the creation of an entire research center, the European Commission's grant funded but a single project. What does this imply? First, the lack of an overarching organizational structure entails that the funding agency's attention would be directed towards the particularities of the actual project. Consequently, the TECHNOLIFE grant contract included a detailed outline of the project, including its main objectives, potential impacts, as well as an extensive work plan specifying the individual work packages, thereby setting a rigid (time) frame to maneuver in. That way, the scope and course of the project was determined well before any actual research had been carried out. Second, the very nature of the grant – i.e. its limited duration of 33 months – indicates the absence of a long-term perspective. Under a Framework Programme logic, once a project comes to an end, it really does end. Researchers might choose to apply for another grant by responding to a different call for research proposals, however, it remains uncertain whether such an application would be successful or whether a suitable call would be available in the first place. Hence, in comparison to CNS-ASU, which was originally funded for five years, only to be extended for another five, Framework Programme projects such as TECHNOLIFE are much more temporary: They pop up, research is being conducted, and then, after a period of usually just two to three years, they vanish again. In such a funding environment, continuity is a rare commodity, and research practices have to be adapted accordingly. In sum, it seems apparent that the funding conditions in Arizona and Bergen were markedly different. Interestingly, however, these differences concerned the very characteristics that allowed for NanoFutures to develop its upstream agenda. As argued, it was the embeddedness in an overarching center structure, the initial lack of a detailed project outline, as well as the long-term perspective that provided some leeway, deflected pressure, and enabled the project to develop incrementally. In the case of TECHNOLIFE, the conditions for the project's development were less supportive. This begs the question how the project exactly came to endorse its upstream engagement agenda.

[55] Centre for the Study of the Sciences and the Humanities (2009) *History of the Centre*. Available at: http://web.archive.org/web/20111227114703/http://www.uib.no/svt/en/about-the-centre/history-of-the-centre.

The answer leads back to the significance of local arrangements: While the European Commission did not formally fund the creation of an entire center structure, there simply was no need to, as the center was already *in place*. As a matter of fact, the Centre for the Study of the Sciences and the Humanities would not only provide a suitable working environment – e.g. workspaces, Internet access, printers and copiers, a library – but would furthermore contribute an over two-decade-long track record in interdisciplinary science studies research. Thus, at least in its rudiments, the upstream agenda was already there, entrenched in the Centre's programmatic structure, i.e. its critical, science policy-directed perspective, its interest in the role of science *in* society, as well as its inter- and multidisciplinary research profile. Let's consider these qualities one by one:

To begin, the Centre for the Study of the Sciences and the Humanities explicitly follows the idea that "in modern scientifically-based high risk societies there is a documented need for critical reflection" concerning "research policy", "the prioritizing of specific research fields and types of knowledge", as well as "ethical and political questions concerning the danger of misuse and the risk of unintended negative consequences". Consequently, following a "pragmatic perspective", the Centre conceives science as "an *activity*, governed by basic norms," that raises "questions concerning science and power" and asks for "an understanding of different institutions, groups and interests". Ultimately, the Centre seeks to investigate "the political priorities for research in a particular field", how these "research norms function in practice", as well as what "kinds of harm or damage" they might "inflict upon […] the outside world".[56] Taken together, through its strive towards critical reflection of science policy and issues of governance, as well as its constructivist view of science as a social activity, the Centre was well-equipped to host a project such as TECHNOLIFE, which sought to "understand the policy discourse" (KR, 13) with regard to a number of new and emerging technologies, but also tried to remain "quite critical" (KR II, 11), focusing on instances where "protest had erupted and where critical issues had been raised" (KR, 13).

Second, however, it was not only this reflexive stance that created a stimulating research evironment, but furthermore the Centre's more general interest in the role of science as a social institution that resonated with TECHNOLIFE's upstream agenda. By emphasizing science's "responsibility towards society" and tackling questions such as "how may laypersons be included in assessing scientific research" or participate in "discussions

[56] All quotations taken from Centre's website, see footnotes 54 and 55.

concerning ethical and political problems"[57], the Centre's research profile provided an ideal intellectual basis for a project that aimed to "improve existing conceptual frameworks and procedures for implementing and representing the social needs and interests of citizens at early stages of policy-making and research" (TECHNOLIFE 2012, 3), thereby advocating "creative ways of making participation and dialogue permeate governance of science and technology at all levels" (ibid., 31). Moreover, the Centre's focus on the presentation of science in the media fit well with TECHNOLIFE's intention of highlighting "the increasing importance of ICTs, as mediators, symbols and drivers of development." (ibid., 13) Thus, in contrast to the Arizonian case, the Bergen-based researchers of TECHNOLIFE could build upon an already well-established academic culture, which had fostered research on the relationship between science and society for over two decades. To be sure, this does not mean that their research was unoriginal or that TECHNOLIFE was just 'business as usual'[58], but simply indicates that they were able to conceptualize and carry out their project within an academic environment that was supportive rather than obstructive, enabling rather than constraining. Put differently, in the context of the Bergen Centre, TECHNOLIFE was no anomaly, no conceptual outlier or alien appearance, but exactly the kind of research that was supposed to be happening. Research on interplay between science and society was a core concern of the Centre – and the researchers of TECHNOLIFE had set out to deliver.

Third and finally, and again on a local level, TECHNOLIFE's upstream agenda was further encouraged by the interdisciplinary character of the Centre, which "incorporates sociological and historical studies as well as the philosophy of the sciences and the humanities"[59]. On the one hand, the research team's background and experience in philosophy-driven ethical assessments had enabled them to convincingly respond to the EC's FP7 call, which explicitly asked for "ethical frameworks of new and emerging fields of science and technology" (EC 2008b, 11). On the other hand, however, their affiliation with the social sciences, and STS in particular, reminded them that, in order to be "relevant for European science and technology policy" (ibid.), ethical deliberations would have to be more than

[57] Centre for the Study of the Sciences and the Humanities (2009) *Theory of Science*. Available at: http://web.archive.org/web/20111227171534/http://www.uib.no/svt/en/research/theory-of-science.

[58] In fact, by bringing together the concepts of imagined communities (Anderson 2006 [1983]), social imaginaries (Taylor 2004), sociotechnical imaginaries (Jasanoff and Kim 2009), and sub-politics (Beck et al.2001) and introducing them as a promising approach to the ethical analysis of new and emerging technologies, the TECHNOLIFE team made sure to depart from all-too-familiar paths and contribute a novel angle to pending issues of concern.

[59] Centre for the Study of the Sciences and the Humanities (2009) *Theory of Science*. Available at: http://web.archive.org/web/20111227171534/http://www.uib.no/svt/en/research/theory-of-science.

mere legitimization exercises allowing policymakers and industry stakeholders to carry on with business as usual, but should indeed maintain a critical impetus, opening up issues instead of closing them down. As a TECHNOLIFE researcher stressed when commenting on the Centre's research profile and its role in applying for the project:

> "Yeah, we have had quite a few ethics projects, so in that sense this fits rather well into that line because, well, we always had a very critical view of ethics. We said it doesn't work, we need to find a new way of doing it – it has to become more communicative, it has to become more deliberative, it has to take into account the insides from STS, it has to consider the political dimension of what it's doing because, well, ethicists are quite naïve. And we also said that in the application and fortunately the ethicists themselves liked it – or the reviewers, I don't know if they were ethicists –, so that is quite clearly relevant. I mean this centre is a bit like, is between many fields, […] so ethics is definitely one of them." (KR, 9)

The quotation serves as a telling example for the kind of interdisciplinary thinking the Center promotes: Even though there is a distinct background in ethics, this does not mean that ethical assessments are perceived as the holy grail *per se*. To the contrary, the TECHNOLIFE researchers held a "very critical view of ethics", wishing it to be "more communicative", "more deliberative", taking "into account the insides from STS", and considering "the political dimension of what it's doing". Thus, instead of adhering to a single disciplinary framework, the project team incorporated ideas from various scholarly traditions, constantly trying to adapt and improve established models and methods. This, ultimately, resulted in the formation of a rather idiosyncratic research approach, marked by a multifaceted potpourri of ideas that transcended traditional disciplinary boundaries. Arguably, it was precisely this potpourri, this Bergen version of programmatic messiness, that encouraged and inspired the implementation of the upstream agenda, which became so central to the TECHNOLIFE methodology.

All in all, when comparing TECHNOLIFE and NanoFutures, one finds that both projects were embedded in local structures that facilitated, although in very different ways, the creation of bottom-up public engagement processes: In Arizona, the overarching center structure provided some leeway to tinker and experiment, allowing the NanoFutures team to gradually contrive an upstream methodology that wasn't there to begin with; in Bergen, the hosting center contributed a critical, science policy-directed research tradition that provided a solid foundation for the researchers of TECHNOLIFE. Thus, in both cases, the local arrangements, i.e. the encompassing center structures, acted as allies in that they encouraged or, at least, allowed for things to happen. In the context of CNS-ASU and the Centre for the Study of the Sciences and the Humanities, it was possible to 'think upstream', maintain a critical position towards contemporary S&T policy, and, hence, conduct future-

oriented Nano research that by its very design transgressed the intellectually narrow and democratically dubious boundaries of unidirectional, top-down legitimization exercises. If the NanoFutures project would not have had "lots of leeway" (IB, 22) to grow and develop over time, and if the TECHNOLIFE researchers would not have echoed the Center's call "for critical reflection [in this case, of ethics]", chances are that both projects would have turned out quite differently, featuring not only different questions, methodologies, and, ultimately, results, but possibly also taking a different stance on what it means to do public engagement work – e.g. top-down information instead of bottom-up deliberation, risk assessments instead of fathoming plausibility (NanoFutures) and civic imaginations (TECHNOLIFE), aiming for clear-cut results instead of pointing towards complexity, ambivalence, and ambiguity – thus making an entirely different sociopolitical argument. Simply put, and once more referring to a well-known STS idiom, *things could have been different*. But they were not, and this was no coincidence, as the spaces and places fostered a certain path of development, contributed to the establishment of an upstream agenda, and allowed for a critical take on questions of truth, facticity, power, and governance. To be sure, they were not the sole reason for why the projects developed as they did, but they played a significant role – as an actor in a complex network of distributed agency, as a contributing factor, as a crucial element in a very specific programmatic assemblage. In the realm of science, local arrangements count; thus, as researchers *of* science, we should not forget to count them *in*.

As stated in the beginning, this section was intended to be exploratory rather than comprehensive, indicative rather than conclusive. What follows is that the investigations made thus far could be extended in multiple directions: For instance, it would be interesting to examine in further depth how the NanoFutures project was embedded within the wider (CNS-)ASU context, collaborated with other (local) projects, and infused its concepts and findings into the Center's overarching technopolitical agenda. In the case of TECHNOLIFE, it might prove insightful to take a closer look at the project's research consortium, i.e. the Centre's cooperation with Lancaster University, the University of Manchester, the University of Tartu, and others, or ask what it is that makes the Centre for the Study of the Sciences and the Humanities so successful in applying for substantial Framework Programme grants.[60] Similar questions could be posed with regard to the DEEPEN project, where one might want

[60] Almost immediately after the official end of TECHNOLIFE, the Bergen-based researcher were able to secure yet another FP7 grant, acting as coordinating partner of the *Integrated Assessment of Societal Impacts of Emerging Science and Technology from within Epistemic Networks* (EPINET) project, which was funded by the European Commission with a budget of EUR 148 8746 and will run until April 2015.

to reflect on the central position and social scientific legacy of Lancaster University or the fairly tight entanglement of (science) policy research and policy consulting in the UK. Long story short, there are multiple ways in which the thick descriptions given above could even be thickened further; however, by choosing a comparative approach and focusing on technopolitical cultures as well as specific local arrangements, the section should have succeeded in underlining a central argument: Spaces and places matter – they impinge on the process of (social) scientific knowledge production and co-determine what kind of research can or should be conducted at a given time and place. DEEPEN, TECHNOLIFE, and NanoFutures could not have been carried out anywhere, anytime; they were not above culture but part of very specific technopolitical assemblages, co-produced by distinct spatial and temporal circumstances. As Livingstone argues, "the impact of place [and space] on science is inescapable" as research is always "marked by the particularities of location." (2003, 186) Consequently, in order to convincingly analyze and map the process of science 'in the making', paying attention to such local, national, and transnational – in short, geographical – arrangements appears crucial. With that, this analysis of the spaces and places of three particular instances of upstream public engagement research finds its (preliminary) end. Following, in a final empirical section, we shall adopt yet another perspective and concentrate on the theoretical and methodological assumptions that guided the conceptualization and realization of the projects' bottom-up agenda.

4.3. Making Futures Public: The Upstream Epistemology and Technologies of Imagination

Thus far, by exploring the intricacies of funding and shedding light upon the spaces and places of social science Nano research, the analysis has mainly focused on the economic requirements and background conditions that are needed to carry out upstream engagement projects in the first place. However, as vital as such structural resources may be, they still cannot guarantee that a research project will develop in a certain direction – in our case, one that is oriented towards citizens' imaginations and bottom-up deliberation. To state it bluntly, just because opportunities for conducting a certain type of research exist, this does not automatically mean that they are actually going to be seized. To do so, scholars still have to conceptualize 'suitable' research approaches, that is, approaches that ask the 'right' questions, incorporate theoretical frameworks that underpin the respective research agenda, and feature methodologies capable of putting this agenda into practice. With respect to the three projects under consideration, this entails that in order to truly create upstream engagement and dialogue around new and emerging technologies, the researchers of DEEPEN, TECHNOLIFE, and NanoFutures had to design conceptual frameworks that would resonate with this particular agenda.[61] To be sure, all of these approaches were quite unique in that they posed different questions, focused on different (nano)technologies, and employed different methodological concepts. However, when carefully examining the project reports and in particular the interview material, it becomes evident that they also had much in common beyond their shared interest in Nano and upstream engagement. For example, one can find similar understandings as to what is at stake, similar problem descriptions, similar theoretical perspectives, as well as similar expectations regarding how the chosen methodology might tackle those issues of concern. Hence, when looking at the three projects, there seems to be significant overlap – conceptually, theoretically, methodologically. This section, then, seeks to address these commonalities, and it will do so in two ways:

First, drawing on Knorr-Cetina's (1999) work on "epistemic cultures", we shall concentrate on what I propose to call the "upstream epistemology", that is, a specific way of thinking about science, technology, governance, and citizen engagement that is largely shared by the members of the three social science projects. Such a shared, or collective,

[61] The rudiments of these frameworks have been briefly outlined in chapter 3 and can be found in more detail in the respective project deliverables (e.g. see Davies et al. 2009; Selin 2011; TECHNOLIFE 2012).

epistemology can best be understood as a common set of assumptions, imaginations, beliefs and values (see Haas 1992), as a certain mode of ordering the (technopolitical) world (see Law 1994), as a distinct way of coming to terms with complex (technoscientific) realities (Felt et al. 2010). Hence, a shared epistemology is something that unites social actors – in this case, a group of social science and humanities scholars – in their sense-making and knowledge-producing activities. There are a few things to keep in mind with respect to such common epistemic frameworks: For starters, collective epistemologies should always be seen as rooted in and complement by individual epistemologies, i.e. the ways individuals understand, give order to, and make sense of their (sociotechnical) surroundings. Only trough interaction and continuous testing can such individual epistemic practices become collective ones. Once negotiated and stabilized, however, collective epistemologies may retroact on their more private siblings, informing personal ways of sense- and meaning-making. Thus, collective and individual epistemologies co-produce one another; they are not mutually exclusive but interdependent, inextricably intertwined as two dimensions of a single phenomenon, that is, the process of interpreting, evaluating, and appropriating our physical, social, and symbolic worlds. What follows is that even though this section seeks to delineate a common epistemic configuration, i.e. the upstream epistemology, this distinct intellectual amalgam represents but a conflation of the interviewed researcher's individual epistemological narratives[62]. In other words, what, at a first glance, might appear as a single logical entity should in fact be understood as a plurality of knowledge practices that find common ground in a presumed master narrative. Which brings us to a second point: Collective epistemologies – such as the upstream epistemology – should not be regarded as ontologically fixed entities 'out there', but rather as tentative formations that have to be enacted and rehearsed. They are not pre-given or 'natural' orders but socially constructed avenues of knowing, contingent and situated rather than inherent and universal. Consequently, outlining the upstream epistemology entails tracing a complex discursive process rather than pinning down a ready-made concept. The precise contours of this discourse largely depend upon the characteristics of the empirical material at hand, as a different set of data may bring forth quite different (epistemological) narratives. Hence, what the first section will present is but one possible version of what it might mean to conduct upstream engagement research in the field of Nano and emerging technologies. Third and finally, efforts to identify commonalities – in this case, a shared epistemology – often demonstrate a deliberate disregard of difference. In this respect, the following analysis

[62] For more information on "epistemological narratives", see Mills et al. (2010), keyword "narratives".

will be no exception. Upstream engagement research at the intersection of science, society, and governance is not only a prominent but also a very active subfield of STS that covers a broad range of issues and raises a host of questions. As a result, researchers in this field appear to have developed quite nuanced, complex, but also fairly ambiguous views of what is at stake. Unfortunately, the subsequent deliberations won't be able to account for all these nuances and subtleties but, following the principal goal of carving out the general silhouette of the proclaimed upstream engagement epistemology, shall instead concentrate on but a few broad narratives that denote the common epistemological nucleus which, in its essentials, seems to be shared by all of the interviewed researchers. Thus, as in the previous empirical section, the analysis will not be comprehensive but exploratory, encouraging further investigations and reflective assessments. In sum, this first section will mark an attempt to provide one possible outline of a shared upstream epistemology – an epistemology that is carried and maintained by the researchers themselves, that represents a fluid, malleable discourse rather than a set-in-stone concept, that unites three social science projects that were located at different places, conducted at different points in time, and had different research foci, under one common epistemic agenda. [63]

Yet, epistemological frameworks alone do not suffice. In order to really generate upstream engagement, the three projects also had to develop methodologies that would

[63] This epistemology-centered approach nicely corresponds with two concepts that are central to the fields of science studies and STS, that is, Thomas Kuhn's (1970 [1962]) work on scientific paradigms and Ludwik Fleck's (1981 [1935]) notion of thought collectives and thought styles. However, there are reasons why it seems more appropriate to speak of an "upstream epistemology" rather than an "upstream paradigm" or "upstream thought style": On the one hand, Kuhn's consensus-based paradigms more aptly describe processes in the natural sciences than the social sciences, an argument Kuhn himself acknowledges (see 1970 [1962], VIII, 15). Also, his paradigms are marked by a "clarity" and "rigidity" that could not be found in the empirical material used in this thesis. The interviewed researchers' knowledge ways seemed much more tentative and informal. Thus, with respect to the research material at hand, promulgating an "upstream paradigm" would mean assuming a clearly defined consensus that does not seem to exist. On the other hand, Fleck's broader theory of knowledge could easily be applied to the realm of the social sciences and humanities, as well as to non-scientific environments. However, and this is something that is frequently overlooked in contemporary discussions of his work, Fleck conceptualized thought styles as "directed perception, with corresponding mental and objective assimilation" (1981 [1935], 99), stressing that "when a conception permeates a thought collective strongly enough, […] any contradiction appears unthinkable and unimaginable." (ibid., 28) As stated in the "Descriptive Analysis" included in the University of Chicago Press edition of *Genesis and Development of a Scientific Fact* (presumably written by Thaddeus J. Trenn and/or Robert K. Merton): "A thought style functions by constraining, inhibiting, and determining the way of thinking. Under the influence of a thought style one cannot think in any other way. It also excludes alternative modes of perception." Obviously, the epistemological approach proposed in this section takes a quite different perspective, emphasizing the enabling capacities of shared knowledge ways rather than their assimilatory, thought-inhibiting potential. Thus, while both Kuhn's and Fleck's work serves as an important point of reference, the notion of "upstream epistemology" seems more suitable as a theoretical framing for the empirical investigations conducted in this section.

translate their research agenda from a purely conceptual realm into practice. Arguably, they did so by creating what Felt and co-authors (2013b) have termed "technologies of imagination", that is, the idea of designing techniques and methods that encourage participants to develop and negotiate individual and collective imaginations, whereby "imaginations" can be defined as "outcomes of imagination", i.e. "the ability and practice to relate and associate what is perceived as possible with what is seen as 'given' or 'real'." (ibid., 3) Thus, while the investigated projects employed different methodologies and engaged citizens in different ways, they all sought to conceptualize processes that would "take seriously the cultural narratives citizens develop when addressing emerging technologies." (ibid., 3) It will be the task of the second section (4.3.2.) to address the particularities of such technologies of imagination, outlining some common features and concerns as well as commenting on the underlying politics, ultimately seeking to develop the concept further by enriching it with narratives of three distinct research projects. This approach might be considered an epitome of research on research, as the section will attempt to *elicit researchers' imaginations of creating technologies of imagination*. Theory-wise, the section will draw on Law's (2004) take on the classic science studies argument that methods do not 'reflect' given realities but actively partake in the construction of reality. As Law puts it: "The argument is no longer that methods *discover* or depict realities. Instead, it is that they participate in the *enactment* of those realities." (ibid., 45; emphasis as original) Consequently, one might hypothesize that the projects' technologies of imagination enact quite different realities than, say, the European Commission's Eurobarometer surveys or top-down information dissemination exercises. As Law argues with respect to a Eurobarometer survey on the attitudes of EU citizens towards farm animal welfare (Special Eurobarometer 2007), such studies generate "a hybrid consumer-citizen", enact "the EU as a neoliberal political site", perform "Europe as an isomorphic population of individuals in a homogeneous, bounded, conceptual space", and "reproduce statistics and survey research as reliable tools for describing and so enacting social reality" (see Law 2009, 249). In contrast, as we shall come to see, the projects' technologies of imagination enact a different type of reality, one that takes into account how citizens conceptualize themselves and their environments, that focuses on dissent, ambiguity, and situatedness rather than homogeneity and harmonizing top-level classifications, and that is quite conscious about its own politics and enactments of reality. As Law has argued, methods are neither "innocent" nor "purely technical" but "performative"[64] (Law 2004, 143). It will be the goal of this section

[64] The term "performative" was originally coined by the British philosopher of language John

to outline the specific *kind* of performativity needed to instigate imagination-bound bottom-up deliberation about new and emerging technologies.

All in all, by outlining the rudiments of the upstream epistemology and discussing methodology under the framework of technologies of imagination, this section will add yet another layer to our panoramic account of the structural, intellectual, and conceptual requirements of upstream engagement research.

4.3.1. The Upstream Epistemology

According to Haas (1992), epistemic communities can be defined and identified by their "shared set[s] of causal and principled (analytic and normative) beliefs, a consensual knowledge base, and a common policy enterprise (common interests)". (ibid., 18) Despite significant conceptual and methodological differences, DEEPEN, TECHNOLIFE, and NanoFutures can be considered as belonging to such a common epistemological framework, one that is built around what I propose to call the "upstream epistemology", i.e. a core set of assumptions, interpretations, values, and interests that serves as an epistemic – that is, knowledge-related – backbone for the conduct of upstream engagement research. Following, we shall examine the crucial pillars of this distinct epistemology in some more detail, seeking to provide an insightful account of its normative, conceptual, and theoretical underpinnings.

The *first pillar* pertains to what Jasanoff (2004) has termed the "idiom of co-production", stressing the idea that "the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we chose to live in it", that science and technology "both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments and institutions", that one can "gain explanatory power by thinking of natural and social orders as being produced together", and that "modernity […] can be properly appreciated only if we take this co-production into account." (ibid., 2-3) Hence, the idiom of co-production emphasizes the notion that science, technology, and society should not be perceived as separate domains but rather as co-

---

Langshaw Austin in his renowned book *How to do Things with Words* (1962). In essence, Austin used the term to distinguish between utterances that *do* something and are indicative of specific actions – i.e. *performative* utterances – and utterances that merely describe or report on an already existing state of affairs (see Austin 1962; MacKenzie 2004). In STS, the notion of performativity has emerged as a key concept that does not refer to utterances of individuals alone, but to the whole range of social interactions as well as material agency (Pickering 1994; Barad 2003).

dependent, densely intertwined constituents of present-day modernity, thereby rejecting the teachings of both natural and social determinism as well as criticizing the "realist ideology that persistently separates the domains of nature, facts, objectivity, reason and policy from those of culture, values, subjectivity, emotion and politics." (ibid.) In such a framework, science is not conceived as "a simple reflection of truth about nature", but as complex process that "calls attention to the social dimensions of cognitive commitments and understandings […]." (ibid.) To be sure, this way of thinking about the relationship between science, technology, and society is not restricted to Jasanoff's writing but deeply rooted in the field of science and technology studies (STS) and related approaches — from the sociology of scientific knowledge (SSK) over the social construction of technology (SCOT) and actor-network-theory (ANT) to more governance and science policy-oriented concepts such as the notion of sociotechnical imaginaries (e.g. see Jasanoff and Kim 2009) or the one of technopolitical cultures (e.g. see Felt et al. 2010). And it is also well entrenched within the epistemic communities of the three investigated projects. To give but one example:

> "So, as an STS scholar I'm interested in, you know, the relationships between people and technology, and once I started to appreciate the profound role that technology has in kind of shaping our existence, I became interested in this idea of planning and priority setting and curious about how different institutions go about thinking about the future of technology. […] So my motivation in a general sense was to understand future orientation and how that impinges upon technological development." (CS, 1)

Leaving aside the prevalent future-theme for the moment – we shall address it separately later on – this quote serves as an epitome of co-productionist reasoning: In essence, the assumption is made that while technology strongly "shapes" societal structures, i.e. "our existence", the course of technological development remains – at least to a certain degree – malle- and negotiable. Thus, technology and society is seen as mutually constituted, "impinging upon" one another in a process of continuous co-production and co-evolution. Thereby, the applied language and phrasing, most notably the notions of "to shape" and "to impinge upon", is in line with the typical STS jargon that seeks to avoid any form of social or technological determinism by employing a 'soft' terminology which underlines the multifarious and fundamentally contingent character of reciprocal exertion of influence. Within such an epistemological-theoretical framework, it is necessary to consider the material resilience of technological artefacts but also to acknowledge people's power in bending and adapting those technologies to societal requirements, with the ultimate goal of working towards more just and socially reflexive technoscientific environments:

"Science and technology play important roles […], both by providing the material means through which change takes place, and through their power to trigger imaginations of change and improved futures." (TECHNOLIFE 2012, 14)

"[For me, responsibility would mean] to try to create other forms of knowledge, other forms of institutions that can promote a better way of living and co-existing with technology." (KR II, 12)

While the first quote stresses science and technology's capacity to trigger social change, the second refers to the way knowledge and (governance) institutions may act upon technoscientific developments, potentially making them more socially robust. However, such clear-cut examples of co-productionist thinking are rather rare, as the very idea of a mutual co-dependence of science, technology, society, and politics appears to have become self-evident within the upstream engagement research community. Thus, when reading through the project deliverables and talking to the individual researchers, it became apparent that while the co-productionist perspective served as a theoretical background underpinning most practical arguments, the concept had become so ingrained that there was simply no need to reiterate its basic premise. Put differently, the idea of co-production appeared as what Latour and Woolgar (1986) have labelled "type 5 statements", that is, statements or ideas that have become so uncontroversial, widely accepted, taken for granted, and ingrained in a research community's epistemological constitution that they do not have to be made explicit anymore. Yet, one can find traces of a co-productionist view when looking at the ways the researchers frame and relate to current issues of concern. As one interviewee stated when asked whether more socially reflexive ways of governance could be institutionalized:

"Well, there are very small experiments going on, and maybe, if I should be a little bit optimistic, if the present crisis should teach us something, and I mean the last year was just incredible, you know, there was one disaster after the other, there was Fukushima, there was, well, the ongoing economic meltdown, […] there was the whole thing with the Arab Spring, what is going on in the Middle East, I mean, and many of these things are, or all of them are intertwined with science and technology […]. So maybe […] if the system is sufficiently shaken, then more humble ways of producing science and technology […] could become a possibility on the horizon. " (KR II, 12)

What is interesting about this account is that it is not only indicative of a particular scientific perspective but indeed of an entire worldview, one that acknowledges the pervasive role of science and technology in contemporary human affairs but also believes this impact to be steer- and governable. Arguably, such an understanding is crucial to the very idea of upstream engagement: If science was thought of as a separate domain of truth, a purely reason-bound endeavor and mirror of reality, seeking to foster upstream engagement would

be nonsensical – after all, how to debate what by definition is non-debatable? Yet, as soon as science is conceived as a human enterprise, a social activity that is not detached from but a part of society, upstream engagement does not only become logically possible but also a vital democratic virtue. In this sense, the co-productionist perspective represents the first and perhaps most fundamental pillar of the upstream epistemology, the conceptual conditio sine qua non of bottom-up deliberation and the intellectual basis of all that follows.

The *second pillar* of the upstream epistemology is the move towards a more critical public understanding of science (cPUS). As scholars have argued, engaging the public in the governance of science and technology has become a "gold standard" (Felt and Fochler 2008, 489), a "[commonplace] in contemporary public policy around science, innovation and emerging technologies." (Strassnig 2009, 7) However, much of this engagement work follows a traditional public understanding of science (PUS) (see Michael 1992; Wynne 1992; 1995), that is, a concept that "[problematizes] publics, and their cognitive processes and capabilities, thereby implying scientific knowledges, practices, and institutions to be unproblematic." (Wynne 1995, 362) Furthermore, the concept bases on the so-called "deficit model" (Irwin and Wynne 1996), which asserts that "people lack information about – and thus understanding of – the purported 'true nature' of a techno-scientific development" (Felt et al. 2010, 529) and are thus unable "to make reasoned decisions" (Felt et al. 2009, 90). Ultimately, laypeople's lack of knowledge is used to explain their mistrust in or refusal of science, which is supposed to be 'rectified' by the provision of top-down information, following the idea that "more understanding of science's basic principles would lead to a greater 'rationality,' more 'informed' debate and, ultimately, to increased social consensus." (Michael 1992, 331)

In sharp contrast to this classic public understanding of science, proponents of the critical public understanding of science (cPUS) have argued that "the communication of scientific knowledge should not be seen as a linear transfer of knowledge from scientists to laypeople" (Mager 2010, 9), since "the positions taken by lay people are much more complex than any top-down vision ever seems to recognize." (Felt et al. 2008, 234) Hence, laypeople do not passively 'receive' information from the top down; rather, they actively select, interpret, and appropriate knowledge by "relating it to and embedding it in their own experiences and bodies of knowledge" (see Mager 2010, 9), in ways that do not necessarily correspond to experts' visions (see ibid.). Thus, the critical public understanding of science conceives the uptake of knowledge "as an inherently social and situated process, which may

not be reduced to as simple mechanisms as those assumed by the deficit model" (Fochler 2007, 34). Needless to say, it was this second, critical tradition that played a central role in the three projects' upstream epistemologies. Let's take a closer look:

First, and most generally, cPUS thinking seems to have manifested in the projects' intention to go beyond simplistic yes-or-no, true-or-false surveys as exemplified by the European Commission's Eurobarometer polls. Thus, instead of 'measuring' public knowledge, DEEPEN, TECHNOLIFE, and NanoFutures sought to "deepen" (Davies et al. 2009, 14) and "improve" (TECHNOLIFE 2012, 14) understanding by devising methodologies that would allow citizens to develop, voice, and negotiate their own imaginaries and positions, ultimately striving for complexity and ambivalence rather than clear-cut answers:

> "Where our intuitions begin to fail us as a guide in ethical and political matters, what is required first of all is improved understanding." (Davies et al. 2009, 55)

> "You know, what we were basically arguing is that public responses are complex and ambivalent and they are not black and white. People are not saying 'yes' or 'no' – they portray dilemmas rather than giving answers." (SD, 21-22)

Second, this interest in people's "dilemmas" was underpinned by the desire to "take the European knowledge society seriously" and "bring in the missing masses" by "taking people seriously" (KR II, 6) and showing "the richness […] of lay negotiations of science [and technology]" (Davies 2008, 15):

> "[There is] a huge disillusionment with the ruling elite, you know? So in that sense and because, I mean, because we had been trying seriously to bring in the missing masses or to take the European Knowledge Society seriously by taking people seriously, by listening to what they actually say. We just tried to make a forum where people can actually say what they feel, you know, we didn't want to impose a rigid structure […]. So, this was to get the kind of unmediated concerns, you know?" (KR II, 6)

The elicitation of such "unmediated concerns" is a common goal among all the examined projects, and we shall address its practical implications in the subsequent section when discussing the applied methodologies in more detail. What is important to recognize at this point, however, is that the projects under consideration intended to create public engagement settings that would allow participants to construct their own narratives and interpretations, draw on their own knowledges and experiences, and voice concerns whenever they arise. Hence, instead of "[imposing] a rigid structure", the researchers sought to "[listen] to what [the people] actually say", leaving room for surprising answers and

genuinely unexpected ways of knowing. As a key text of the NanoFutures project explains when commenting on the project's deliberation exercises:

> "Involving a wide range of stakeholders in deliberative technology assessment builds upon lessons of STS, particularly critical public understanding of science research that has shown that people immediately outside of technological development make sense of technology in surprising ways, ways that cannot be known by the analyst a priori." (Selin 2011, 732)

Once again, what can be observed in this quote is a clear departure from the traditional public understanding of science which mainly seeks to 'inform' and 'educate' people about scientific truths and facts; instead, the researchers chose to focus on people's imaginaries, their individual narratives and sense-making practices. Thus, instead of 'testing for knowledge', the researchers demonstrated interest in examining how knowledge was being created and negotiated.

Third, the projects also sought to foster critical reflection by providing "thought provoking" (Bennett 2008, 150) discussion material – e.g. posters with Nano-related images and newspapers snippets, short fictional stories, movie clips – and encouraging participants to debate and challenge the narratives embedded within those resources. This is particularly visible in the case of NanoFutures, where participants in the online deliberative fora were asked to comment on, scrutinize, and rework a number brief, Nano-enabled future scenes that had been "vetted" by groups of 'expert' scientists in advance:

> "The website is designed to allow users from different professional communities to see each other's thoughts and critiques. Users can debate in a discussion forum where they are invited to critique the scenes and encouraged to address issues of governance, control, ethics, religion, and cultural, economic and legal change. […] The goal of the deliberation phase of NanoFutures is to create clear thinking around the social implications of nanotechnology and as such open the future to critical reflection." (Selin 2011, 730-731)

Thus, critical thinking was not treated as noise or interference obscuring the 'real' data but, indeed, constituted the very form of public participation sought after. Ultimately, it was those critical reflections and counter narratives that played a central role in many of the projects' key deliverables (e.g. see Selin and Hudson 2010, Davies 2011, TECHNOLIFE 2012). Which brings us to a final point.

Fourth and finally, while the interviewed project members were well aware that their research related to questions of governance and policy making and thus actively sought to communicate their findings to industry stakeholders and representatives of governmental institutions, they also hoped to retain a certain "independence", i.e. a cautious, cPUS-informed distance that would allow them remain agnostic toward some of

most prevalent political-economic narratives. Above all, they strove to evade the danger of being co-opted, that is, their research being turned into a mere legitimization exercise, an "alibi" for policymakers to continue with business as usual:

> "Of course, I mean, that's the problem everybody working in this field has, that you are somehow, you want to engage with the actors in the field, on the other hand you want to remain independent of them. And you don't want to give them an alibi, you want to promote the kind of public discourse, you want what you do to be in the interest of the public not of the technology developers […]." (KR, 10)

Again, the preferable way of retaining such independence (or "authenticity", see section 4.1.2.) was seen as maintaining a critical stance and conceptualizing the projects as platforms for alternative views to be heard:

> "If you look at the folders that we handed out in Brussels and that are also put on the web page and the policy recommendations, I mean, there are some very critical statements there […]. [The project] managed to stay quite critical. We also had many critical voices in the forums. And we did not try to suppress the critical voices, we did what we said, I think, we have put them out there on the Web […] people can read for themselves." (KR II, 11)

All in all, by going beyond simplistic tick-box questionnaires, focusing on citizens' narratives and imaginaries, fostering critical reflection, and keeping a certain distance to the master narratives of both governmental institutions and industry, DEEPEN, TECHNOLIFE, and NanoFutures departed from a traditional public understanding of science and subscribed to a more critical, interpretationist logic, which undoubtedly served as a major constituent of the three projects' upstream agenda.

The upstream epistemology's third pillar then refers to a very particular idea of what it actually means to conduct future-oriented research. As noted in the introductory chapters of this thesis, one defining quality of our current moment appears to be the thinking and living towards the future (see Adams et al. 2009), a certain *state of anticipation* that asks societal actors in general and the sciences in particular to get hold of matters of uncertainty by fostering the continuous assessment of the 'not yet'. In a political realm, numerous technoscientific controversies, growing economic pressures, and the increased level of uncertainty in the age of post-normal science have *co-produced* a governance climate that seeks to strengthen anticipatory capacities by *colonizing the future* (Brown and Michael 2003) through means of forecasting, extrapolation, and probability assessments. In particular in the field of Nano, governance institutions have demonstrated interest in taking hold of the future by embracing "roadmaps as a strategic policy tool" (EC 2004b, 12) and

asking for "scientific information […] to help better predict or detect the potential impact of nanomaterials" (NSTC 2011, 13). Thus, what one finds in many Nano-related policy documents is a latent technological determinism paired with conceptions of the future as a domain that can – and should – be predicted and controlled, following the principal aim of creating "favourable conditions for industrial innovation to ensure that R&D is translated into affordable and safe wealth-generating products and processes." (EC 2005a, 3)

In sharp contrast to such an essentialist, risk- and market-oriented perspective, social science and humanities scholars engaged in Nano-related research have made the argument that "the future is not something that already exists and therefore is susceptible for social-scientific discovery" (Goorden et al. 2008, 177); instead, the future should be thought of as "continuously shaped and reshaped by initiatives and interactions of a multitude of human and non-human actors" (ibid.), as something that is neither fixed nor predetermined, but always open to negotiation. From such a constructivist point of view, the idea that 'the future' can be calculated or predicted is challenged by the assumption that futures are always *in the making*, set in motion by "socio-political, legal, scientific, economic and everyday performative, enacting practices […], producing layers upon layers of past and present futures as well as future presents and pasts." (Adam 2005, 2)

Having followed the empirical discussion thus far, it should come as no surprise that the three projects under consideration adhered to this latter, constructivist position rather than the prediction-centered model that can be found in many contemporary policy documents. As a NanoFutures researcher pointed out:

> "I don't think we went into this [project] with a kind of a futurist view. I think we went into it with a kind of dynamic constructivist view, and with a kind of democratizing view. […] So, we recognised that futures were part of it, but, of course, prior to the nanotech work my big effort had been on the limits of prediction and predictability for decision making. So, I saw the future as a kind of a very problematic domain that could not be left to itself." (DS, 4)

What is apparent from this quote is that the future was not generally dismissed as an issue of concern. Quite on the contrary, the interviewee perceived the future as a "problematic domain that could not be left to itself." Yet, it was not the future from a "futurist" perspective that was of interest – that is, a perspective where one "studies the future and makes predictions about it based on current trends"[65] –; rather, it were the myriad ways of how futures are being constructed and debated that were central to the NanoFutures – but also to the DEEPEN and TECHNOLIFE – approach. Thus, instead of looking into the future and

[65] See Oxford Dictionaries Online, keyword "futurist".

attempting to forecast or predict prospective developments, the researchers sought to look at how futures were being produced and discussed, accepted, refuted, and negotiated. As the quote already indicates, this "constructivist view" can also be regarded as a "democratizing" one, since the conception that the future is being made in the 'here and now' rather than set in stone awaiting its materialization allows for debate as to what kind of future(s*)* ought to be created. Hence, the switch from an essentialist or realist perspective to a constructivist point of view is not merely a theoretical one, but also one of political significance: If the future is not an ontologically fixed entity 'out there' but the outcome of continuous negotiations, people may actively partake in future-making processes, following the idea that their visions and expectations "are not just rhetorical articulations of the future, but are actually constitutive of futures" (Selin 2011, 734), playing "an important role in the reception, up-take [sic] and legitimation of scientific and technological innovations." (Adam 2005, 6) In sum, the projects' adopted a threefold approach to future anticipation, seeking to 'democratize the future' by stressing its constructed nature, to "understand future orientation and how that impinges upon technological development" (CS, 1), as well as to "reinvigorate the discussion about what kind of scientific and technological future we want to create." (TECHNOLIFE 2012, 13) In doing so, DEEPEN, TECHNOLIFE, and NanoFutures opened the future to bottom-up deliberation, seeking to capture citizens' imaginations of "plausible" or "desirable" (Nano) futures rather than producing probability assessments or conducting risk-benefit analyses. Which brings us to a final point: If futures are created in the 'here and now', they are also situated, i.e. an outcome of specific technopolitical cultures and sociotechnical imaginaries. Hence, imagined futures might always be seen as reflections of the present as well as mirrors of the past (see Brown and Michael 2003), a notion well known to the projects at hand. As a DEEPEN researcher would state:

> "Well, I think […] that the future can be a kind of speculation, and when people talk about the future it can be seen as something that is sort of abstracted from the here and now. And we wanted to make sure that those connections are very much to the forefront." (PM, 6)

Thus, by looking at how futures were being (de)constructed, the researchers sought to learn about people's own frames of reference, that is, their individual or collective but always situated imaginations, ways of ordering, and sense-making practices. In this sense, they were not interested in 'the future' as such but in *people's futures*, i.e. futures that were both created and negotiated *by* the people but that also referred to the living worlds *of* the people. Ultimately, by turning the future into a debatable entity and encouraging the articulation of counter-narratives, this constructivist, citizens' imagination-centered

approach to matters of future anticipation served as another vital cornerstone of the three projects' upstream agenda.

The fourth and final pillar of the upstream epistemology marks the move away from the so-called "risk paradigm" (e.g. see Starr 1969; Beck 1992), i.e. a – not to say the – dominant policy framework in which "'risk' is highlighted […] not just as an important element, but as *definitive* of all the issues raised in the governance of science and technology" (Felt et al. 2007, 37; emphasis as original), appearing "almost emblematic of governance itself." (ibid., 31) Within this paradigm, risk assessments that "seek to provide a single answer: safe or unsafe" (Stirling and Mayer 1999, 5) have been "firmly upheld as the gate-keeping scientific tool for policy decisions on precaution as if [they] addressed all aspects of incertitude." (Felt et al. 2007, 37) However, STS scholars have been critical of the concept of risk as a dominant governance principle for decades (e.g. see Wynne 1989; Jasanoff 1990; Winickoff et al. 2005), usually focusing on two major points of concern:

First, the argument has been made that the logic of risk as it appears in contemporary policy documents largely neglects risk assessments' own normativity, that is, the "subjective judgments, influential social values, contestable assumptions and administrative procedures that are open to contingent framings and the tacit or deliberate exercise of power." (Felt et al. 2007, 33) In this sense, governance authorities tend to objectify the (often probabilistic, quantitative) measurements of risk, in utter disregard of "why different risk assessments on the same issue can obtain widely varying results, even though each has apparently been conducted in accordance with the tenets of 'sound science'." (ESRC 1999, 7) Thus, the currently prevalent logic of risk conceals how "claims related to technological risk are socially constructed" (Jasanoff 1990, 13), remaining ignorant to the subjective definitions, framings, and assumptions as well as the social, ethical, and political dimensions that underpin any analysis of risk, thereby reifying what "should be opened to more deliberative processes." (Felt et al. 2007, 85)

The second major concern pertains to the paradigm's focus on risk and risk alone. As stated, conventional risk assessments usually build on narrow, technical conceptions of 'risk', seeking to provide but a single answer: safe or unsafe. This entails, however, that other issues and concerns raised by new technoscientific developments are being marginalized, e.g. leaving aside "matters of social need, prioritisation, […] and choice". (Felt et al. 2007, 31) As a result, conventional approaches to risk governance have been criticized for their inability to address and provide answers to a host of questions: What are the social,

ethical, and legal implications of certain technoscientific developments? Who might benefit and who may lose from such inventions? What are the underlying agendas and interests? Which technological and scientific pathways should society pursue? What should a future society look like? Which values, mores, and ethics should be prioritized? And who should be allowed to decide upon such issues? (see ibid., 35) Considering political questions such as these has been described as central to the establishment of more socially responsible modes of innovation governance (Felt et al. 2007; Davies et al. 2009) but goes far beyond the scope of traditional risk analysis. As STS scholars have argued, "the established techniques of risk assessment seem unable to accommodate the wide diversity of issues" (Stirling and Mayer 1999, 5) or "fully […] characterise the fundamental risks and uncertainties associated with the potential impacts of a new technology." (ESRC 1999, 6)

As indicated, all of the three examined projects, i.e. DEEPEN, TECHNOLIFE, and NanoFutures, shared this critical view of the risk paradigm and its dominant role in contemporary policy discourse. The reasons and rationales given for this rejection differed slightly; however, the paradigm was unanimously seen as neglecting complexity, ambivalence, and the depth and breadth of public concerns towards matters of scientific and technological innovation. As a TECHNOLIFE researcher argued:

> "We need to go beyond this risk analysis. It doesn't work. If you take uncertainty and complexity seriously, you cannot seriously claim that we are going to first calculate the risks of implementing this or that technology and then put the policy solution on top of that. It's absurd because, well, first of all, it's extremely utilitarian. It follows a utilitarian morality, you know, that everything that counts is risks and benefits and politics is about distributing the risks and benefits and that's it." (KR II, 13)

And a member of the DEEPEN team would contend:

> "So, definitely, that moving away from the risk paradigm, that was important to us. So not just framing things in terms of risk […]. I mean, I think the problem with the risk paradigm is that […] if you're prepared to look in more detail at talk there is always richness there that goes beyond that." (SD, 23)

Thus, the risk paradigm was perceived as logically flawed as well as epistemologically and politically inadequate, unable to "deal with [the] kind of ambivalence and complexity" (SD, 22) the projects sought to produce and portray. In essence, the researchers were convinced that the paradigm "doesn't work" and "is broken" and that it was time for another conceptual model to take its place. As a CNS-ASU member would explain:

> "First of all, you know, the risk paradigm is broken. We know this and yet we persist. […] Do we try to accommodate nanotechnology to the broken risk paradigm? Do we try to massage the risk

> paradigm to accommodate nanotechnologies […]? Or do we try to overturn the risk paradigm in order to solve [….] the problems of […] nanotechnology? […] The risk paradigm is there and entrenched and broken. We need something to bridge it pretty damn quickly. " (DG 8-9)

And "bridging" the paradigm is what the projects attempted to do: NanoFutures, for instance, positioned the concept of plausibility as a counterproposal to the entrenched ways of risk-based thinking, seeking to capture citizens' views on "plausible nano-enabled products" (Bennett 2008) rather than centering the debate on questions of risk and safety alone. TECHNOLIFE, on the other hand, drew on Jasanoff and Kim's concept of sociotechnical imaginaries (Jasanoff and Kim 2009), Beck's notion of sub-politics (Beck et al. 2001), as well as Marres' and Latour's 'issue-oriented' perspective on public involvement (Marres 2005; Latour 2007) to address the unresolved and "underrepresented public issues" (KR, 3) present in current technoscientific developments. Last but not least, the DEEPEN project suggested a "reconfiguration" of the notion of "responsible development" (see Davies et al. 2009) in order to move beyond "the banal calculations of 'risks vs. benefits'" (ibid., 37) and turn from "reactive forms of risk governance to more integrative forms of innovation governance" where "direct public participation and deliberation is to play a formative role." (ibid. 27) Thus, all three projects explored ways of "how to get beyond the language of risk" (MK, 27), advocating more open forms of deliberation on technoscientific innovation that would pay attention to citizens' concerns beyond mere safety considerations. In that sense, the move away from the risk paradigm constituted yet another central pillar of the projects' upstream agenda, emphasizing the multifacetedness of citizens' unease with science and technology and arguing that less restrictive modes of public engagement appear as central to a governance of innovation that endeavors to take contemporary knowledge societies seriously.

All in all, this section sought to provide an overview of the major constituents of the so-called "upstream epistemology", that is, a common set of assumptions, values, and interests that serves as a conceptual and ideological basis for the conduct of upstream public engagement research in science and technology. It was argued that this epistemic framework rests upon four pillars: A co-productionist approach to the relationship between science, technology, and society; the move towards a critical public understanding of science; a constructivist, citizens' imagination-centered approach to the anticipation of technoscientific futures; as well as attempts to move beyond the risk paradigm and incorporate more open, integrative, and deliberative forms of public engagement. Put otherwise, the four pillars can also be interpreted as a de-naturalization of science and

technology as separate, truth and fact-based domains 'out there', as a rebuttal of the idea that scientific knowledge was ontologically different from other kinds of knowledge and expertise, as a de-essentialization of the future as something predetermined that can be calculated and predicted, as well as a contestation of the concept of risk as a suitable policy framework for a socially reflexive governance of innovation. Taken together, these epistemic convictions made for a robust ideology, a technopolitical agenda that challenged present forms of governance and indicated that in order to better deal with pending problems – e.g. public disaffection with and mistrust of particular fields of science (see Felt et al. 2009, 9) –, things ought to be done differently. What this might mean in practice shall now be explored in the final section of this chapter, which takes a closer at the projects' methodological frameworks, i.e. DEEPEN's, TECHNOLIFE's, and NanoFutures' "technologies of imagination".

4.3.2. Technologies of Imagination

The previous section has outlined the basic tenets of the upstream epistemology and its overt technopolitical agenda. Yet, in order to actually conduct upstream public engagement research, theoretical considerations alone do not suffice but have to be accompanied by methodological frameworks capable of putting abstract concepts into empirical practice. As indicated, the researchers of the three projects under consideration sought to develop such upstream engagement-oriented methodologies, i.e. methodologies that would "go beyond these kind of banal deliberative processes and public opinion surveys that do present these yes-or-no answers" (SD, 22), creating "something that is more, that is deeper […], that holds out the possibility of saying 'no' or presents different kinds of imaginations or other ways of doing policy, for instance." (ibid.) Thus, in line with Law's (2004) argument that methods are performative and actively partake in the construction of the realities they claim to (passively) observe and (objectively) describe, the researchers of DEEPEN, TECHNOLIFE, and NanoFutures intended to trigger upstream public engagement by designing participatory methods that refrained from top-down information dissemination or simplistic tick-box questionnaires, creating *spaces* and *places* of knowledge production (see Livingstone 2003; Felt et al. 2012) that would encourage debate rather than closing it down, allowing participants to draw and reflect on their own experiences and bodies of knowledge, to negotiate meanings instead of 'having to understand them', as well as to voice concerns and dismiss ready-made visions whenever *they* (i.e., the participants) thought it necessary. Following Felt and others (2013b), one might think of such methodological frameworks as

"technologies of imagination", that is, methods and techniques that invite users to discuss "potential sociotechnical worlds from different angles" (ibid., 16) and "imagine what the development of [(nano)technologies] in specific areas of social life could mean for them as individuals and for the future of society as a whole" (ibid, 13-14) by "[relating] and [associating] what is perceived as possible with what is seen as 'given' or 'real'." (ibid., 3) Ultimately, such "technologies of imagination" pay attention to 'lay' forms of expertise and sense-making that are all too often bracketed out in conventional public engagement settings (e.g. see Fochler 2007), "[taking] seriously the cultural narratives citizens develop when addressing emerging technologies." (Felt et al. 2013b, 3)

As we shall come to see, the process of designing such engagement methodologies is a delicate and inherently political undertaking as it – at least to some extent – predefines the conditions under which the encounters between researchers and participants are to take place, determining, for instance, who is allowed to speak as well as what counts as a legitimate knowledge-related action. Against this background, the interview material suggests that with regard to upstream public engagement, three issues are of particular concern: Who is allowed to participate? At what stage of an ongoing technoscientific innovation process does the engagement activity actually take place? And: In what way are people expected to participate? Following, we shall address these questions in some more detail, with particular attention to the third question, for this is where the concept of technologies of imagination makes its most prominent appearance.

To begin, there is the question of *who should be allowed to participate* or *who is considered a 'relevant' participant*. As STS scholars have argued, public engagement settings are "never simply an arena in which interactive deliberation takes place," but always perform "a certain vision of the public without acknowledging that they are doing this." (Felt et al. 2007, 57). In this sense, engagement exercises should be understood as concrete constellations of "who is given voice or not" (ibid.), who are the "invited" publics as opposed to the ones left out (see Wynne 2008), as well as whose knowledge and expertise ultimately counts (e.g. see Epstein 1995; Irwin 1995). The researchers of DEEPEN, TECHNOLIFE, and NanoFutures seemed well aware of these politics of public engagement and took a clear stance on what kind of "vision of the public" they wanted to enact. Most fundamentally, they appeared convinced of "the need to bring in more voices in science and technology policies in general" (KR II, 2) and thus sought to "get as many perspectives and voices as possible" (SD, 14) different from "the ones usually heard" (KR II, 8), with the ultimate goal of "trying to

represent or understand public voices a little bit better" and "be taken up by policy in some way." (SD, 19) What does this mean in practice? For starters, it means that the projects sought to bring together a broad range of citizens from heterogeneous social, professional, and, in the case of DEEPEN and TECHNOLIFE, national backgrounds, holding distinct sociotechnical imaginaries as well as different kinds of experiences and (lay) expertise. Thus, diversity was seen as an asset, a way of "bringing in the missing masses" (KR II, 14), "[collecting] some new perspectives" (KR II, 16), and pointing out some of the "underrepresented public issues" (KR, 3) that are often overlooked – or willfully ignored – in the governance of science and technology. However, while all three projects under consideration sought to assemble such diverse groups of people, they did so in quite different ways: The TECHNOLIFE team, for instance, aimed to elicit the "concerns of European communities, groups and societies" (TECHNOLIFE 2012, 5), using mail, email but also Internet platforms such as YouTube and Facebook to promote their project and draw as many people as possible to the online discussion fora. Overall, more than 200 people registered at these fora, adding to the overall number of 10 000 unique site visits (see TECHNOLIFE 2012, 40). Nevertheless, one researcher mused when asked about the project's initial objectives:

> "You know, you always have this huge ambition when you start doing things. […] Personally, at least, I had somehow a naïve idea that we would reach even more people. That we would, we could even have some kind of a complete overview of the imaginary landscape of European publics. […] Of course, I had to realize that […] there probably are many people that we would like to get in touch with that we won't get in touch with. […] And this, I'm sure it has limited the kind of voices that we were able to include." (KR, 2-5)

Problems in execution notwithstanding, what is important to realize is that the TECHNOLIFE researchers had the "ambition to include many different groups" (KR, 5) and aspired to provide a kind of panoramic view of the European Knowledge Society, following the main goal of "taking the public seriously" (KR II, 13). The DEEPEN project, in turn, coincided with the TECHNOLIFE approach in that it sought to gather "as many perspectives and voices as possible" (SD, 14); however, the DEEPEN team opted for a more "topic-specific" (ibid.) recruitment strategy, convening six focus groups of six to eight individuals selected around "standard demographic criteria [but also] commonalities likely to have relevance to negotiations of the ethical issues nanotechnology presents." (Macnaghten et al. 2010, 17) These groups were a church group, a student environmental and social justice group, a group of (female) users of organic products and alternative therapies, a group of (male) 'confident supporters' of technology, a group with interests in local community involvement,

as well as a group who saw themselves as having authority in their workplaces (see ibid.). Again, the aim of conducting the focus groups was to obtain "a large tranche of data" which could "be used to examine the ways in which laypeople grapple with the meaning of a technology that remains 'in-the-making'", providing "an account of the content and context of lay hopes and concerns around nanotechnology, to an extent that has not been possible with previous research." (ibid., 17-18) Last but not least, and not unlike the TECHNOLIFE approach, the NanoFutures team too sought to bring together representatives of "different professional communities" in a number of online discussion fora, encouraging people to "address issues of governance and control, ethics and religion, and cultural, economic and legal change." (Selin 2011, 730-731) Amongst the invited participants were social scientists (e.g. members of the Society for Social Studies of Science), natural scientists and engineers, public policy folk (e.g. members of the Consortium for Science, Policy and Outcomes), non-governmental organizations engaged with nanotechnology, individuals with a general interest in Nano (e.g. members of the Foresight Institute; the Center for Responsible Nanotechnology community), as well as various other publics (e.g. ASU alumni; participants of the National Citizens Technology Forum).[66] (see ibid., 731) And while NanoFutures researchers recognized that there were "obvious shortcomings in the selection of these communities", they nevertheless felt that the selections would "offer a reasonable range of perspectives", revealing "different epistemologies[,] […] different standards of plausibility and different ideas about governance, ethics and desirability." (ibid., 732) All in all, while none of the projects would deliver a comprehensive picture of citizens' sociotechnical imaginaries – an impossible undertaking, to be sure –, they all sought to broaden the spectrum of invited publics, turning away from expert-centered, deficit model-oriented information dissemination exercises and seeking to give voice to those who usually go unheard. Thus, despite all conceptual differences, the projects provided a fairly unanimous answer to the question of who should be allowed to participate: More people than usual, and not only those in charge.

Second, there is the question of *when is the 'right' time to start deliberation*, that is, at what stage of an ongoing technoscientific innovation process should public intervention actually take place? Within the context of upstream engagement and the governance of science and technology, this question can be linked to the so-called Collingridge Dilemma (Collingridge 1980), i.e. the notion that "impacts cannot be easily predicted until the technology is

[66] For more information on these institutions, see Selin 2011.

extensively developed and widely used", but that "change is difficult when the technology has become entrenched." (see Rip et al. 1995, 7; quoted after Gow 2005, 35) Thus, while it might prove difficult to discuss the social, ethical, or legal implications of a technology as long as the technology has not yet fully materialized in society, deliberative activities may lose their chance of making an actual difference as soon as the technology has become so well-entrenched and 'locked in' that any modifications or renegotiations seem impossible.

It appears that the researchers of DEEPEN, TECHNOLIFE, and NanoFutures were well aware of this "double-bind" (ibid.) dilemma and sought to suggest potential solutions in their project deliverables. Most fundamentally, they would argue that in order to evade 'locked-in' situations, "social justice, equality and power ought to be contemplated and discussed upstream […] already *at early stages* at [sic] R&I". (TECHNOLIFE 2012, 30; emphasis GR) Consequently, they sought to "develop new frameworks for the *early* identification, characterization and deliberation upon ethical issues" (ibid., 3; emphasis GR), frameworks that wouldn't "remove the motivation or the passion that people may have to somehow influence developments." (KR II, 7) However, given Nano's status as an emerging technology 'in the making' that has – despite its presence in many consumer products – not yet fully matured and whose potential is still being explored, how could – following Collingridge's argument – reliable "predictions" of the social, ethical, and legal implications of Nano ever be attainable? Again, the answer to this question is indicative of the projects' technopolitical agenda as such: As has been argued in the previous section of this chapter with regard to the intricacies of future anticipation, the three projects under consideration did not intend to 'predict' anything; rather, they sought to initiate upstream deliberation around plausible or implausible, desirable or undesirable technoscientific futures, shifting the central question from "What will the future be like?" to "What kind of future do we, as a society, want to create?" Thus, instead of focusing on a *reactive* debate about potential risks – again, it is "reactive" because in such a conceptual framework, the future is conceived as a fixed domain that can be predicted and hence (re)acted upon –, the projects sought to instigate *proactive*, citizen imaginaries-centered deliberations concerning the social acceptability of specific technoscientific trajectories, thereby promoting a move from a governance of risk to more integrative forms of innovation governance (see Davies et al. 2009). What is particularly noteworthy in this context is the notion of being or becoming "proactive". As one interviewee stated:

> "I think we should become very proactive […]. Proactive and engaging with ongoing events. You know, there will be restructurings of Western societies. There is a need for change. And people

> working in STS or ELSA or Technology Assessment should actually claim a knowledge about how to facilitate this change. […] Yeah, [a] proactive stance I think is good." (KR II, 32)

In this quote, the adoption of a proactive stance appears as an obligation rather than a matter of choice, an imperative if contemporary science and technology studies and its subfields are to play a guiding role in present and future technoscientific controversies. But what does it actually mean to be or become proactive? As one interviewee explained with regard to the concept of anticipatory governance, an approach that – in its CNS-ASU version – developed alongside the NanoFutures project and incorporates a forward-looking, proactive agenda (e.g. see Barben 2010; Selin 2010):

> "And the metaphor that I use when I talk about this [i.e. future anticipation, GR] […] is of actual physical exercise. And when you go to a gymnasium and work out and you do your presses and you do your curls and you do your pulls, you're not doing that because at some point in the future you believe that you are going to have to push a beam that's fallen on your chest […]. You're doing that because you believe that you're building in your body a capacity to face whatever physical and emotional stresses you are necessarily going to face, […] whatever they might happen to be. And so in that sense, you know, anticipatory governance is exercise, one can also use the term rehearsal." (DG, 7-8)

According to this quotation, taking an anticipatory stance towards the future can be understood as a kind of workout, a state of exercise where one proactively trains, prepares, and rehearses for tasks that are yet unknown or, in the language of post-normal science, uncertain. Of course, in the context of upstream public engagement, any "presses", "curls", and "pulls" have to be substituted by "talks", "reflections", and "negotiations"; however, these activities serve a similar purpose, which is to build capacities in order to better deal with future challenges. Again, this has nothing to do with prediction or forecasting but represents an alternative form of future orientation, one that builds upon a "radical rejection of prediction" (Guston 2008, VII) and instead embraces more deliberative and, potentially, more democratic ways of innovation governance.

All in all, the empirical data suggests that DEEPEN, TECHNOLIFE, and NanoFutures had a fairly clear vision of how Collingridge's methodological quandary could be solved or, at least, systematically bypassed: By arguing that matters of technoscientific innovation ought to be discussed upstream at the very early stages of research and development (R&D) and simultaneously departing from the aim of predicting the future, the projects demonstrated how uncertainty could be turned from a problem to be eradicated into a state that can be governed by means of proactive engagement. Which leads us to a third and final question: How can such a proactive, forward-looking debate actually be initiated? How, indeed, is it possible to ignite deliberation and discussion about that which is yet unknown? The answers

to these questions shall lead us to the very heart of the idea of technologies of imagination, that is, a particular politics of engagement inscribed into concrete methods and techniques employed to stimulate public deliberation and fuel citizens' imagination.

As a brief reminder: Following Felt and others (2013b), the concept of technologies of imagination entails the idea of developing research methods that will encourage participants to "engage with expectations and promises" (ibid., 7) about new and emerging technologies, to "develop and negotiate individual and collective *imaginations*" (ibid., 3) pertaining to these technologies, as well as to consider "potential sociotechnical worlds from different angles" (ibid., 16), reflecting on what the development of certain technoscientific inventions "could mean for them as individuals and for the future of society as a whole" (ibid, 14). In essence, such methods are meant to create "a space in which open criticism of expertise and experts [is] possible" (ibid., 13), according "all participants a voice, independent of their background or experience." (ibid., 4) Consequently, technologies of imagination take a clear technopolitical stance, focusing on lay people's narratives and imaginaries instead of experts' judgements, fostering bottom-up deliberation instead of top-down information, and facilitating critical reflection instead of acting as a form of public appeasement, thus seeking to open up issues rather than striving for (premature) closure. In sum, technologies of imagination might be understood as the methodological counterpart of the upstream agenda outlined in the previous section of this chapter, a practical realization of the idea that a socially reflexive governance of science and technology should be aware of the "processes through which people engage with complex new issues" and "form opinions on emerging technologies." (ibid., 3)

An important element of the concept of technologies of imagination is the provision of stimulus material, that is, "a broad repertoire of resources to stimulate discussion without closing down or narrowing issues from the outset." (ibid., 4) Such "resources" can be provided in various forms (e.g. texts, pictures, videos, etc.) and integrated into the engagement process in multiple ways. For instance, Felt and others (2013b) describe the development and design of IMAGINE, an elaborate, multistage engagement method modeled after – but making significant changes to – the card game PlayDecide. Just as the game, IMAGINE uses different sets of cards to "capture the breadth of available positions and issues", encouraging "participants to focus on specific aspects" while "allowing flexibility [and] providing some structure." (ibid., 5) Ultimately, the cards were supposed to act as material support, enabling participants "to creatively engage with the elements […] and

imagine how an emerging technology – in [their] case nanotechnology – could develop in the future." (ibid., 1) Methods such as these can be found in all of the three projects under consideration, and even though these methods were not formally labeled as "technologies of imagination", they acted as such, serving as a conceptual means of triggering debate and stimulating people's imaginary capacities:

The NanoFutures team, for example, created six fictional, Nano-enabled product scenes, reaching from a disease detector able to track people's health status and detect diseases, over cranial chip implants capable of feeding data to the brain of a user while the user sleeps, thereby enabling overnight learning, to the vision of a "barless prison", realized by injecting prisoners with caged drugs that are being released if a prisoner crosses certain boundaries, causing a variety of effects, from mild nausea over temporal incapacitation to death.[67] These product descriptions were posted on the project website and participants were asked to "assess [their] plausibility" (see Selin 2011, 730) in dedicated discussion fora and/or rewrite them using a wiki platform. Ultimately, the scenes were meant to "stimulate [participants] to reflect upon meanings, potentials and problems surrounding nanotechnology", with the goal of "[cultivating] our collective ability to govern the implications of out technological ingenuity."[68]

The DEEPEN researchers, in turn, produced a series of posters with text, quotes, charts, and images, covering basic issues such as "What is nanotechnology?" but also providing panoramic displays of current Nano-enabled products such as sunscreens, anti-bacterial silver coatings for fridges, or computer chips, as well as potential future applications such as targeted drugs, human enhancement technologies, or nanobots able to "create whole objects from raw materials" (DEEPEN 2008, 8). However, the posters did not solely concentrate on nanotechnological applications but furthermore addressed related issues such as uncertainty and regulation, control and surveillance, access and inequality. Ultimately, the posters were supposed to act as "stimulus material introducing nanotechnology and the visions around it" (Davies et al. 2009, 22), encouraging focus group participants to "further reflect on and act out futures where aspects of nanotechnology had become reality." (ibid.) As a DEEPEN researchers remembered:

[67] The product scenes as well as the accompanying discussion fora and wiki sites have been taken off the Web. However, they can still be accessed with the help of Archive.org's Wayback Machine under: http://web.archive.org/web/20080612181559/http://cns.asu.edu/nanofutures/.

[68] Again, see the NanoFutures website at Archive.org under: http://web.archive.org/web/20080628105519/http://cns.asu.edu/nanofutures/scenarios.html.

"So there were eight posters and we had them printed out in a large format kind of A0 or something like that, and they mixed quotes from different documents and people with images and scans of newspaper headlines and stories. […] Each poster had a mishmash of voices and images and sources. […] People could choose what they were interested in or concerned about or excited by and lead the discussion around that. […] They stimulated discussion." (SD, 10-11)

Last but not least, the TECHNOLIFE team created three short, Nano-related movies of three to four minutes each that were supposed to work as "a kind of science fiction of the everyday life" (KR, 20), "[triggering] questions and [triggering] debates" (AD, 4), allowing the researchers to see "how people were grounding their claims in relation to the movies." (KR, 12) The movies were made in a "strongly market-oriented fashion" (TECHNOLIFE 2012, 19) but also featured dystopian undercurrents – such as a reference to Nazi eugenics in the clip on human enhancement – that would put the commercial content into question. Ultimately, the movies were meant to be "kaleidoscopic" (AD, 4), i.e. providing multiple perspectives and addressing a number of issues, so that they "[could] be watched and interpreted from very different angles" (ibid.), serving as a common starting point for discussion and encouraging a thorough "questioning of […] technology" (ibid., 5).

As one can see, the three projects under consideration employed quite different methodological tools and artifacts – from short product scenes over panoramic posters to kaleidoscopic movie clips. However, these artifacts were all designed to achieve a common objective, that is, to trigger upstream deliberation and foster critical reflection by stimulating people's imaginary capacities and encouraging them to consider and position themselves against potential technoscientific futures. But how, exactly, was this to be done? How were these tools supposed to encourage discussion and propel people's imagination? Again, a closer look into the interview material provides some potential answers to these questions, as it offers insight into researchers' assessments of the fundamental workings of their 'artifacts of imagination':

First, interviewees argued that the stimulus material was meant to function as a sort of "hook", that is, as a way to draw people's interest, to lure them in and get them to participate:

"It's a way which comes from fishing. So when you fish you have an angle, you have a line, and then you have a sort of hook, and then the fish eats whatever is on the hook and is then captured by the hook and cannot get loose. So our tools have that hook in them." (AR, 21)

While this particular quote refers to the utilization of complexity scenarios (see Robinson 2008) in constructive technology assessment (CTA), similar narratives could be found in the

case of TECHNOLIFE and NanoFutures, both projects that used their stimulus material as online "recruitment devices" to attract people's attention and 'fish' for as many participants as possible:

> "We used the movies as kind of recruitment devices [and] we placed them in online forums. And then we started to get some attention online and then people started to […] migrate to the [TECHNOLIFE] forums." (KR, 5)

Thus, even before any actual deliberation had occurred, the projects' stimulus material served as a means to reach a broader audience and awaken people's interest, thereby fulfilling a pivotal role in the quest for upstream public engagement.

Second, the researchers argued that the stimulus material was meant as a "kind of conversation piece, a way to begin to frame and initiate a conversation" (CS, 2), but also as a means of "establishing a common world" and "[focusing] the discussion" (KR, 25). In that sense, the stimulus material acted as a kind of "boundary object that can be used as [an] exploratory tool for collective exploration as the discussion develops." (KR II, 17) What is important to recognize, however, is that such "robust" but nevertheless "adaptable" boundary objects (see Star and Griesemer 1989) were not only seen as capable of facilitating the conversation among the participants of a specific engagement exercise, but were furthermore perceived as "dialogical objects" between the participants and the project researchers, for example when the former would attempt to *de-scribe* the technopolitical *prescriptions* that are (tacitly) *inscribed* in the stimulus material (see Akrich 1992; Felt et al. 2013b). As a TECHNOLIFE researcher explained:

> "These kinds of objects that you can create […] can become kind of dialogical or cultural objects, [they] can also have a life of their own and […] you can build different perspectives into [them]. And then, when people participate, they change, you know. And then you can just follow the course of the object and you see where it goes. So […] you can […] use them for collective exploration. (KR, 25)

Thus, with regard to the deliberation exercises, the stimulus material played a crucial role in at least two distinct ways: On the one hand, the scenes, poster, and videos were both robust and concrete enough to serve as a common point of reference, enabling participants to focus and reflect on the same technoscientific issues and developments. On the other hand, however, the material was also open and malleable enough so that participants could raise critical questions, challenge certain assumptions, dismiss certain preconceptions, and formulate alternative visions. To put it in actor-network terms, while the scenes, posters, and videos served as "immutable mobiles" (Latour 1987) throughout the projects'

dissemination and early discussion phase, their "plasticity" (Star and Griesemer 1989) allowed them to become mutable as the debate continued and participants started to de- and re-assemble the *inscribed* narratives. Ultimately, both these qualities appeared as central to the realization of upstream public engagement, which leaves only one final question to be answered: How was it possible to achieve such openness, malleability, and plasticity in the first place? Put otherwise: How did the researchers design the utilized stimulus material so that participants would be encouraged to assess it critically rather than simply accepting it as fixed and ready-made top-down information? A final point provides some potential answers.

Third and finally, the interview material indicates that the researchers had quite clear visions of how the stimulus material should be constructed in order to achieve the intended results, that is, a lively upstream debate about technoscientific futures. In this regard, two narratives emerged as most prevalent:

For one, the researchers argued that the stimulus material ought to be "provocative enough to evoke a response from the reader" (Bennett 2008, 150). As a TECHNOLIFE researcher stated: "What was clear from the beginning was that we wanted to play some kind of provocation […] and invite people to take part." (KR, 18) However, as the quote already indicates, this "provocation" was not seen as an end in itself but rather as a way to make people participate and kick off a larger debate:

> "In a sense, the point is not to discuss the movie, the point is that people discuss whatever is of concern to them. So […] you discuss […] another entry that provokes you. It's just to get things going with a certain focus. So, in that sense, I think the movies worked quite well because you can see people start out discussing issues in the movies and then gradually they drift off to other things." (KR, 32)

Thus, the idea of evoking critical responses in order to spark a larger debate was central to the initial conception of the stimulus material. However, these responses were also considered valuable findings in themselves, for they were seen as indicative of people's sociotechnical and technopolitical imaginaries. Hence, as already argued in the previous section with regard to the projects' upstream agenda, criticism and disagreement was not perceived as an undesired byproduct of deliberation, but indeed as the very kind of public response the researchers sought after:

> "Yeah, but that's another great thing because […] it doesn't matter if they criticize them [i.e. the movies, GR]. Then you just ask 'why', you know, you just ask every time you can just 'why', 'but why', and then you just take the criticism and then you learn something new. So that's: 'Why you didn't like them? How should we have done it differently?' And that's interesting too." (KR, 26-27)

Ultimately, the implementation of a 'provocative edge' that would encourage critical reflection appears to have been one of the key strategies by which the researchers of DEEPEN, TECHNOLIFE, and NanoFutures sought to ensure that their 'artifacts of imagination' remained malle-, mut-, and negotiable.

The second strategy bases on an idea that has already been mentioned above, namely the notion of producing "kaleidoscopic" (AD, 4) stimulus material, i.e. texts, posters, or videos that do not attempt to provide a single, coherent vision of 'the future' but rather a potpourri of "different voices and stories" (SD, 10) that can be interpreted from various perspectives:

> "So in principle we wanted to do something that would look more like a movie that has many different angles and that can be watched like it was a kaleidoscopic movie, so that it can be watched and interpreted from very different angles. Because what we wanted to avoid is to give one single vision of the future […]. We wanted the movie to trigger questions and to trigger debates. We didn't want to tell to people clearly 'Your future could be like this, like this, like this, like this.' So you know, there are these possible futures." (AD, 4)

Thus, instead of providing a linear, narratively homogeneous storyline, the intent was to produce a "mishmash of voices and images and sources" (SD, 10). Thereby, the researchers sought to contrast "powerful images with other powerful images" (AD, 5) in order to "create a break [and] smash that image" (KR, 21), following the ultimate goal of "opening up for discussion and questioning." (AD, 5) In that sense, instead of presenting coherent plots, the researchers assembled contrasting "snapshots" (IB, 8) that were supposed to allow participants to "[engage] with [a] technology" by "[deplacing] the technology into [their] own context[s]" (IB, 4). Thus, rather than 'closing things down' by leading participants onto preconceived paths, this kaleidoscopic way of presenting Nano-related developments was meant to stimulate an open, only loosely moderated debate that would build on people's sociotechnical and technopolitical imaginaries rather than ready-made master narratives. Ultimately, this may also be the reason why none of the projects under consideration utilized full-fledged scenarios, for such story-laden, "internally consistent accounts" (Mietzner and Reger 2005, 224) of the future might bear the danger of pre-framing the debate in a way that hinders the elaboration and negotiation of alternative pathways.

With this, we shall conclude our discussion of the three projects' artifacts of imagination, having emphasized their significance for the initiation of upstream deliberation.

All in all, this final empirical section sought to take a closer look at the three projects' methodological frameworks, exploring how these relate to the concept of upstream public engagement. In essence, the argument was made that despite significant differences the applied methodological choreographies all acted as "technologies of imagination", that is, as methods which are intended to stimulate participants' imagination, inviting them to discuss potential technoscientific futures from different angles and reflect what such developments might imply for them as individuals as well as for society at large. In practice, this particular approach to future anticipation was underpinned by three distinct methodological choices:

First, as a response to the crucial question of *who* should be allowed to participate in an engagement exercise, the three projects under consideration turned away from traditional forms of expert consultation or stakeholder workshops and instead sought to broaden the range of invited publics, opening their online discussion fora to anyone interested in taking part (TECHNOLIFE, NanoFutures) or organizing a number demographically heterogeneous focus groups (DEEPEN), thereby giving voice to those who usually go unheard and acting as a *space* for the formulation of alternative epistemologies, 'lay' opinions, and bottom-up critique.

Second, the projects took a clear stance on *when* upstream public engagement should take place, arguing that matters of technoscientific innovation ought to be discussed at the very early stages of research and development (R&D), at a point when emerging technologies have not yet become 'locked in' and trajectories might still be open to debate. In this regard, the difficulty of discussing the potential implications of a technology that has not yet fully materialized (e.g. nanotechnology) was sought to be overcome by moving away from the aim of predicting the future and, instead, a turn towards more proactive forms of future anticipation – forms that would focus on social desirability rather than risk versus benefits assessments, on social plausibility and acceptability rather than sheer technological feasibility.

Last but not least, as a sort of practical answer to the question of *how* lay citizens should be allowed to participate in an engagement process, the project researchers created "provocative", "kaleidoscopic" stimulus material that was supposed to stir people's imagination, spark discussion, and encourage critical reflection. Thus, participants were not seen as passive receivers in need of top-down information, but, indeed, as valuable contributors whose experiences and situated knowledges could eventually form the basis of a more democratic governance of innovation.

Taken together, these particular answers to questions of *who*, *when*, and *how* made for a fairly robust methodological setup, a setup that was both supportive of and essential to the conduct of upstream public engagement research, thus representing the final piece of this chapter's empirical puzzle.

The end of this section also marks the end of the empirical analysis. Time to wrap up and draw some conclusions.

5. Conclusions and Outlook

This thesis aimed to explore the current state of affairs in S&T policy making by seeking answers to a specific question: What are the resources, knowledges, and skills, the conditions, competences, and proficiencies needed to carry out qualitative, upstream-oriented social science research in the field of new and emerging technologies? What does it take to conduct research that is contrarian in that it challenges established governance practices, that is subversive in that it seeks to introduce alternative concepts and perspectives, and that is genuinely democratizing by promoting bottom-up forms of public participation, (re)conceptualizing lay citizens as 'carriers' of expertise who ought to have a say in a more inclusive governance of technoscientific innovation?

In order to tackle this question on empirical grounds, the thesis investigated three Nano-related upstream engagement-oriented research projects – i.e. NanoFutures, DEEPEN, and TECHNOLIFE – providing thick descriptions organized around four key areas of interest. In a nutshell, the main findings for each of these areas can be summarized as follows:

First, with respect to the *intricacies of funding*, the argument was made that in order to obtain funding and successfully compete in the 'game of coin', researchers must actively engage in the creation of funding opportunities, e.g. through public policy counseling, through participating in the development of guidelines for future funding programs, as well as through entering into pre-application talks with the respective authorities. Moreover, to secure their intellectual autonomy and ensure a project's scientific authenticity, scholars might be compelled to 'shield' their research against funding agencies' agendas and interests, a measure that may involve the careful deconstruction of top-down master narratives as well as the employment of a 'promissory language' to enroll agencies to one's own research objectives. Last but not least, in order to ensure a research community's continued existence, researchers might need to increase their project's perceived impact and value by (a) enhancing its public visibility, e.g. by using the Internet as a presentation and communication platform, and (b) by embracing a two-tiered publication strategy, catering more 'scientific' articles to the academic community and more accessible, result and recommendation-focused deliverables to policymakers.

Second, and in recognition of the need to consider the *geographies of science* (Livingstone 2003), it was argued that projects such as NanoFutures, DEEPEN, or TECHNOLIFE could not have been carried out anywhere at any time, but, rather, should be conceived as eventual outcomes of fairly specific spatial and temporal configurations; that

is, of particular technopolitical cultures and concrete local arrangements. With regard to technopolitical cultures, the argument was made that despite different preconditions in Europe (DEEPEN, TECHNOLIFE) and the United States (NanoFutures), the experiences with BSE, GMO, and other technoscientific controversies, the complexity and uncertainty of post-normal NBIC science, as well as the perceived lack of public trust in science had fostered a relatively supportive climate for (upstream) public engagement research, facilitating the conduct of scientific projects in that area. With respect to local arrangements, it was shown that the projects originated in research environments that made it possible to 'think upstream', maintain a critical position towards current S&T policy practice, and carry out future-oriented Nano research that would conceptually oppose the unidirectionality of top-down legitimization exercises. In sum, it was demonstrated that the spaces and places of (social) scientific knowledge production act as important resources, co-determining what kind of research can be conducted at a particular location at a certain point in time.

Third, in an attempt to carve out what I propose to call the *upstream epistemology*, the thesis addressed the theoretical and conceptual resources, but also the beliefs, assumptions, and aspirations that underpin the pursuit of upstream public engagement research. In essence, the case was made that this common epistemic framework would build upon four main pillars: A co-productionist approach to the relationship between science, technology, and society – i.e. the idea that these domains are deeply intertwined rather than separate from one another; an orientation towards a critical public understanding of science – i.e. a challenging of the deficit model and the notion that a better understanding *of* science must inevitably lead to increased social consensus *on* questions of scientific and technological advancement; a constructivist, citizens' imagination-centered approach to the anticipation of technoscientific futures – i.e. the conception that possible futures and their potential implications ought to be discussed and negotiated rather than estimated through quantitative assessments; as well as attempts to move beyond the risk paradigm and incorporate more open, integrative, and deliberative forms of public engagement that take into account the full depth and breadth of public concerns towards matters of technoscientific innovation. Taken together, those pillars were said to constitute the theoretical and epistemic backbone of upstream engagement research, rooting the concept in a dense mesh of (techno)political and (socio)scientific core convictions.

Fourth and finally, and furthering the concept of *technologies of imagination* introduced by Felt and others (2013b), it was established that all three projects under consideration employed methods designed to put the abstract idea of upstream public

engagement into practice. More precisely, and in accordance with the basic tenets of the upstream epistemology (see above), the researchers developed methodological frameworks that were intended to stimulate participants' imagination, encouraging them to discuss potential technoscientific futures from different angles and reflect what such developments might imply for them as individuals as well as for society at large. Furthermore, these methods were supposed to (a) widen the spectrum of invited publics by bringing together a broad range of (lay) citizens from heterogeneous social, professional, and national backgrounds; to (b) address potential issues at the very early stages of research and development (R&D), at a point when emerging technologies have not yet become 'locked in' and trajectories might still be open to (public) negotiation; and to (c) incorporate "provocative" and "kaleidoscopic" stimulus material that would facilitate discussion and encourage critical reflection, allowing lay participants to act as valuable contributors whose experiences and situated knowledges might form the basis of a more democratic governance of technoscientific innovation. In that sense, the three projects' technologies of imagination represented the logical methodological conclusion to the concept of upstream public engagement, constituting yet another resource vital to the successful realization of this particular kind of qualitative social science research.

The findings outlined above are the result of focused case study analysis, but they are nevertheless indicative of some more general developments, both within the field and beyond. As a conclusion to this thesis, I would like to briefly address some of those trends, pinpointing potential areas of further study:

For starters, the sheer breadth of resources and capacities necessary for the proper conduct of upstream public engagement research indicates that a new type of researcher is required, one who is not only competent with regard to 'traditional' academic skills such as the development and application of theory and method, but who is also proficient when it comes to interacting with funding bodies and/or policymakers, as well as knowledgeable of the particular technopolitical cultures within which a research project is set to take place. Thus, rather than being 'scholarly scholars' – i.e. the classic idea of the academic in the ivory tower – social scientists/humanities scholars conducting deliberative research in the field of new and emerging technologies need to incorporate capabilities usually associated with Mode 2 knowledge production (e.g. see Gibbons et al. 1994), such as the capacity to take into account the needs and interests of different (extra-scientific) stakeholders, the ability to communicate with and to epistemic communities outside their own field, as well as the

willingness to conceive themselves as fundamentally social actors rather than unattached custodians of scientific truth. In that sense, there appears to be a growing demand for researchers who not only teach co-productionism, but who also know how to navigate and conduct research in an increasingly overtly co-productionist world.

Moreover, the empirical analysis also hints at an interesting shift regarding the exploration and evaluation of public views on specific technoscientific developments. While upstream engagement research by definition focuses on (lay) citizens' narratives (DEEPEN), imaginaries (TECHNOLIFE), ideas and expectations (NanoFutures), more recently, efforts have been made to consider not only the content but also the context of these attitudes and opinions (e.g. see Davies 2011). Thus, instead of solely concentrating on the "what", researchers increasingly attempt to investigate the "how" by taking into account the situatedness of statements and positions, considering, for example, professional backgrounds, national technopolitical cultures, as well as the role of previous experiences. Ultimately, this turn towards citizens' epistemologies is meant to deepen "understanding [of] public responses to the future of technology" (ibid., 324), providing data that are not only of scientific interest, but might also proof valuable to governmental institutions such as the European Commission which has just recently iterated its commitment to "tackle […] pressing societal challenges" (EC 2011b, 2) and address the "major concerns shared by citizens in Europe and elsewhere." (EC 2011a, 5)

A final salient finding pertains to the alleged move from government to governance, which is said to indicate "a change in the long-standing balance between the state and civil society." (Stoker 1998, 21) The empirical data gathered for this research suggests that such a fundamental shift has not yet occurred, let alone been completed. Rather, the current S&T policy landscape appears to be characterized by a conflation of 'old' and 'new' assumptions, that is, on the one hand, assumptions that are still very much anchored in the traditional, top-down ways of government, as well as, on the other hand, assumptions that point towards a more inclusive, socially responsible governance of technoscientific innovation. Thus, instead of a comprehensive shift, what can be diagnosed is an ongoing struggle between different concepts and frameworks of thought, between different understandings, imaginaries, and interests. The three projects investigated in this thesis are testimony that upstream public engagement research has found its place in this policy arena; however, the sheer breadth of resources and capacities needed to realize this type of research serve as a constant reminder that this position is neither secured nor guaranteed, but must continually be reasserted and maintained, a demanding process which requires considerable dedication,

persistence, and tact. In Europe, starting 2014, the Horizon 2020 initiative will supersede FP7 as the major funding program for research and innovation. Knowing the field, it should come as no surprise that the first STS-informed policy briefings have already been released (see Felt et al. 2013a).

6. References

Adam, Barbara (2005) *Futures in the Making: Contemporary Practices and Sociological Challenges*. Conference Paper, ASA 2005, Philadelphia. Online available at: http://www.cardiff.ac.uk/socsi/futures/conf_ba_asa230905.pdf.

Adams, Vincanne; Murphy, Michelle; Clarke, Adele E. (2009) "Anticipation: Technoscience, Life, Affect, Temporality." In: *Subjectivity*, Issue 28, pp. 246-265.

Akrich, Madeleine (1992) "The De-Scription of Technical Objects." In: Bijker, Wiebe E.; Law, John (Eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge, MA; London: The MIT Press.

Anderson, Benedict (2006 [1983]) *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. London; New York: Verso.

Aristotle (1883 [ca. 343 BC]) *Aristotle's History of Animals: In Ten Books*. London: George Bell. Online available at: http://archive.org/details/aristotleshistor00arisiala.

Austin, John Langshaw (1962) *How to do Things with Words*. Oxford: Oxford University Press.

Barad, Karen (2003) "Posthumanist Performativity: Toward and Understanding of How Matter Comes to Matter." In: *Signs: Journal of Women in Culture and Society*, Vol. 28, No. 3, pp. 801-831.

Barben, Daniel (2010) "Anticipatory Governance." In: Guston, David H. (Ed.) *Encyclopedia of Nanoscience and Society*. London: Sage.

Barben, Daniel; Fisher, Erik; Selin, Cynthia; Guston, David H. (2008) "Anticipatory Governance and Nanotechnology: Foresight, Engagement, and Integration." In: Hackett, Edward J.; Amsterdamska, Olga; Lynch, Michael; Wajcman, Judy (Eds.) *The Handbook of Science and Technology Studies*. Cambridge, Mass: MIT Press.

Beck, Ulrich (1992) *Risk Society: Towards a New Modernity*. New Delhi: Sage.

Beck, Ulrich (1999) "From Industrial Society to Risk Society: Questions of Survival, Social Structure and Ecological Enlightenment." In: Beck, Ulrich. *World Risk Society*. Cambridge: Polity Press, pp. 48-72.

Beck, Ulrich; Bonß, Wolfgang; Lau, Christoph (2001) "Theorie reflexiver Modernisierung: Fragestellungen, Hypothesen, Forschungsprogramme." In: Beck, Ulrich; Bonß, Wolfgang (Eds.) *Die Modernisierung der Moderne*. Frankfurt am Main: Suhrkamp, pp. 11-59.

Bennett, Ira (2008) "Developing Plausible Nano-enabled Products." In: Fisher, Erik; Selin, Cynthia; Wetmore, Jameson M. (Eds.) *Yearbook of Nanotechnology in Society, Volume I: Presenting Futures*. Springer, pp. 149-155.

Bibel, Wolfgang; Andler, Daniel; da Costa, Olivier; Küppers, Günter; Pearson, Ian D. (2004) *Converging Technologies and the Natural, Social and Cultural World*. Special Interest Group Report for the European Commission via an Expert Group on Foresighting the New Technology Wave. Online available at: ftp://ftp.cordis.europa.eu/pub/foresight/docs/ntw_sig4_en.pdf.

Bloor, David (1976) *Knowledge and Social Imagery.* London; Boston: Routledge and Kegan Paul.

Bogner, Alexander; Menz, Wolfgang (2009) "The Theory-Generating Expert Interview: Epistemological Interest, Forms of Knowledge, Interaction." In: Bogner, Alexander; Littig, Beate; Menz, Wolfgang (Eds.) *Interviewing Experts*. Basingstoke; New York: Palgrave Macmillan.

Brown, Nik; Michael, Mike (2003) "A Sociology of Expectations: Retrospecting Prospects and Prospecting Retrospects." In*: Technology Analysis and Strategic Management*, 15(1), pp. 3-18.

Brown, Nik; Michael, Mike (2005) "Scientific Citizenship: Self-representation of Xenotransplantation's Publics." In: *Science as Culture*, Vol. 14, No. 1, pp. 38-57.

Callon, Michel; Law, John (1982) "On Interests and Their Transformation: Enrolment and Counter-Enrolment." In: *Social Studies of Science*, Vol. 12, No. 4, Theme Section: Laboratory Studies, pp. 615-625.

Charmaz, Kathy (2006) *Constructing Grounded Theory. A Practical Guide Through Qualitative Analysis*. London: Sage.

Clarke, Adele E. (2005) *Situational Analysis: Grounded Theory After the Postmodern Turn*. Thousand Oaks, Calif.: Sage Publications.

Collingridge, David (1980) *The Social Control of Technology*. London: Pinter.

Collins, Harry M. (Ed.) (1982) *The Sociology of Scientific Knowledge: A Sourcebook*. Bath: Bath University Press.

Commission of the European Communities (2005) *European Values in the Globalised World*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Online available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0525:FIN:EN:PDF.

Crow, Michael M.; Sarewitz, Daniel (2001) "Nanotechnology and Societal Transformation." In: Teich, Albert H.; Nelson, Stephen D.; McEnaney, Ceilia; Lita, Stephen J. (Eds.) *AAAS Science and Technology Policy Yearbook*. New York: American Association for the Advancement of Science.

Davies, Sarah (2008) "'A Bit More Cautious, a Bit More Critical': Science and the Public in Scientists' Talk." In: Bell, Alice R.; Davies, Sarah; Mellor, Felicity (Eds.) *Science and its Publics*. Newcastle: Cambridge Scholars Publishing.

Davies, Sarah (2011) "How We Talk When We Talk About Nano: The Future in Laypeople's Talk." In: *Futures*, Vol. 43, Issue 3, pp. 317-326.

Davies, Sarah; Kearnes, Matthew; Macnaghten, Phil (2009) *Reconfiguring Responsibility: Lessons for Public Policy (Part 1 of the Report on Deepening Debate on Nanotechnology)*. Durham: Durham University. Online available at: http://www.geography.dur.ac.uk/Projects/LinkClick.aspx?link=Publications%2fReconfiguring+Responsibility+September+2009.pdf&tabid=2903&mid=4948.

Davies, Sarah; Kearnes, Matthew; Macnaghten, Phil (2010) "Nanotechnology and Public Engagement: A New Kind of (Social) Science?" In: Kjølberg, Kamilla; Wickson, Fern Elizabeth (Eds.) *Nano Meets Macro: Social Perspectives on Nanoscale Sciences and Technologies*. Singapore: Pan Stanford, pp. 405-423.

DEEPEN (2006) *Annex 1 - Description of Work*. Unpublished Framework Programme 6 Proposal Document, pp. 35.

DEEPEN (2008) *Fieldwork Resources (Durham Concept Boards)*. Online available at: http://www.geography.dur.ac.uk/Projects/LinkClick.aspx?link=Publications%2fWP4+posters+(all).pdf&tabid=1994&mid=3070.

DEEPEN (2009) *Defining Nanotechnology's Responsible Development Workshop. Public Report*. Online available at: http://www.geography.dur.ac.uk/Projects/LinkClick.aspx?link=Downloads%2fharrogate+workshop+report.pdf&tabid=1994&mid=3070.

Department for Business, Innovation and Skills. Government Office for Science. Foresight Horizon Scanning Centre (2010) *Technology and Innovation Futures: UK Growth Opportunities for the 2020s*. Online available at: http://www.bis.gov.uk/assets/foresight/docs/general-publications/10-1252-technology-and-innovation-futures.pdf.

Delgado, Ana; Rommetveit, Kjetil; Barceló, Miquel; Lemkow, Louis (2011) "Imagining High-Tech Bodies: Science Fiction and the Ethics of Enhancement." In: *Science Communication*, Vol. 34, No. 2, pp. 200-240.

Drexler, Eric K. (1986) *Engines of Creation. The Coming Era of Nanotechnology*. New York: Anchor.

EC (unspecified) *Science in Society: Sharing Knowledge – Engaging Society*. Leaflet. Online available at: ftp://ftp.cordis.europa.eu/pub/fp7/ sis/docs/sis_en.pdf.

EC (2001) *Science and Society Action Plan*. Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions. Online available at: http://www.iglortd.org/Content/ERA/Com01_714en.pdf.

EC (2002a) *FP6: Frequently Asked Question*s. Online available at: http://europa.eu/comm/research/fp6/pdf/faq_en.pdf.

EC (2002b) *The Sixth Framework Programme in Brief*. Online available at: http://ec.europa.eu/research/fp6/pdf/fp6-in-brief_en.pdf.

EC (2004a) *Participating in European Research: Guideline for Applicants under the Sixth Framework Programme for European Research & Technological Development (2002-2006)*. 2nd Edition. Online available at: http://ec.europa.eu/research/fp6/pdf/how-to-participate_en.pdf.

EC (2004b) *Towards a European Strategy for Nanotechnology – Communication from the Commission*. Online available at: ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nano_com_en_new.pdf.

EC (2005a) *Nanosciences and Nanotechnologies: An Action Plan for Europe 2005-2009*. Online available at: http://ec.europa.eu/research/industrial_technologies/pdf/nano_action_plan_en.pdf.

EC (2005b) *Some Figures about Nanotechnology R&D in Europe and Beyond*. Online available at: ftp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nano_funding_data_08122005.pdf.

EC (2006) *Work Programme 2006. Science & Society. Draft. 15th Update*. Online available at: ftp://ftp.cordis.europa.eu/pub/fp6/docs/wp/sp2/t_wp_200215_en.pdf.

EC (2007) *FP7 in Brief: How to get involved in the EU 7th Framework Programme for Research*. Online available at: http://ec.europa.eu/research/fp7/pdf/fp7-inbrief_en.pdf.

EC (2008a) *Commission Recommendation of 07/02/08 on a Code of Conduct for Responsible Nanosciences and Nanotechnologies Research*. Online available at: ftp://ftp.cordis.europa.eu/pub/fp7/docs/nanocode-recommendation.pdf.

EC (2008b) *Work Programme 2008. Revised. Capacities. Part 5. Science in Society*. Online available at: ftp://ftp.cordis.europa.eu/pub/fp7/docs/wp/capacities/sis/s_wp_200802_en.pdf.

EC (2009a) *Challenging Futures of Science in Society: Emerging Trends and Cutting-Edge Issues. The MASIS Report*. Online available at: ftp://ftp.cordis.europa.eu/pub/fp7/sis/docs/sis_masis_report_en.pdf.

EC (2009b) *Nanosciences and Nanotechnologies: An Action Plan for Europe 2005-2009*. Second Implementation Report 2007-2009. Online available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0607:FIN:EN:PDF.

EC (2010) *Europe 2020 Flagship Initiative Innovation Union*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee and the Committee of the Regions. Online available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0546:FIN:EN:PDF.

EC (2011a) *Horizon 2020 – The Framework Programme for Research and Innovation – Communication from the Commission*. Online available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0808:FIN:en:PDF.

EC (2011b) *Horizon 2020 – The Framework Programme for Research and Innovation – Executive Summary of the Impact Assessment*. Online available at: http://ec.europa.eu/research/horizon2020/pdf/proposals/horizon_2020_impact_assessment_report_executive_summary.pdf#view=fit&pagemode=none.

EC (2012) *Work Programme 2013. Capacities. Part 5. Science in Society*. Online available at: http://ec.europa.eu/research/participants/portal/download?docId=32895.

EIPP (2009) *Public Participation in Europe: An International Perspective*. Online available at: http://www.partizipation.at/fileadmin/media_data/Downloads/Zukunftsdiskurse-Studien/pp_in_e_report_03_06.pdf.

Epstein, Steven (1995) "The Construction of Lay Expertise: AIDS Activism and the Forging of Credibility in the Reform of Clinical Trials." In: *Science Technology Human Values*, Vol. 20, No. 4, pp. 408-437.

ESRC (1999) *The Politics of GM Food: Risk, Science & Public Trust*. *Special Briefing No 5.* Online available at: http://www.sussex.ac.uk/Users/prfh0/adams_et_al_briefing_on_uncertainty.pdf.

Felt, Ulrike (2003) "'One Science – Many Europes?' On the Difficulties of Transferring Experiences in Science-Society Interactions." In: Felt, Ulrike (Ed.) *O.P.U.S. Optimising Public Understanding of Science and Technology. Final Report,* pp. 645-652. Online available at: http://www.univie.ac.at/virusss/opus/OPUS%20Report%20Final.pdf.

Felt, Ulrike; Barben, Daniel; Irwin, Alan; Joly, Pierre-Benoît; Rip, Arie; Stirling, Andy; Stöckelová, Tereza (2013a) *Science in Society: Caring for Futures in Turbulent Times*. European Science Foundation. Science Policy Briefing, No. 50, June 2013.

Felt, Ulrike; Bister, Milena D.; Strassnig, Michael; Wagner, Ursula (2009) "Refusing the Information Paradigm: Informed Consent, Medical Research, and Patient Participation." In: *health: An Interdisciplinary Journal for the Social Studies of Health, Illness and Medicine*, Vol. 13(1), pp. 87-106.

Felt, Ulrike; Erlemann, Martina; Fochler, Maximilian (2003) "NGOs and Non-Governmental Initiatives as PUS-Actors in Austria: Heterogeneity and Expansion." In: Felt, Ulrike (Ed.) *O.P.U.S. Optimising Public Understanding of Science and Technology. Final Report,* pp. 412-421. Online available at: http://www.univie.ac.at/virusss/opus/OPUS%20Report%20Final.pdf.

Felt, Ulrike; Fochler, Maximilian (2008) "The Bottom-Up Meanings of the Concept of Public Participation in Science and Technology." In: *Science and Public Policy*, 35(7), pp. 489-499.

Felt, Ulrike; Fochler, Maximilian (2012) "Re-ordering Epistemic Living Spaces: On the Tacit Governance Effects of the Public Communication of Science." In: Rödder, Simone; Franzen, Martina; Weingart, Peter (Eds.) *The Sciences' Media Connection – Public Communication and its Repercussions*. Sociology of the Sciences Yearbook Volume 28, pp. 133-154.

Felt, Ulrike; Fochler, Maximilian; Mager, Astrid; Winkler, Peter (2008) "Visions and Versions of Governing Biomedicine: Narratives on Power Structures, Decision- Making and Public Participation in the Field of Biomedical Technology in the Austrian Context." In: *Social Studies of Science*, Vol. 38(2), pp. 233-255.

Felt, Ulrike; Fochler, Maximilian; Winkler, Peter (2010) "Coming to Terms with Biomedical Technologies in Different Technopolitical Cultures: A Comparative Analysis of Focus Groups on Organ Transplantation and Genetic Testing in Austria, France, and the Netherlands." In: *Science, Technology, & Human Values*, Vol. 35, No.4, pp. 525-553.

Felt, Ulrike; Igelsböck, Judith; Schikowitz, Andrea; Völker, Thomas (2012) "Challenging Participation in Sustainability Research." In: *DEMESCI – International Journal of Deliberative Mechanisms in Science*, Vol. 1, No. 1, pp. 4-34.

Felt, Ulrike; Müller, Ruth (2011) "Tentative (Id)entities. On Technopolitical Cultures and the Experiencing of Genetic Testing." In: Biosocieties, 6(3), pp. 342-363.

Felt, Ulrike; Schumann, Simone; Schwarz, Claudia; Strassnig, Michael (2013b) "Technology of Imagination: A Card-Based Public Engagement Method for Debating Emerging Technologies." In: *Qualitative Research*, Published Online on 4 January 2013.

Felt, Ulrike; Wynne, Brian; et al. (2007) *Taking European Knowledge Society Seriously*. Report to the Expert Group on Science and Governance to the Science. Economy and Society Directorate, Directorate-General for Research. European Commission. Brussels. Online available at: http://ec.europa.eu/research/science-society/document_library/pdf_06/european-knowledge-society_en.pdf.

Fisher, Erik (2006) *Midstream Modultation: Integrating Societal Considerations Into and During Nanotechnology Research and Development: A Case Study in Implementing U.S. Federal Legislation*. Doctoral Dissertation.

Fisher, Erik; Mahajan, Roop L. (2006) "Contradictory Intent? US Federal Legislation on Integrating Societal Concerns into Nanotechnology Research and Development." In: *Science and Public Policy*, Vol. 33, Nr. 1, pp. 5-16.

Fisher, Erik; Selin, Cynthia; Wetmore, James (Eds.) (2008) *Yearbook of Nanotechnology in Society. Volume I: Presenting Futures*. Dordrecht: Springer Netherlands.

Fochler, Maximilian (2007) *Participating in which Kind of Governance? Tracing Bottom-Up Perspectives on the Governance of Science and the Possibilities and Limits of Public Engagement*. Doctoral Dissertation. Online available at: http://sciencestudies.univie.ac.at/fileadmin/user_upload/dep_sciencestudies/pdf_files/pdfs_abgeschlossene_projekte/Abschlussarbeiten/diss_fochler.pdf.

Foucault, Michel (1982) "The Subject and Power." In: *Critical Inquiry*, Vol. 8, No. 4, pp. 777-795.

Fleck, Ludwik (1981 [1935]) *Genesis and Development of a Scientific Fact*. Chicago; London: University of Chicago Press.

Funtowicz, Silvio O.; Ravetz, Jerome R. (1993) "Science for the Post-Normal Age." In: *Futures*, Vol. 25, Issue 7, pp. 739-755.

Gaughan, Monica; Bozeman, Barry (2002) "Using Curriculum Vitae to Compare some Impacts of NSF Research Grants with Research Center Funding." In: *Research Education*, Vol. 11, No. 1.

Gibbons, Michael; Limoges, Camille; Nowotny, Helga; Schwartzman, Simon; Scott, Peter; Trow, Martin (1994) *The New Produdction of Knowledge. The Dynamics of Science and Research in Contemporary Societie*s. Thousand Oaks, Calif.: SAGE Publications.

Giddens, Anthony (1999) "Risk and Responsibility." In: The Modern Law Review, Vol. 62, Issue 1, pp. 1-10.

Gitelman, Lisa (Ed.) (2013) *"Raw Data" is an Oxymoron*. Cambridge, MA: The MIT Press.

Given, Lisa M. (Ed.) (2008) *The Sage Encyclopedia of Qualitative Research Methods. Volumes 1 & 2*. Thousand Oaks, Calif: SAGE Publications.

Glaser, Barney G. (2001) *The Grounded Theory Perspective: Conceptualization Contrasted with Description*. Mill Valley, Ca.: Sociology Press.

Glaser, Barney G.; Strauss, Anselm L. (2006 [1967]) *The Discovery of Grounded Theory: Strategies for Qualitative Research*. New Brunswick, NJ: Aldine Transaction.

Goorden, Lieve; van Oudheusden, Michiel; Evers, Johan; Deblonde, Marian (2008) "Nanotechnologies for Tomorrow's Society: A Case for Reflective Action Research in Flanders, Belgium." In: Fisher, Erik; Selin, Cynthia; Wetmore, Jameson M. (Eds.) *Yearbook of Nanotechnology in Society, Volume I: Presenting Futures*. Springer, pp. 163-182.

Gow, Gordon A. (2005) *Policymaking for Critical Infrastructure: A Case Study On Strategic Interventions in Public Safety Telecommunications*. Aldershot: Ashgate Publishing Limited.

Groves, Christopher (2011) "Public Engagment and Nanotechnology in the UK: Restoring Trust or Building Robustness?" In: *Science and Public Policy*, 38 (10), pp. 783-793.

Guston, David H. (2006) *Societal Implications of Nanotechnology*. Presentation. Discovery Lecture Series 2006 at Purdue University.

Guston, David H. (2007) "The Center of Nanotechnology in Society at Arizona State University and the Prospects for Anticipatory Governance." In: Cameron, Nigel Malcolm de Segur (Ed.) *Nanoscale: Issues and Perspectives for the Nano Century*. Chichester: Wiley, pp. 377-392.

Guston, David H. (2008) "Preface." In: Fisher, Erik; Selin, Cynthia; Wetmore, Jameson M. (Eds.) *Yearbook of Nanotechnology in Society, Volume I: Presenting Futures*. Springer, pp. V- VIII.

Guston, David H. (2010a) "Public Engagement with Nanotechnology." In: *2020 Science: A Clear Perspective on Emerging Science and Technology*. Blog Entry. Online available at: http://2020science.org/2010/03/30/public-engagement-with-nanotechnology/.

Guston, David H. (2010b) "The Anticipatory Governance of Emerging Technologies." In: *Journal of Korean Vacuum Society*, Vol. 19, No. 6, pp. 432-441.

Guston, David H. (2012) *Shaping Sustainable Nanotechnology Futures*. Presentation. Sustainable Nanotechnology Organization: Plenary V, Societal and Policy Considerations. Online available at: http://www.susnano.org/images/Plenary%20V%20Guston.pdf.

Guston, David H.; Sarewitz, Daniel (2002) "Real-time technology assessment." In: *Technology in Society*, 24, pp. 93-109.

Haas, Peter M. (1992) "Epistemic Communities and International Policy Coordination." In: *International Organization*, Vol. 46, No. 1, pp. 1-35.

Habermas, Jürgen (1987 [1969]) *Toward a Rational Society: Student Protest, Science, and Politics*. Cambridge, UK: Polity Press.

Hagendijk, Rob (2004) "The Public Understanding of Science and Public Participation in Regulated Worlds." In: *Minerva*, Vol. 42 (1), pp. 41-59.

Hagendijk, Rob; Healey, Peter; Horst, Maja; Irwin, Alan (2005) *Science, Technology and Governance in Europe*. Stage Final Report. Online available at: http://www.stage-research.net/STAGE/documents/STAGE_Final_Report_final.pdf.

Hanna, Paul (2012) "Using Internet Technologies (such as Skype) as a Research Medium: A Research Note." In: *Qualitative Research*, Vol. 12, No. 2, pp. 239-242.

Hecht, Gabrielle (2000) *The Radiance of France: Nuclear Power and National Identity after World War II*. Cambridge, MA: MIT Press.

Holmberg, Christine; Bischof, Christine; Bauer, Susanne (2013) "Making Predictions: Computing Populations." In: *Science Technology and Human Values*, Vol. 38, No. 3., pp. 398-420.

Hölscher, Lucian (1999) *Die Entdeckung der Zukunft*. Frankfurt am Main: Fischer.

Horlick-Jones, Tom; Walls, John; Rowe, Gene; Pidgeon, Nick; Poortinga, Wouter; Murdock, Graham; O'Riordan, Tim (2007) *The GM Debate: Risk, Politics and Public Engagement*. New York: Routledge.

House of Lords (2000) *Science and Society.* 3rd Report. HL 38. Online available at: http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm.

Huesemann, Michael; Huesemann, Joyce (2011) *Techno-Fix: Why Technology Won't Save Us or the Environment*. Gabriola Island, B.C.: New Society Press.

Irwin, Alan (1995) *Citizen Science: A Study of People, Expertise and Sustainable Development*. Routledge: London.

Irwin, Alan (2001) "Constructing the Scientific Citizen: Science and Democracy in the Biosciences." In: *Public Understanding of Science*, Vol. 10, No. 1, pp. 1-18.

Irwin, Alan (2006) "The Politics of Talk: Coming to Terms with the 'New' Scientific Governance." In: *Social Studies of Science*, Vol. 36, No. 2, pp. 299-320.

Irwin, Alan; Michael, Mike (2003) *Science, Social Theory, and Public Knowledge*. Maidenhead: Open University Press.

Irwin, Alan; Wynne, Brian (Ed.) (1996) *Misunderstanding Science? The Public Reconstruction of Science and Technology*. Cambridge: Cambridge University Press.

Jasanoff, Sheila (1990) *The Fifth Branch: Science Advisers as Policymakers*. Cambridge: Harvard University Press.

Jasanoff, Sheila (2003) "Technologies of Humility: Citizen Participation in Governing Science." In: *Minerva*, 41(3), pp. 223-244.

Jasanoff, Sheila (2004) "The Idiom of Co-Production." In: Jasanoff, Sheila (Ed.) *States of Knowledge: The Co-Production of Science and Social Order*. London, New York: Routledge, pp. 1-12.

Jasanoff, Sheila (2005) *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton: Princeton University Press.

Jasanoff, Sheila; Kim, Sang-Hyun (2009) "Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea." In: *Minerva*, 47 (2), pp. 119-146.

Jones, Richard (2008) "The Economy of Promises." In: *Nature Nanotechnology*, 3, pp. 65-66.

Jordan, Andrew; Wurzel, Rüdiger K. W.; Zito, Anthony (2005) In: "The Rise of 'New' Policy Instruments in Comparative Perspective: Has Governance Eclipsed Government?" In: *Political Studies*, Vol. 53 (3), pp. 477-496.

Kaiser, Mario; Kurath, Monika; Maasen, Sabine; Rehmann-Stutter, Christoph (Eds.) (2010) *Governing Future Technologies. Nanotechnology and the Rise of an Assessment Regime.* London; New York: Springer.

Kass, Gary (2000) "Recent Developments in Public Participation in the United Kingdom." In: *TA-Datenbank-Nachrichten*, Nr. 3 (9), pp. 20-28.

Kearnes, Matthew (2010) "The Time of Science: Deliberation and the 'New Governance' of Nanotechnology." In: Kaiser, Mario; Kurath, Monika; Maasen, Sabine; Rehmann-Stutter, Christoph (Eds.) *Governing Future Technologies. Nanotechnology and the Rise of an Assessment Regime.* London; New York: Springer, pp. 279-302.

Kearnes, Matthew; Macnaghten, Phil; Wilsdon, James (2006) *Governing at the Nanoscale: People, Policies and Emerging Technologies*. London: DEMOS. Online available at: http://www.demos.co.uk/files/governingatthenanoscale.pdf?1240939425.

Kearnes, Matthew; Rip, Arie (2009) "The Emerging Governance Landscape of Nanotechnology." In: Gammel, Sefan; Lösch, Andreas; Nordmann, Alfred (Eds.) *Jenseits von Regulierung: Zum politischen Umgang mit der Nanotechnologie*. Berlin: Akademische Verlagsgesellschaft.

Kearnes, Matthew; Wynne, Brian (2007) "On Nanotechnology and Ambivalence: The Politics of Enthusiasm." In: *NanoEthics*, Vol. 1, Issue 2, pp. 131-142.

Kjølberg, Kamilla Lein; Strand, Roger (2011) "Conversations About Responsible Nanoresearch." In: *Nanoethics*, 5(1), pp. 99-113.

Knorr-Cetina, Karin (1981) *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*. Oxford: Pergamon Press.

Knorr-Cetina, Karin (1999) *Epistemic Cultures: How Sciences Make Knowledge*. Cambridge, MA: Harvard University Press.

Kuhn, Thomas (1970 [1962]) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Latour, Bruno (1984) "Portrait of a Biologist as Wild Capitalist." Unpublished English translation. Originally published as: "Le Dernier des Capitalistes Sauvages: Interview d'un Biochimiste." In: *Fundamenta Scientiae*, Vol. 4, No. 3/4, pp. 301-327.

Latour, Bruno (1987) *Science in Action: How to follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

Latour, Bruno (1989) "Pasteur et Pouchet: Hétérogenèse de l'Histoire des Sciences." In: Serres, Michel (Ed.) *Éléments d'Histoire des Sciences*. Paris: Bordas.

Latour, Bruno (1993) *We Have Never Been Modern*. Cambridge, MA: Harvard University Press.

Latour, Bruno (1994) "On Technical Mediation: Philosophy, Sociology, Genealogy." In: *Common Knowledge*, 3(2), pp. 26-64.

Latour, Bruno (1999) *Pandora's Hope. Essays on the Reality of Science Studies*. Cambridge, MA: Harvard University Press.

Latour, Bruno (2003) "Why Has Critique Run Out of Steam? From Matters of Fact to Matters of Concern" In: *Critical Inquiry*, Vol. 30, No. 2, pp. 225-248.

Latour, Bruno (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford; New York: Oxford University Press.

Latour, Bruno (2007) "Turning Around Politics: A Note on Gerard de Vries' Paper." In: *Social Studies of Science*, Vol. 37, No. 5, pp. 811-820.

Latour, Bruno (2010) "An Attempt at a 'Compositionist Manifesto'." In: *New Literary History*, 41, pp. 471-490.

Latour, Bruno; Woolgar, Steve (1986 [1979]) *Laboratory Life: The Construction of Scientific Facts*. Princeton: Princeton University Press.

Law, John (1994) *Organizing Modernity: Social Ordering and Social Theory*. Cambridge, MA: Blackwell Publishers.

Law, John (2004) *After Method: Mess in Social Science Research*. London: Routledge.

Law, John (2009) "Seeing Like a Survey." In: *Cultural Sociology*, Vol. (3)2, pp. 239-256.

Leydesdorff, Loet (2007) "Luhmann's Communication-Theoretical Specification of the 'Genomena' of Husserl's Phenomenology." In: Pires, Edmundo Balsemão (Ed.) *Espaços Públicos, Poder e Comunicação: Public Spaces, Power and Communication*. Coimbra: Edições Afrontamento.

Leydesdorff, Loet; Welbers, Kaspers (2011) "The Semantic Mapping of Words and Co-Words in Contexts." In: *Journal of Infometrics*, Vol. 5 (3), pp. 469-475.

Livingstone, David N. (2003) *Putting Science in its Place: Geographies of Scientific Knowledge*. Chicago; London: The University of Chicago Press.

MacKenzie, Donald (2004) "The Big, Bad Wolf and the Rational Market: Portfolio Insurance, the 1987 Crash and the Performativity of Economics." In: *Social Studies of Finance*, Vol. 33, No. 3, pp. 303-334.

Macnaghten, Phil (2007) *Nanotechnology, Risk and Sustainability: Moving Public Engagement Upstream. End of Award Report.* Online Available at: http://www.esrc.ac.uk/my-esrc/grants/RES-338-25-0006/outputs/Download/91fb2fdb-ebe5-4ae9-84ad-7d33f23e1962.

Macnaghten, Phil; Davies, Sarah; Kearnes, Matthew (2010) "Narrative and Public Engagement: Some Findings from the DEEPEN Project." In: Schomberg, René von; Davies, Sarah (Eds.) *Understanding Public Debate on Nanotechnologies: Options for Framing Public Policy*. Online available at:

http://ec.europa.eu/research/science-society/document_library/pdf_06/understanding-public-debate-on-nanotechnologies_en.pdf.

Macnaghten, Phil; Kearnes, Matthew B.; Wynne, Brian (2005) "Nanotechnology, Governance, and Public Deliberation: What Role for the Social Sciences?" In: *Science Communication*, Vol. 27, No. 2, pp. 268-291.

Macnaghten, Phil; Guivant, Julia S. (2011) "Converging Citizens? Nanotechnology and the Political Imaginary of Public Engagement in Brazil and the United Kingdom." In: *Public Understanding of Science*, Vol. 20, No. 2, pp. 207-220.

Mager, Astrid (2010) *Mediated Knowledge: Sociotechnical Practices of Communicating Medical Knowledge via the Web and their Epistemic Implications*. Doctoral Dissertation. Online available at: http://sciencestudies.univie.ac.at/fileadmin/user_upload/dep_sciencestudies/pdf_files/publikationen/thesis/Mager_Diss_2010.pdf.

Marres, Noortje (2005) "Issues Spark a Public Into Being: A Key but often Forgotten Point of the Lippmann-Dewey Debate." In: Latour, Bruno; Weibel, Peter (Eds.) *Making Things Public: Atmospheres of Democracy*. Karlsruhe; Cambridge, Mass.: ZKM; MIT Press, pp. 208-217.

McGrail, Stephen (2010) "Nano Dreams and Nightmares: Emerging Technoscience and the Framing and (Re)Interpreting of the Future, Present and Past." In: *Journal of Futures Studies*, 14 (4), pp. 23-48.

Mekel, Michele (2006) "Nanotechnologies: Small Science, Big Potential and Bigger Issues." In: *Development*, 49(4), pp. 47-53.

Merton, Robert K. (1942) "The Normative Structure of Science." In: Merton, Robert K. (1973) *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: The University of Chicago Press, pp. 267-280.

Michael, Mike (1992) "Lay Discourses of Science: Science-in-General, Science-in-Particular, and Self." In: *Science, Technology, & Human Values,* Vol. 17, No. 3, pp. 313-333.

Michael, Mike (2009) "Publics Performing Publics: Of PiGs, PiPs, and Politics." In: *Public Understanding of Science*, Vol. 18, No. 5, pp. 617-631.

Mietzner, Dana; Reger, Guido (2005) "Advantages and Disadvantages of Scenario Approaches for Strategic Foresight." In: *International Journal of Technology Intelligence and Planning*, Vol. 1, No. 2, pp. 220-239.

Mills, Albert J.; Eurepos, Gabrielle; Wiebe, Elden (Eds.) (2010) *Encyclopedia of Case Study Research*. *Volume I*. Thousand Oaks, Calif.: SAGE Publications.

Mol, Annemarie (2002) *The Body Multiple: Ontology in Medical Practice*. Durham; London: Duke University Press.

Nordmann, Alfred (2004) "Social Imagination for Nanotechnology." In: European Commission. Community Health and Consumer Protection. (Ed.) *Nanotechnologies: A Preliminary Risk Analysis*. Online available at: http://ec.europa.eu/health/ph_risk/documents/ev_20040301_en.pdf.

Nordmann, Alfred (2009) "European Experiments." In: *OSIRIS*, 24, pp. 278-302.

Nowotny, Helga; Scott, Peter; Gibbons, Michael (2001) *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Cambridge: Polity Press.

NSF (2005) *New Grants Are Awarded to Inform the Public and Explore the Implications of Nanotechnology – Press Release 05-179*. Online available at: http://www.nsf.gov/news/news_summ.jsp?cntn_id=104505.

NSF (2006) *Investing in America's Future: Strategic Plan FY 2006-2011*. Online available at: http://www.nsf.gov/pubs/2006/nsf0648/NSF-06-48.pdf.

NSF (2011) *Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2011-2016*. Online available at: http://www.nsf.gov/news/strategicplan/nsfstrategicplan_2011_2016.pdf.

NSTC – National Science and Technology Council (2000) *National Nanotechnology Initiative: Leading to the Next Industrial Revolution*. Online available at: http://www.whitehouse.gov/files/documents/ostp/NSTC%20Reports/NNI2000.pdf.

NSTC – National Science and Technology Council (2011) *National Nanotechnology Initiative: Strategic Plan*. Online available at: http://www.nano.gov/nnistrategicplan211.pdf.

Peterson, C.L. (2004) "Nanotechnology: From Feynman to the Grand Challenge of Molecular Manufacturing." In: *Technology and Society Magazine*, IEEE, Vol. 23, 4, pp. 9-15.

Pickering, Andrew (1994) "After Representation: Science Studies in the Performative Idiom." In: *PSA. Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Vol. 2, pp. 413-419.

Pinch, Trevor J.; Bijker, Wiebe E. (1989 [1987]) "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other." In: Bijker, Wiebe E.; Hughes, Thomas P.; Pinch, Trevor (Ed.) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. Cambridge, MA: The MIT Press, pp. 17-50.

Porter, Theodore M. (1995) *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. Princeton, NJ: Princeton University Press.

Power, Michael (1998) *The Audit Society: Rituals of Verification*. Oxford: Oxford University Press.

Ramsden, Jeremy J. (2005) "What is nanotechnology?" In: *Nanotechnology Perception*, 1 (2005), pp. 3-17.

Rip, Arie (2005) *Technology Assessment as Part of the Co-Evolution of Nanotechnology and Society: The Thrust of the TA Program in NanoNed*. Paper contributed to the conference "Nanotechnology in Science, Economy and Society", Marburg, Germany, January 13-15. Online available at: http://cgi-host.uni-marburg.de/~nano-mr/downloads/s4/rip_paper_final.pdf.

Rip, Arie (2006) "Folk Theories of Nanotechnologies." In: *Science as Culture*, Vol. 15, No. 4, pp. 349-365.

Rip, Arie; Misa, Thomas J.; Schot, Johan (1995) "Constructive Technology Assessment: a New Paradigm for Managing Technology in Society." In: Rip, Arie; Misa, Thomas J.; Schot, Johan (Eds.) In: *Managing Technology in Society: The Approach of Constructive Technology Assessment*. London; New York: Pinter, pp. 1-12.

Rip, Arie; Voss, Jan-Peter (2009) *Umbrella Terms in the Governance of Emerging Science and Technology: Bridging the Tension between Relevance and Scientific Advance*. Paper presented at the "Jahrestagung des Arbeitskreises Politik und Technik: 'Governance von Zukunftstechnologien'", Berlin, May 22nd. Online available at: http://www.politics-science-technology.org/files/VortragsfolienBerlin09/Rip-Voss_UmbrellaTerms.pdf.

Robinson, Douglas K. R. (2008) *Complexity Scenarios for Emerging Techno-Science: Addressing Strategy-Context Fit by Prospecting Level Dynamics of Governance*. Presentation Paper. Third International Seville Seminar on Future-Oriented Technology Analysis: Impacts and Implications for Policy and Decision-Making. Online available at: http://foresight.jrc.ec.europa.eu/fta_2008/papers_parallel/theme_1/1-1%20Robinson-Paper.pdf.

Robinson, Douglas K. R. (2010) *Constructive Technology Assessment of Emerging Nanotechnologies: Experiments in Interactions*. Doctoral Dissertation. Online available at: http://www.constructive-ta.com/.

Roco, Mihail C.; Bainbridge, William S. (Eds.) (2001) *Societal Implications of Nanoscience and Nanotechnology*. Dordrecht; Boston; London: Kluwer Academic Publishers.

Roco, Mihail C.; Bainbridge, William S. (Eds.) (2002) *Converging Technologies for Improving*

Human Performance: Nanotechnology, Biotechnology, Information Technology, and Cognitive Science. NSF/DOC-sponsored report. Dordrecht: Kluwer Academic Publishers. Online available at: http://wtec.org/ConvergingTechnologies/Report/NBIC_report.pdf.

Rowe, Gene; Frewer, Lynn J. (2005) "A Typology of Public Engagement Mechanisms." In: *Science, Technology, & Human Values*, Vol. 30, No. 2, pp. 251-290.

Royal Society (2004) *Nanoscience and Nanotechnologies: Opportunities and Uncertainties*. Online available at: http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2004/9693.pdf.

Schot, Johan; Rip, Arie (1997) "The Past and Future of Constructive Technology Assessment." In: *Technological Forecasting and Social Change*, Vol. 54, Issues 2-3, pp. 251-268.

Schmidt, Jan C. (2004) "Unbounded Technologies: Working Through the Technological Reductionism of Nanotechnology." In: Baird, Davis; Nordmann, Alfred, Schlummer, Joachim (Eds.) *Discovering at the Nanoscale*. Amsterdam: IOS Press, pp. 35-50.

Schummer, Joachim (2010) "From Nano-Convergence to NBIC-Convergence: 'The Best Way to Predict the Future Is to Create It'." In: Kaiser, Mario; Kurath, Monika; Maasen, Sabine; Rehmann-Stutter, Christoph (Eds.) *Governing Future Technologies. Nanotechnology and the Rise of an Assessment Regime*. London; New York: Springer, pp. 57-72.

Sciencewise (2010) *International Comparison of Public Dialogue on Science and Technology.* Publication of the Sciencewise Expert Resource Center. Online available at: http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Publications/International-Comparison-of-Public-Dialogue.pdf.

Seguin, Eve (2000) "The BSE Crisis. Strengths and Weaknesses of Existing Conceptual Approaches" In: *Science and Public Policy*, 27(4), pp. 293–301.

Seguin, Eve (2003) "The BSE Saga: A Cannibalistic Tale." In: *Science as Culture*, 12(1), pp. 3-22.

Selin, Cynthia (2010) "Anticipation." In: Guston, David H. (Ed.) *Encyclopedia of Nanoscience and Society*. London: Sage.

Selin, Cynthia (2011) "Negotiating Plausibility: Intervening in the Future of Nanotechnology." In: *Science and Engineering Ethics*, Vol. 17, Issue 4, pp. 723-737.

Selin, Cynthia; Hudson, Rebecca (2010) "Envisioning Nanotechnology: New Media and Future-Oriented Stakeholder Dialogue." In: *Technology in Society*, 32, pp. 173-182.

Special Eurobarometer (2001) *Europeans, Science and Technology – Special Eurobarometer*

55.2. Online available at: http://ec.europa.eu/research/press/2001/pr0612en-report.pdf.

Special Eurobarometer (2005) *Europeans, Science and Technology – Special Eurobarometer 224*. Online available at: http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf.

Special Eurobarometer (2007) *Attitudes of EU Citizens towards Animal Welfare*. Online available at: http://ec.europa.eu/public_opinion/archives/ebs/ebs_270_en.pdf.

Special Eurobarometer (2010a) *Science and Technology – Special Eurobarometer 340*. Online available at: http://ec.europa.eu/public_opinion/archives/ebs/ebs_340_en.pdf.

Special Eurobarometer (2010b) *Food-related Risks – Special Eurobarometer 354*. Online available at: http://ec.europa.eu/public_opinion/archives/ebs/ebs_354_en.pdf.

Star, Susan Leigh; Griesemer, James R. (1989) "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." In: *Social Studies of Science*, Vol. 19, No. 3, pp. 387-420.

Starr, Chauncey (1969) "Social Benefit versus Technological Risk: What is Society Willing to Pay for Safety?" In: *Science*, September 1969, Vol. 165, pp. 1232-1238.

Stein, Josephine Anne (2003) "Public Understanding of Science in the United Kingdom: A Leading Country, but to what Destination?" In: Felt, Ulrike (Ed.) *O.P.U.S. Optimising Public Understanding of Science and Technology. Final Report,* pp. 589-609. Online available at: http://www.univie.ac.at/virusss/opus/OPUS%20Report%20Final.pdf.

Sterling, Andy (2006) *From Science and Society to Science in Society: Towards a Framework For 'Co-Operative Research'.* Project Report. European Commission Directorate General for Research. Online available at: http://ec.europa.eu/research/science-society/pdf/goverscience_final_report_en.pdf.

Stirling, Andy (2008) "'Opening Up' and 'Closing Down' Power, Participation, and Pluralism in the Social Appraisal of Technology." In: *Science, Technology, and Human Values*, 33 (2), pp. 262-294.

Stirling, Andy (2012) "Opening Up the Politics of Knowledge and Power in Bioscience." In: *PLoS Biology*, 10 (1), pp. 1-5. Online available at: http://sro.sussex.ac.uk/40172/1/journal.pbio.1001233.pdf.

Stirling, Andy; Mayer, Sue (1999) *Rethinking Risk: A Pilot Multi-Criteria Mapping of a Genetically Modified Crop In Agricultural Systems in the UK*. A Report by SPRU in Association with GeneWatch, funded by Unilever in Consultation with the Green Alliance and a variety of other Environmental and Consumer Non-Governmental Organisations. Online Available at: www.sussex.ac.uk/Users/prfh0/Rethinking%20Risk.pdf.

Stilgoe, Jack (2007) "Nanodialogues: Experiments with Public Engagement in Science." Online available at: http://www.demos.co.uk/files/Nanodialogues%20-%20%20web.pdf?1240939425.

Stoker, Gerry (1998) "Governance as Theory: Five Propositions." In: *International Social Science Journal*, Vol. 50 (155), pp. 17-28.

Strassnig, Michael (2009) *Ethics is like a Book that One Reads when One has Time: Exploring Lay 'Ethical' Knowledge in a Public Engagement Setting*. Doctoral Dissertation. Online available at: http://sciencestudies.univie.ac.at/fileadmin/user_upload/dep_sciencestudies/pdf_files/pdfs_abgeschlossene_projekte/Abschlussarbeiten/DISS_STRASSNIG_M.pdf.

Suchman, Lucy (2011) "Anthropological Relocations and the Limits of Design." In: *Annual Review of Anthropology*, Vol. 40, pp. 1-18.

Tanaka, Tomohiro (2005) "Medical Business Ethics: The HIV-Tainted-Blood Affair in Japan." In: Takahashi, Takao (Ed.) *Taking Life and Death Seriously - Bioethics from Japan. Advances in Bioethics*, Volume 8, pp. 253-273.

Taniguchi, Norio (1974) "On the Basic Concept of 'Nano-Technology'." In: Japan Society of Precision Engineering (Ed.) *Proceedings of the International Conference on Production Engineering,* Part II, Tokyo 1974.

Taylor, Charles (2004) *Modern Social Imaginaries*. Durham, NC: Durham University Press.

TECHNOLIFE (2012*) techn01life: Project Final Report*. Online available at: http://technolife.no/wosyq3tmp/content/filelist_b9b0f429-0e6c-49f5-8944-24541635e46e/1336510179106/technolife_final_report_for_website.pdf.

Thrift, Nigel (1999) "Steps to an Ecology of Place." In: Massey, Doreen; Allen, John; Sarre, Philip (Eds.) *Human Geography Today*. Cambridge: Polity Press.

Toumey, Chris (2004) "Nano Hyperbole and Lessons from Earlier Technologies." In: *Nanotechnology Law & Business*, 1(4), pp. 397-405.

United Nations Educational, Scientific and Cultural Organization (2010) *World Social Science Report: Knowledge Divides*. Online available at: http://unesdoc.unesco.org/images/0018/001883/188333e.pdf.

U.S. Government Printing Office (2003) *21st Century Nanotechnology Research and Development Act*. Online available at: http://www.gpo.gov/fdsys/pkg/PLAW-108publ153/html/PLAW-108publ153.htm.

VA Report (2011) *Public Engagement: International Review, Analysis and Proposals on Indicators for Measuring Public Engagement*. VA Report 2011 (2). Online available at: http://v-a.se/downloads/varapport2011_2.pdf.

Vermeulen, Niki (2009) *Supersizing Science: On Building Large-Scale Research Projects in Biology*. Doctoral Dissertation.

Vlieger, Esther; Leydesdorff, Loet (2010) "How to Analyze Frames Using Semantic Maps of a Collection of Messages." Unpublished Manual. Online available at: http://www.leydesdorff.net/indicators/pajekmanual.2010.pdf.

Voß, Jan-Peter; Bauknecht, Dierk; Kemp, René (Eds.) (2006) *Reflexive Governance for Sustainable Development*. Cheltenham: Edward Elgar Publishing.

Watts, Laura (2008) "The Future is Boring: Stories from the Landscapes of the Mobile Telecoms Industry." In: *Technology Analysis and Strategic Management*, 15(1), pp. 3-18.

Wilsdon, James; Willis, Rebecca (2004) "Techno probe: Science Risks a Re-run of the GM Debacle without Debate on its Latest Find." In: *The Guardian*, September 1 2004. Online available at: http://www.guardian.co.uk/society/2004/sep/01/nanotechnology.science.

Wilsdon, James; Wynne, Brian; Stilgoe, Jack (2005) *The Public Value of Science: Or How to Ensure that Science Really Matters*. London: DEMOS. Online available at: www.demos.co.uk/files/publicvalueofscience.pdf.

Winickoff, David; Jasanoff, Sheila; Busch, Lawrence; Grove-White, Robin; Wynne, Brian (2005) "Adjudicating the GM Food Wars: Science, Risk, and Democracy in World Trade Law." In: *Yale Journal of International Law*, 30(1), pp. 81-123.

Winner, Langdon (2003) *Congressional testimony. Hearing before the Committee on Science. US House of Representatives*. 108th Congress, 1st Session, 9 April 2003. Online available at: http://homepages.rpi.edu/~winner/testimony.htm.

Wynne, Brian (1989) "Frameworks of Rationality in Risk Management: Towards the Testing of Naïve Sociology." In: Brown, Jennifer (Ed.) *Environmental Threats: Perception, Analysis, and Management*. London: Belhaven Press, pp. 33-47.

Wynne, Brian (1992) "Misunderstood Misunderstanding: Social Identities and Public Uptake of Science." In: *Public Understanding of Science*, Vol.1, No.3, pp. 281-304.

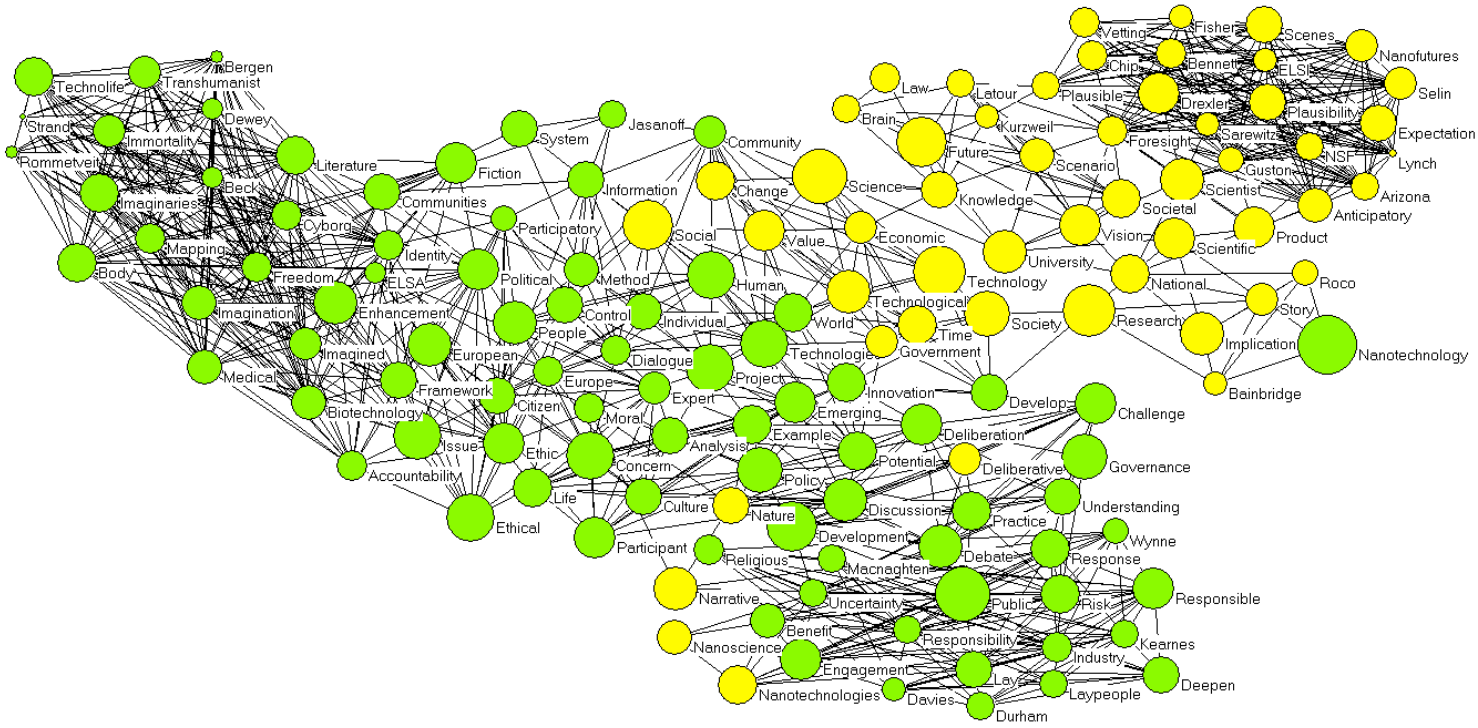
Wynne, Brian (1995) "Public Understanding of Science." In: Jasanoff, Sheila; Markle, Gerald E.; Petersen, James C.; Pinch, Trevor (Eds.) *Handbook of Science and Technology Studies*. Thousand Oaks, Calif.: Sage Publications, pp. 361-388.

Wynne, Brian (2006a) "Afterword." In: Kearnes, Matthew; Macnaghten, Phil; Wilsdon, James (2006) *Governing at the Nanoscale: People, Policies and Emerging Technologies*. London: DEMOS. Online available at: http://www.demos.co.uk/files/governingatthenanoscale.pdf?1240939425.

Wynne, Brian (2006b) "Public Engagement as a Means of Restoring Public Trust in Science – Hitting the Notes, but Missing the Music?" In: *Community Genet*, 9 (3), pp. 211-220.

Wynne, Brian (2007) "Public Participation in Science and Technology: Performing and Obscuring a Political- Conceptual Category Mistake." In: *East Asian Science, Technology and Society: An International Journal*, Vol. 1, No.1, pp.99-110.

ANNEX I – Semantic Map



A semantic map based on deliverables (published and unpublished) from three Nano-related upstream public engagement projects (NanoFutures, DEEPEN, and TECHNOLIFE). Map generated using the Kamada-Kawai algorithm, coloring based on SPSS factor analysis.

ANNEX II – Curriculum Vitae

CURRICULUM VITAE

Gernot Rieder

born July 12, 1984
in Klagenfurt, Austria

Stuckgasse 10, 1070 Wien
Email: gernot.rieder@gmx.at
Website: http://gernotrieder.net
Mobil Tel.: +43 669 10 2222 04

EDUCATION AND DIPLOMAS

-- 2010 – 2013	Master's Student at the Department of Science and Technology Studies, University of Vienna
-- Spring 2007	Bachelor Degree in Communication Studies, University of Vienna
-- since 2005	Student at the Department of East Asian Studies, Subject Area: Sinology, University of Vienna
-- since 2004	Student at the Department of Communication Studies, University of Vienna
-- since 2003	Student at the Department of Theatre-, Film-, Media Studies, University of Vienna
-- 2003	Basic Military Service in Austria (paramedic)
-- 1994-2002	Secondary Education at the BG/ BRG Ingeborg Bachmann in Klagenfurt, Austria
-- 1990-1994	Elementary School in Klagenfurt, Austria

SCHOLARSHIPS AND GRANTS

-- 07.2011 – 06.2012	Research Scholarship, Austrian Science Fund
-- 2008	Additional Scholarship of Excellence, University of Vienna
-- 2008	Scholarship of Excellence, University of Vienna

-- 2007	Additional Scholarship of Excellence, University of Vienna
-- 2007	Scholarship of Excellence, University of Vienna

THESES

-- Bachelor Thesis I	"Internet Governance oder: Wer regiert den Cyberspace? Eine Darstellung der Entwicklung der administrativen Verwaltung des Internet und die aktuelle Diskussion zur Problematik der Domainvergabe." Vienna (2006), Advisor: Erich Geretschläger
-- Bachelor Thesis II	"Dimensionen einer Mensch-Computer Interaktion. Bildhafte Darstellung und symbolische Vermittlung als bezeichnende Elemente einer modernen Interface Kultur." Vienna (2007), Advisor: Frank Hartmann

TALKS

-- October 2012	*Nano Futures in the Making: On the Modalities of Social-Scientific Scenario Building.* Society for the Study of Nanoscience and Emerging Technologies (S.NET), Twente
-- October 2012	*(De-)Constructing Technoscientific Futures: On the Modalities of Social-Scientific Scenario Building.* Society for Social Studies of Science (4S), Copenhagen

TRANSLATIONS

-- 2010	Buckland, Michael (2010) *Vom Mikrofilm zur Wissensmaschine: Emanuel Goldberg zwischen Medientechnik und Politik*. Berlin: Avinus. Available at Amazon

BOOK REVIEWS

-- 2010	Bublitz, Hannelore; Marek, Roman; et al. (2010) *Automatismen*. München: Wilhelm Fink Verlag. Review published online

TEACHING

-- 2007 – 2008	Tutor at the Department of Communication Studies, University of Vienna (1 to 2 courses per semester), Topics (example): Interface Communication, Web 2.0, Science Utopia

EMPLOYMENT

-- 04.2013 – 09.2013	Proofreader (English), Faculty of Social Sciences, University of Vienna
-- 11.2012 – 03.2013	Proofreader (English), Department of Science and Technology Studies, University of Vienna
-- 07.2011 – 09.2012	Project Member "Making Futures Present: On the Co-production of Nano and Society in the Austrian Context", Department of Social Studies of Science, University of Vienna
-- 02.2011 – 06.2011	Student Assistant at the Department of Social Studies of Science, University of Vienna
-- 2007 – 2008	Tutor at the Department of Communication Studies, University of Vienna
-- Winter 05/06/07	Communication Agent (Online Marketing) at Domsich, Kossatz & Steinberger Beratungs OEG

LANGUAGE SKILLS

-- German	mother tongue
-- English	excellent, written and spoken
-- Mandarin	advanced learner
-- French	advanced learner
-- Spanish	Notions
-- Italian	Notions