The notion of 'responsible development' in new approaches to governance of nanosciences and nanotechnologies

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Kamilla

Abstract

This PhD dissertation looks at the development of nanosciences and nanotechnologies (nanoST), a field that has gained tremendous political and economic momentum in the first decade of the 21st century. It is also a field that has provided a frame for timely discussions and explorations of governance of emerging technology, in light of its potential to change social and environmental structures both for better and worse. The aim of this dissertation has been to understand better if, and in what way, new approaches to the governance of science could lead to 'responsible development' of nanoST, as commonly claimed. Through four empirical studies the research has searched for responsible practices in a) the research-field of Ethical, Legal and Social Aspects (ELSA) of nanoST, b) participatory exercises, c) uninvited public debate, and d) a code of conduct for nanoresearch. While the extent to which such new approaches to governance are succeeding individually has been a topic of much debate, one of the contributions of this dissertation is that it has studied four different practices as part of the same research project.

The first paper is based upon a text study of ELSA literature, where 244 texts were systematised according to four key categories; Governance, Science, Perception and Philosophy. Most of the texts clearly raised questions from more than one category, and led to the conclusion that cross-category literature provided a potential for nanoELSA to develop into a more creative and integrated field. In the second paper, I studied the representations of nanoST in Norwegian newspapers, to get a sense of the perspectives available for those not particularly seeking out information about new technologies. The main conclusion of this study was that the dominating representations fail to constitute nanoST as a matter of concern, and that more voices and viewpoints about nanoST are desired in the public sphere. The third paper makes and analyses the claim that tensions stemming from unresolved theoretical conflict manifest as problems for the emerging practice of participatory approaches. It argues that for public engagement to prove successful, basic questions related to why, when,

who, where and how should be openly confronted, as choices in relation to each one of these questions have consequences for the available choices in the others. In the fourth paper the European Commission 'recommendation on a code of conduct for responsible nanosciences and nanotechnologies research' is used as a frame for a series of conversations with nanoresearchers about the notion of responsible nanoresearch. Three different interpretations of the notion of responsible nanoresearch are suggested and discussed. The paper conclude that sensitivity towards own values and moral choices is as important as dialogue and communication for nanoST research to be truly responsible.

In studying these different approaches, two overall conclusions are drawn. The first is that new approaches to governance have indeed provided an important step in the right direction towards a more 'responsible development'. The level of reflexivity and willingness to debate the notion of responsibility across the sectors of nanoresearch in itself constitutes a more responsible practice. Responsible development of nanoST can never mean a guarantee of 'good' nanoST for all. Rather, it involves acknowledging precisely how this is unachievable. The broad focus and debate about the governance of nanoST has initiated processes where this is beginning to be more widely recognized.

Secondly, mindfulness – in the sense of ongoing questioning of given 'instructions' and actions against personal values – is identified as a rather neglected aspect in the effort towards a responsible development of nanoST. As a supplement to deliberation and dialogue *between* roles, individuals who can challenge their roles themselves – the instructions and institutions –are necessary when faced with a scientific and technological development that may change more rapidly than the instructions and institutions can adapt.

Sammendrag

Denne doktorgradsavhandlingen tar utgangspunkt i utviklingen av nanovitenskap og nanoteknologi (nanoVT), et forskningsfelt det har blitt knyttet stor politisk og økonomisk forventning til det siste tiåret. Det er samtidig et felt som har satt ramme for en betimelig utforskning av nye tilnærminger til regulering av ny teknologi, i lys av dens potensiale for å endre samfunnsmessige og miljømessige strukturer på godt og vondt. Formålet med forskningen har vært å forstå bedre hvorvidt nye tilnærminger til regulering av vitenskap og teknologi bidrar til en mer ansvarlig utvikling av nanoVT, slik det ofte hevdes. Gjennom fire empiriske studier har prosjektet søkt etter ansvarlige praksiser i a) forskningsfeltet som studerer etiske, legale og samfunnsmessige aspekter (ELSA) av nanoVT, b) deltakende metoder, c) åpen offentlig debatt, og d) retningslinjer for ansvarlig nanoforskning. Slike nye tilnærminger for regulering av vitenskap og teknologi har blitt viet en god del oppmerksomhet hver for seg, og det pågår en debatt om hvorvidt de oppnår målet om ansvarlig utvikling. Denne studien har imidlertid hatt som formål å studere flere ulike initiativer, og utforske begrepet om ansvarlig utvikling på tvers av dem.

Den første studien i avhandlinga er basert på en tekststudie av ELSA litteratur, og systematiserer 244 artikler i henholde til fire hovedkategorier: ”governance”, vitenskap, oppfatning/opplevelse og filosofi. De fleste tekstene adresserte spørsmål innenfor flere enn en av disse kategoriene, og artikkelen konkluderer med at forskning som utforsker spørsmål på tvers av etablerte kategorier er verdifull fordi den gir nanoELSA mulighet til å utvikle seg til et felt som tar tak i grunnleggende utfordringer i møtet mellom nanoVT og samfunn. I den andre artikkelen studerte jeg formidling av nanoVT i norske aviser, for å se hva slags inntrykk som er tilgjengelig for de som ikke oppsøker informasjon om ny teknologi. Hovedkonklusjonen er at de dominerende historiene i liten grad problematiserer utviklingen av nanoVT, og at det er behov for flere stemmer og perspektiver om nanoVT i den offentlige sfæren. Den tredje artikkelen fremsetter og diskuterer en påstand om at deltakende metoder for nanoVT er

preget av spenning mellom ulike teoretiske standpunkt som skaper utfordringer for denne typen metoder i praksis. Den argumenterer med at for at deltakende metoder skal vinne fram, må grunnleggende spørsmål knyttet til hvorfor, når, hvem, hvor og hvordan diskuteres i sammenheng. Dette fordi valg man tar innefor hvert enkelt av disse spørsmålene får konsekvenser for valgmulighetene i de andre. I den fjerde artikkelen brukes EU kommisjonens retningsliner for ansvarlig nanoforskning som ramme for en serie med samtaler med nano-forskere om ansvarlighet. Tre ulike tolkninger av begrepet om ansvarlig forskning blir foreslått og diskutert. Artikkelen konkluderer med at sensitivitet i forhold til egne verdier og moralske valg er viktig som tillegg til dialog og kommunikasjon for at nanoforskning skal være ansvarlig.

Det blir trukket to overordnede konklusjoner på tvers av studiene. Den første er at nye tilnærminger til regulering av vitenskap og teknologi har bidratt til en mer ansvarlig praksis. Denne konklusjonen baserer seg på en argumentasjon om at den mer eksperimentelle og refleksive holdningen som nå finnes på tvers av ulike sektorer i utviklingen av nanovitenskap og nanoteknologi i seg selv representerer en mer ansvarlig tilnærming. Ansvarlig utvikling av nanoVT kan aldri bety en garanti for god eller ufarlig nanoteknologi for alle. Tvert imot handler det nettopp om å akseptere at dette er uoppnåelig og inkludere denne innsikten i ulike former for praksis. Bredt fokus og debatt omkring regulering av ny teknologi har satt i gang prosesser der dette er i ferd med å bli mer anerkjent.

Den andre konklusjonen er at et aspekt som ikke har blitt tillagt så mye oppmerksomhet i debatten omkring ansvarlig utvikling av ny teknologi, er personlig tilstedeværelse og vurdering av oppgavene og ansvarsområdene som tillegges de ulike rollene og sektorene. Som et supplement til dialog mellom roller og sektorer, er individets ’indre dialog’ viktig fordi den muliggjør en regelmessig evaluering av institusjoner og instruksjoner. Dette er av stor betydning når man har å gjøre med en vitenskapelig og teknologisk utvikling som er i rask endring - i noen tilfeller raskere enn institusjonene og instruksjonene vil kunne tilpasse seg.

List of publications

Paper I: Kjølberg, K. and Wickson, F. (2007) Social and ethical interactions with nano: mapping the early literature, *Nanoethics* 1(2):89–104

Paper II: Kjølberg, K. (2009) Representations of Nanotechnology in Norwegian Newspapers: Implications for Public Participation, *Nanoethics,* 3(1): 61-72.

Paper III: Delgado, A., Kjølberg, K.L. and Wickson, F. (2010) Public Engagement Coming of Age: From theory to practice in STS encounters with nanotechnology, *Public Understanding of Science*, http://pus.sagepub.com/content/early/2010/05/11/0963662510363054

Paper IV: Kjølberg, K.L. (forthcoming) Conversations about responsible nanoresearch, Submitted

Contents

Introduction

This PhD dissertation is concerned with the development of nanosciences and nanotechnologies (nanoST), a field that has gained tremendous political and economic momentum over the last decade. It is also a field of research that has provided a frame for important and timely discussions about responsible development of emerging technology, in light of its potential to change social and environmental structures both for better and worse. While there is now broad recognition of the challenges of scientific uncertainty for science policy, and efforts to democratise science is becoming widespread, products based on nanoST keep entering the markets and innovation processes go on relatively unaffected. This provides the backdrop of the research presented in the four papers that make up this dissertation, and in the following pages I will elaborate on this context. The aim of this research has been to understand better if, and in what way, new approaches to the governance of science could lead to a responsible development of nanoST. My approach has been to study different arenas or spheres associated with the following practices of governance: ELSA research, invited and uninvited public debate and codes of conduct for nanoresearch (all of which will be elaborated in the text below) in search for responsible practices. Hence, the four papers focus on the public sphere and the media (paper II), the social studies of nanoST (paper I), participatory exercises (paper III), and finally research policy and nanoST research itself (paper IV).

In this introduction I present the object of research and the research tradition that I have worked within. In section one, I briefly present the sciences and technologies in question, before, in section two, I move on to portray the studies of nanoST from a social perspective as well as some of the science policy context that the field has developed within. Particular emphasis is given in this section to two central notions: 'governance' and 'responsible development'. The third section describes the theoretical and institutional frame and context of this thesis, while section four outlines

the methods employed. The four papers of this thesis are first briefly presented separately in section five and then discussed in relation to each other in section six, drawing lines between them and conclusions based on them. The introduction ends with some elements of (self-)criticism of the project, combined with suggestions for further research in section seven.

1. Nanosciences and nanotechnologies

1.1 Definition

In the simplest sense[1], the prefix 'nano' refers to the scale of one billionth (10^{-9}), which means that one nanometre (nm) equals a billionth of a metre. 'Nano' is used to signify a broad and diverse collection of sciences and technologies, where 'nanosciences' appears across a wide range of scientific disciplines (physics, chemistry, biology, materials science, information technology etc.) and 'nanotechnologies' has applications in a range of different sectors (energy, transport, medicine, textiles, communications etc.) (RS/RAE 2004, RCN 2006, Sire 2009). The precise definition and scope of nanosciences and nanotechnologies, however, is contested (Scientific American 2002, von Schomberg 2010). Contestation begins already when one tries to define the boundaries of what constitutes 'the nanoscale'. The most common seems to be to refer to the term 'nanoscale' as a range between 1-100 nm (EC 2008a, Sire 2009, Grobe *et al.* 2008, Hunt and Mehta 2006), but both the beginning and the end of this range remain subject to ongoing debate. Some claim that it should extend as low as 0.1nm or 0.2nm (because atoms and some molecules are smaller than 1nm) (EC 2006, RS/RAE 2004) or as high as 300nm (because specific properties of the nanoscale may also be observed above 100nm, and particles as large

[1] The text in this section builds upon an earlier version of a popular article in Norwegian (Kjølberg 2008a) as well as the introduction to the anthology 'Nano meets Macro – social perspectives on nanoscale sciences and technologies', which was written in collaboration with Fern Wickson.

as 300nm can for instance be taken up by cells and should therefore be included in nanoparticle risk assessments) (FoE 2008; 2009). For a material to classify as a nanomaterial, it should be 'nanoscale' in at least one dimension (so as to include particles, fibres and coatings etc.). The definition of nanoST is highly significant in both scientific and political terms because it can affect everything from funding, to risk assessment and product labelling[2]. The high stakes involved here are an important reason why the definition of nanoST continues to be contested. Many definitions also distinguish between naturally occurring and man-made nanomaterials (Grobe *et al.* 2008). In addition, further complicating the notion of nanoST, present and potential future applications are often lumped together in the same sentence (Selin 2006). Present applications include things like transparent sunscreens, antibacterial kitchen utensils and stain resistant clothing. More far reaching future visions include the ability to construct almost any type of material structure through the precise placement of individual atoms, something that for nano proponents could lead to a new industrial revolution (Roco and Bainbridge 2003). Others, however, worry over the same visions, painting a scenario of a chain reaction where nano-robots replicate themselves endlessly, filling the biosphere with 'gray goo' (Joy 2000). The research in this thesis does not focus on any type of nanoST in particular, but is a study of the field and the concept of nanoST as a general phenomenon.

Despite this variety, an important reason for still talking about nanoST as something distinct and unique is that objects at the nanoscale may express different properties from those expressed by larger objects of the same material (RS/RAE 2004). Properties, such as colour, conductivity, reactivity and melting point, can all change at the nanoscale. This expression of novel properties of nanomaterials is typically explained by both the presence of quantum effects at this scale, and the increase in

[2] Personally, I support applying a broad scale range in line with the FoE argument that it is desirable to include any new material that may expose properties dissimilar to the bulk form to increased testing. I support functionality in addition to size as important for labelling something nanoST. It is in this sense I use the term nanoST in this dissertation.

surface area to volume ratio that occurs. The properties of larger objects are also affected by nanoscale atomic configuration. For example, both graphite and diamond are made of carbon atoms, but these materials have very different physical properties because of the way in which the atoms are arranged. One of the early areas of significant development in nanoST was the discovery of, and ability to fabricate, a different atomic structure for carbon, including molecules shaped like soccer balls (fullerenes) and cylindrical tubes (carbon nanotubes). Carbon nanotubes are strong, light, and can have very high conductivity (Scientific American 2002). They are therefore a good example of the way in which restructuring atoms at the nanoscale can create materials with novel and useful properties. In most definitions, it is the ability to employ, engage, and manipulate the novel properties of the nanoscale that is crucial for something to count as nanoST (Grobe *et al.* 2008). This means that for many people, nanoST is seen as not just understanding the nanoscale, but actively utilising the novel properties that are in effect there. The UK Royal Commission on Environmental Pollution, in their case study of nanomaterials (2008) point out that "[i]*t is not the particle size or mode of production of a material that should concern us, but its functionality." (p.4).*

1.2 History

A standard account of the history of nanoST has been established (Baird and Shew 2004, Mody 2004, Toumey 2005). It starts with the physicist Richard Feynman's talk to the American Physical Society in 1959, where he made the now famous claim that there is "*plenty of room at the bottom*" (Feynman 1959). This call for a scientific exploration of the atomic level, in much the same manner as the exploration of the Universe, sparked a new interest in this kind of research. Via Taniguchi (1974), who is claimed to be the first to use the term 'nanotechnology', the standard story continues with the invention of the scanning tunnelling microscope (STM) by Gerd Binnig and Heinrich Rohrer (Binning and Rohrer 1987), and the use of the same instrument by Donald Eigler to write 'IBM' using xenon atoms a few years later (Eigler and

Schweizer 1990), illustrating a new ability for precise control of matter at an atomic level. Eric Drexler's visions about molecular manufacturing and nanoscale assemblers gave the field a broad and far reaching prospect (Drexler 1986), although many 'real scientists' were eager to distance themselves from what they saw as science fiction (Bueno 2006, Selin 2007). Finally, the launch of a National Nanotechnology Initiative (NNI) in the USA in the beginning of the new millennium ensured its political and economical significance. Chris Toumey (2005) and Hans Fogelberg (2010) are among those who have suggested that there are reasons to question and problematise this standard story. It may give the impression that the advent of nanoST was bound to happen as it did. It is a story very much told from the proponents and supporters point of view; a success story of a sequence of pioneers of science who shaped history (Toumey 2005). Fogelberg (2010) points out its neglected roots in material science and the political ramification of the omissions in that the standard framing determines who get to be included and excluded from nanoST, for better and worse. The "*authorative founding myth*" (Toumey 2005, p. 23) helps justifying the aggregation of quite different strands of research under a common label of 'nano', by creating a sense of unity in the field. The historical tracing, although it could have taken different routes and had different emphasis, has therefore been important in the success the field of nanoST has had in attracting both political interest and economic funding.

2. NanoST in a socio-political context

2.1 NanoEthics, NanoELSA, STS of nano and SEIN

The studies of nanoST from a social perspective are conducted from different point of views across a number of disciplines, and are therefore both diverse and multifaceted. As the heading of this subsection indicates, several different names are used for these kinds of studies. Both nanoethics and SEIN (social and ethical interactions with nanoST) are used as relatively broad and inclusive labels. Science and Technology Studies (STS) is an interdisciplinary research field with roots in, among other fields,

sociology and with several distinct subfields[3]. STS has been influential for the studies of nanoST, for example by placing it in a broader context of history of science (see for example Kearnes and Wynne 2007, Glimell 2006). Much of the funding for research on nanoST from a social perspective, however, has been channelled through so-called ELSA research programmes; the studies of Ethical, Legal and Social Aspects. ELSA was established as a concept[4] with the Human Genome Project (HGP) in 1990[5]. The ethical, legal and social concerns associated with mapping of the human genome, led to a dedicated 3-5% of the total HGP funding to research specifically looking into these kinds of issues. Biotechnology and genetic engineering provided constant new research tasks for ELSA. Throughout the 1990s the field increasingly grew more established, and the dedication of a few percent of the budget to ELSA research in large scale research programs became quite common (RCN 2008). Following among other things the public opposition to genetically modified (GM) food and agriculture in many countries (and UK in particular), ELSA research was however criticised for having too little impact and arriving too late. With the arrival of nanoST as a political priority, this was taken by some (both researchers and science policy institutions) as an opportunity to show that ethical, legal and social aspects could and should be dealt with differently (RS/RAE 2004, Balbus *et al.* 2006, Kearnes *et al.* 2006). Warnings to avoid that 'nano' would follow the path of GM took many different forms. Kristen Kulinowski (2004) pointed out that public had gone from 'wow to yuck' for GM, and that the same backlash might be the reality for nanoST if public concerns were not taken seriously. Geert van Calster (2008), similarly, drew attention to the how the European public was adverse to the risks of GM, and that one should pay close

[3] For a short history and an account of this research field see for instance: http://www.easst.net/resources (last accessed July 2010). Wikipedia also gives a good brief account of the complex of STS, and some of its central work: http://en.wikipedia.org/wiki/Science_and_technology_studies (last accessed July 2010).
[4] In the HGP the expression ELSI (ethical, legal and social implications) was used, and this acronym is still common in the US, while the acronym ELSA has become the norm in Europe. The change from 'implications' to 'aspects' also signifies a shift in focus towards the more dynamic relation between science and society. Sometimes this is also incorporated in ELSI by letting the I in the acronym signify 'issues'.
[5] http://www.ornl.gov/sci/techresources/Human_Genome/resource/elsiprog.shtml, (last accessed July 2010).

attention to public opinion toward nanoST, "*to avoid a repetition of the regulatory sclerosis*". Phil Macnaghten *et al*. (2005) and Matthew Kearnes *et al*. (2006) argued that the lessons from the failure to govern agricultural GM and the arrival of nanoST represents an "*extraordinary opportunity*" (Macnaghten *et al.* 2005, p.269) for social science and public concerns to be integrated reflexively in regulation and development.[6] In general there has been a sense that bioELSA in many instances were restricted to quite limited questions (of concrete risk) and failed to address a number of more fundamental ethical and social issues.

In the papers in this thesis, the expressions SEIN, nanoethics, nanoELSA and STS are all used, although in this introduction I try to use nanoELSA consistently to avoid confusion. For some authors, the distinctions between these terms are important, reflecting for instance different disciplinary roots and accepted methodology, or the extent to which there is room to draw normative conclusions. My alternation between the terms is a result of the fact that I have worked interdisciplinary and taken inspiration from multiple directions throughout this project, which implicitly is an expression of the fact that I for instance see it as natural to be normative irrespectively. I prefer the expression 'the studies of nanoST from a social perspective', which I see as incorporating all of the approaches mentioned above (as well as for instance the philosophy of science etc.) but which is far too long to use in for instance scientific articles. More importantly, a key influence for me has been the thematisation of the relation between science and policy by scholars such as Brian Wynne, who has been a prominent spokesperson since the early 1990's for the public's ability to contribute with valuable knowledge in questions of science and technology policy (Wynne 1992).

[6] It is worth noting however that the 'regulatory failure of GM' as providing legitimacy for public participation and ELSA research in the UK (that has developed into something of a standard account among ELSA researchers), to some extent originates in the same environments that later became central actors in the organisation of these kinds of exercises (such as Demos and Involve). This is not to say that for instance lack of trust in expertise was not an important factor, but that it is worth taking into account that there is a broader context of co-production here.

Other important sources of inspiration in this respect are the theory of 'post normal science' (PNS), developed by Silvio Funtowicz and Jerome Ravetz, and the notion of 'mode 2 science' coined by Helga Nowotny, Michael Gibbons and colleagues. I will briefly outline their main arguments and terminology here.

The concept of PNS was put forward by Funtowicz and Ravetz (1993; 1994) in the early 1990s, in the argument that different kinds of decision situations require different types of relationships between science and society. The two scholars differentiated between three types of science /society-relationships based on the 'level of uncertainty' and the 'decision stakes' involved, and formed a useful way of thinking about different roles that science can play in political decision making. Their approach specifically challenges the view that quality control of science was always seen as best managed within the scientific community. They coined the term 'extended peer review' to mean the broader involvement of a range of participants in the evaluation of the quality of scientific advice for policy. The concept of PNS is mainly a theoretical position, and as such many questions related to the practical enactment of elements such as 'extended peer review' remain open. Practical suggestions for how to approach science policy challenges in post normal situations have been suggested, not least by the NUSAP[7] methodology.

'Mode 2 science' was introduced as a term by a group of academics to describe what they saw as certain changes in the practice of science (Gibbons *et al*. 1994). 'Mode 2 science' was distinguished from 'mode 1 science' by the way in which it for instance existed between the traditional academic disciplines, as well as across the publicly funded university sector, private research institutes and scientific expert advice for policy. It also in many ways dismantles the traditional distinction between basic and applied research. With mode 2 Nowotny and colleagues (2001) saw knowledge production move in the direction of more democracy and transparency in the

[7] http://www.nusap.net, (last accessed July 2010).

intermingled spheres of science and society. While knowledge production in mode 1 aims for reliable knowledge, the objective of mode 2 knowledge production is to arrive at 'socially robust knowledge'; scientific knowledge that has been exposed to public scrutiny and debate during its production to appear as more in line with social desires, values and goals (Nowotny 1999). In this way, Gibbons, Nowotny and their colleagues made one of the important contributions to the understanding of the 'co-production' of science/technology and society. The idea of co-production, then, is often seen to entail a challenging of the prioritised position of scientific knowledge over other forms of knowledge. Social robustness as a notion is often put in relation with the idea of 'responsible development' of science and technology, which is a core concept in this thesis.

One of the things that bind these kinds of contributors and theories together is the focus on the inadequacy of scientific risk-assessment as a basis for decision making in post normal or mode 2 situations. The scientific uncertainty[8] surrounding for instance the behavior of engineered nanomaterials (pointed out repeatedly, and already in RS/RAE 2004) is used to argue for other sources of decision support and legitimation of action. The apparent lack of scientific knowledge undermines the privileged position of science in political decision making, and leads to the argument for public participation also in decisions concerning science and technology. Silvio Funtowicz and Roger Strand (2010), point out that a lack of trust in scientific expertise and politics is rooted deep into the way it is fundamentally based on risk-assessment and risk-management, where responsibility and trust is tied to the idea of control over consequences. With new emerging technologies, it is increasingly evident that control is unattainable and that trust and responsibility has to be rooted elsewhere. An important component of the PNS theory is the point that contrary to what one used to

[8] There are many important nuances in the different ways that scientific uncertainty is classified and understood, for instance in respect to the distinction between ontological and epistemic uncertainty. It is beyond the scope of this thesis to address this directly, for reference see for instance Wickson, Gillund and Myhr (2010).

believe, facts are now soft (there is uncertainty), while values are hard (there is an urgent need for making decisions based upon values). The critique of the risk-assessment regime is for these scholars partly based upon an environmental and ecological motivation, which is a position that I support, and a perspective and motivation that has been important also for the research in this dissertation.

The influence of these (to a large extent) UK-based theoreticians, in combination with the particular intensity in the UK of public controversies over 'food technologies' (Macnaughten *et al*. 2005, Rogers-Hayden and Pidgeon 2007), has contributed to making this country a particularly interesting place when it comes to science-society relation theory and public participation in science policy. Public participation and upstream[9] public engagement[10] (UPE) (Wilsdon and Willis 2004), was seen by many as a way for politicians to regain public trust in matters of science and technology after several episodes (e.g. the 'mad cow disease' (BSE), the Chernobyl accident, the debate over GM food etc.) leading to eroding confidence (Rogers-Hayden and Pidgeon 2007). It is also hard to get around the fact that public engagement (as well as funding to ELSA research) may be seen as beneficial from a science marketing and science communication point of view, and that this may be a main motivation for support from industrial actors for example. Andrew Stirling (2008) has pointed to how different rationales for public engagement, to some extent have allowed STS/ELSA scholars, politicians and industrial actors to join forces in the interest of organising public engagement exercises, without necessarily always aiming for the same ultimate goal. In addition to the organisation of participatory exercises, there has also been an interest in 'uninvited' (Wynne, 2007) public engagement, in the form of non-governmental

[9] 'Upstream' (and the contrast to 'downstream') is in this tradition used to indicate a time early in a technology's progress from innovation/idea to products on the market. Macnaughten *et al* (2005), Rogers-Hayden and Pidgeon (2007) and Doubleday (2007b) all address the ways in which the depth in the use of these terms by ELSA/STS (where for instance the implicit linearity in the metaphor is being problematised) not always penetrate to policy, even though the term itself has caught on widely.

[10] In this introduction I use these terms alternatively, together with public deliberation, all to broadly mean the initiatives to include publics in science policy and development.

organisations (NGO's) and media debate.

With the advent of nanoST as an economically and politically prioritised field of research, both policy-makers, the ELSA environment, nanoresearchers and even industry, seemed eager to use nanoST as an opportunity to show that they could 'do it right' (Roco and Bainbridge 2001, RS/RAE 2004, Balbus *et al*. 2006, Krupp and Holliday 2005, Macnaughten *et al*. 2005, McCarthy and Kelty 2010). While meaning slightly different things to these various sectors, it somehow contained the sense that nanoST held a promise to develop in a more responsible manner. Especially the prospect to deal with ethical, legal and social aspects from a very early stage in the technological development, and the change to also engage the public in debates early on, was presented as a unique opportunity (Macnaughten *et al*. 2005). Funding for ELSA research was provided early, even though the nature of ethical, legal and social aspects was less clear than for many strands of biotechnology. Already in 2001[11] the US National Nanotechnology Initiative (NNI) stated that research and debate about ethical issues was important (Roco and Bainbridge 2001), and national Centres of Nanotechnology in Society were established in the US. The National Science Foundation (NSF) currently funds two such centres (at Arizona State University and at the University of California, Santa Barbara), which form natural cores for activities and research in this area. In 2004, the Royal Society and the Royal Academy of Engineering in the UK published a report on nanoST (RS/RAE 2004) and its opportunities and uncertainties, with a full chapter devoted to potential ethical and social aspects and another chapter to the importance of deliberating these aspects with the public at an early stage. In Norway, a report inspired by the UK RS/RAE report was published the following year by the Research Council of Norway (RCN) program for funding of nanoresearch (NANOMAT), the National Ethics Committees and the Norwegian Board of Technology (RCN 2005). This report also highlights the need and

[11] http://www.nano.gov/html/society/ELSI.html, (last accessed July 2010).

desire for early and broad debate about ethical and societal issues. In 2009 the Society[12] for the study of nanoscience and emerging technologies (S.Net)[13] was established to promote international relations, collaboration and exchange to the advancement of knowledge and understanding of nanotechnology in society. The first annual conference of the society gathered mainly North American and European scholars in Seattle in the fall of 2009. Since 2007, already, 'the ethics of technologies that converge at the nanoscale' has had its own dedicated journal in Nanoethics.

In other words, the field of nanoST has developed within an environment of increasing acceptance for the PNS/Mode 2 kind of world view: a new social contract for science (Gibbons 1999). In contrast to the traditional social contract of science, based upon a strict separation between science and politics (perhaps most famously articulated in the report 'Science – the endless frontier' by Vannevar Bush (1945)) the new social contract acknowledges the multiple ways that science is interlinked and interwoven with society and politics. Funtowicz and Strand (2007) has approached the same phenomenon by describing how different models of science and policy co-exist today, all challenging the modern model which justifies both science and politics by keeping them strictly apart.

There has however also been a reflexive debate around the new opportunities that came along with nanoST. One of the concerns has been that a lack of uninvited public engagement has allowed organised exercises to dominate the new demand for public inclusion. Robert Doubleday (2007b), for example, explores the many different, and often quite narrow, framings in the use of the term upstream public engagement in UK policy, pointing to for instance how "[*t]he RS/RAE report recommends the use of 'upstream engagement' to anticipate in the present possible futures controversies,*

[12] Earlier, more loosely organised network existed, such as the 'Nanoethics Network', coordinated by the Centre for Bioethics and Nanoethics at the University of Aarhus in Denmark and the International Nanotechnology and Society Network (INSN), organised from Arizona State University in the US.
[13] http://www.thesnet.net/Welcome.html, (last accessed July 2010).

which can be resolved through consensus building" (p. 169). He also argues that limiting public engagement to be about nanoST in particular does not always provide the best framing, as it sometimes excludes broader issues related to science policy (Doubleday 2007a).

With various terminologies and emphasises, then, the view that there is a need to re-think the relationship between science and policy gradually gained ground also in science policy circles around the time when nanoST became a political priority (EC 2001, Felt *et al*. 2007, Nordmann 2009, Tallachini 2009, Fisher 2007a). Hence the willingness to experiment with approaches opens up the strict separation between the responsibilities traditionally seen as belonging to science and politics respectively. In addition to public participation and ELSA research, these approaches include exercises for encouraging and facilitating ethical and social deliberation into nanoresearch practices. It is interesting for instance to see that a journal like Nature Nanotechnology run a column dedicated to 'ethical, legal and other societal issues', and indeed Richard Jones (2009) points out in one of his contributions to this column that the notion of scientists responsibility is changing. The borders between the responsibilities of science and science policy started to be deliberately blurred institutionally, to better reflect that, as pointed out by Nowotny *et al*. (2001) and others; science was always political and that the products of science includes risk and hazard as well as benefits to society (Beck 1992).

With more opportunities and practical experience with concrete approaches, nanoST developed from the perfect case for the fields of STS/ELSA to test out theories in practice to also becoming an arena for internal negotiation of rationales and mandate, for example of the extent to which it should get involved in politics. Rune Nydal and Roger Strand (2008) suggest that the call for an ethics of nanoST before the ethical issues are established should be used as an opportunity to install a 'positive ethics': a constructive search for good visions of society and the place of nanoST in this vision. 'Positive ethics' is contrasted to the way ELSA recently (genome research is used as an example) often has functioned as an activity mainly solving ethical problems that

stood in the way of further technological development. They argue further that a move away from ELSA as problem-solving also allows the field to question the apparently implicit notion that technological innovation in it self is good. In this respect, nanoELSA has been a quite reflexive phenomenon where the role of social research on science and technology itself has been raised and debated in the literature (Kjølberg & Wickson 2007).

This thesis is limited in scope to deal mainly with Europe and to some extent the US. This was a choice of necessity in terms of what could be covered within a PhD project[14]. Since this project is based in Norway, however, a few words should be said in particular about the Norwegian context. The Research Council of Norway (RCN) has run a dedicated funding program for nanotechnology and new materials (NANOMAT) since 2004, and as mentioned above, a report inspired by the UK RS/RAE report (2004) was published at the initiation of this program (RCN 2005). In Norway too, the national strategy for nanoscience and nanotechnology emphasises the intention to include funding for ELSA research (RCN 2006), and the NANOMAT program has indeed funded this kind of projects. The National Institute for Consumer Research (SIFO), the program for applied ethics at the Norwegian Science University (NTNU), the Norwegian institute for agricultural and environmental research (Bioforsk)/the Norwegian university of life sciences (UMB) and GenØk centre for biosafety, as well as Centre for the study of the sciences and the humanities (SVT) at the University of Bergen (where the present project has been affiliated) are environments that have/have had projects in the field of nanoELSA in Norway.

[14] In the RCN-project, of which the PhD project was a part, we sought to broaden this scope somewhat by collaboration and exchange with partners from for instance the Interdisciplinary Research Centre on Sciences and Humanities (Ceiich) of the Univ Nacional Autónoma de México (UNAM). In this thesis, however, which needed to be tighter, the limitation to Europe and the US provided a necessary framing.

2.2 The governance of nanoST

As we have seen, the early focus on scientific uncertainty and social and ethical issues introduced the terminology of democratisation and public involvement in science policy documents for nanoST (see for instance Bainbridge and Roco 2001, RS/RAE 2004, EC 2004, Renn and Roco 2006). As a limitation of this thesis I focus mainly on the EC, where the notions of 'governance' (EC 2001;2007a; 2009) and 'responsible development' (EC 2005; 2008a) have became particularly central (Davies *et al*. 2009). I do however, refer to some particularly relevant aspects of governance in the US and European countries. Ulrike Felt *et al*. (2007) show how especially "*European risk*[15] *governance is presently undergoing important processes of change*" (p.40). Here, nanoST policy became linked to a broader discourse about good governance, described as instruments that should bring the European citizen closer to the democratic processes and reinstall trust in the institutions (EC 2001, Tallacchini 2009). Governance has in this sense developed as a term referring to the broadening of government to include processes that involves stakeholders other than the formal (Malsch and Hvidtfelt Nielsen 2009). It is used to refer to a conglomerate of initiatives that are arranged, facilitated or accepted by the authorities as contributing to decision making processes.

Mathieu Craye (2009) identifies the following elements as making up the EC's policy approach to the 'European governance of nanotechnologies': a) European nanotechnology strategy (as documented in Communication (EC 2004), Action Plan (EC 2005), Implementation Report (EC 2007b)), b) funding of nanotechnology research in FP6 and FP7, c) Support of ongoing International Dialogue on Responsible R&D of Nanotechnology (for instance Tomellini and Giordani 2008) d) DG Sanco 'Safety for Success' dialogue (EC 2008b) and e) the Code of Conduct for N&N

[15] Felt *et al.* (2007) especially argue for a shift from the governance of risk to a governance of innovation to be part of this process, as a means to counter the influence of the 'linear model' of the relation between science and society still holds over governance.

Research (EC 2008a). He argues that, seen together, these documents "*discern an evolution towards a diversified set of instruments and procedures that are followed for dealing with nanotechnology in its various manifestations and stages of development*" (Craye 2009. p. 131).

'Governance' is not an altogether clearly defined term. In my work, I have focussed on organised public participation, uninvited public debate, ELSA research and the code of conduct for nanoresearch. The latter is often associated with the concept of 'soft law', a term that I have not put a lot on emphasis on in this dissertation. Briefly, 'soft law' is used to refer to dynamic regulation without sanctions (self regulation) (Bowman and Hodge 2008). As Matthew Kearnes and Arie Rip (2009) point out, soft law has been a preferred strategy to meet the 'too late/too early' dilemma, where regulators are hesitant to regulate too early and risk inhibiting commercial opportunities, while at the same time they fear regulating too late to stop adverse effects. von Schomberg (2010) points out that while there is now a consensus among policy makers that early involvement is important, the lack of an agreed definition of nanoST further complicates hard legislative action. In the search for alternatives, "*the development of a code of conduct, then, is one of their few options for intervening in a timely and responsible manner*" (von Schomberg 2010, p. 8). The attention to the concept of governance has in this way involved discussion of amendments and alternatives to the dominating strategies of expert led technological risk-assessment and risk-management of market ready consumer products.

The EC funded a number of projects, within the 6th and 7th Framework Program, with the objective of exploring in theory and practice the various aspects of governance of nanoST. One of them, 'Deepening Debate about Nanotechnology' (DEEPEN), had 'Reconfiguring Responsibility' as the title of their concluding report. The project specifically sought to integrate perspectives from the social sciences with perspectives from the humanities (especially the philosophy of science) in order to deepen the understanding of how ethics and responsibility is, and should be, approached through governance for nanoST (Davis *et al*. 2009). Other EC projects have focussed on

deliberative platforms (NANOPLAT), capacity building for environmental NGOs and trade unions in adopting resolutions on the governance of nanotechnology (NANOCAP) and the development of a governance plan for nanotechnologies (FRAMINGNANO) (von Schomberg and Davies 2010).

Exercises of public engagement with nanoST have been initiated in many countries and I will only mention a few central examples here (for a list of examples see for instance 'paper III' of this thesis: Delgado *et al.* 2010). In the UK (as we have seen above, a particular active country in this respect), the organisation *Involve* as well as the think tank *Demos* were early actors, and both published summary reports of their experiences in 2007 (Gavelin *et al.* 2007, Stilgoe 2007). *Involve* established the Nanotechology Engagement Group (NEG) in 2005 as a response to the call for early public engagement with nanoST (Gavelin *et al.* 2007). The Nanodialogues run by *Demos* involved four experiments in engagement with nanoST, including engagement with the research council in UK, the corporation Unilever and members of the public in Harare, Zimbabwe (Stilgoe 2007). Both initiatives provided important practical experience. One of the identified challenges was that of transferring the richness of deliberation to actual policy recommendation and eventually into political action (Gavelin *et al.* 2007, Stilgoe 2007). In the US, public engagement has perhaps been particularly visible through the outreach activities arranged by the University of South Carolina, in collaboration with Benedict College, in the form of citizens' school of nanotechnology, where members of the local community have gone through a programme of interactive learning in order to become empowered and encouraged to engage with nanoST development (Toumey 2006a; 2006b).

Other initiatives of governance are, as we have seen, aimed at generating debate and reflexivity about social and ethical issues among researchers. Doubleday (2007c) identifies this as one of the roles of social science in relation to the call for a 'responsible development of nanotechnology', explicated as to "*represent societal concerns in the laboratory in ways that can help steer developments in more socially acceptable directions*" (p. 172). He addresses the challenges of doing this so that it

does not confirm a traditional division of labour between science and society. Erik Fisher (2007a) traces the trend for social research in nanoST laboratories in the US to, among other things, a House of Representatives official statement that "*the ideal outcome is to integrate social concerns directly into the technology development process*" (p. 280, referring again to Science 2003), as well as theories of co-production. Various strands of technology assessment and anticipatory governance have been important contributions in this respect (Rip and Kulve 2008, Karinen and Guston 2010). These approaches problematise the ways in which processes in science often make implicit assumptions about the social uses to which a technology will be put. Often, techniques like vision assessment, scenario-building, road-mapping and forecasting are used to explore alternatives. Public participation may or may not be a part of these exercises. Collaboration between social and natural researchers is however portrayed as essential for creating and assessing realistic visions and enhancing the capacity for reflexivity and anticipation in the co-evolution of nanST. Fisher (2006; 2007b) has been one central figure within this tradition with the notion of midstream modulation and the program of Socio-Technical Integration Research (STIR).

Although I acknowledge the importance of the type of approaches mentioned in the previous paragraph, I have placed a particular focus on one governance initiative aimed at installing reflexivity in the research community and communication between researchers and other actors, namely the 'recommendation on a code of conduct for responsible nanoscience and nanotechnologies research' (EC 2008a), by the European Commission. This document, published under the Directorate-General for Research, encourages responsible nanoresearch by presenting seven general principles; meaning, sustainability, precaution, inclusiveness, excellence, innovation and accountability. The EC code of conduct (EC-CoC) is a promising initiative, which is discussed in

detail in 'paper IV' of this thesis. There have also been other codes of conduct promoting similar values and responsibilities for nanoST research (Grobe *et al*. 2008, Malsch and Hvidtfelt Nielsen 2009). These include 'the responsible nanocode'[16], 'the Nanorisk Framework' by Environmental Defence and Dupont[17] and the chemical company BASF 'Code of conduct Nanotechnology'[18].

In reality, however, the first nanoproducts and nanoenabled products have entered the market without much debate about social desirability. While the internal political debate about whether there is a need for regulation ensuring specific risk research of nanomaterials is ongoing, these kinds of products keep finding their way to the market (Throne-Holst and Strandbakken 2009). It is claimed that around one thousand nano consumer products are on the market today[19], and concern has been raised about the lack of studies of potential adverse health and environmental effects of nanomaterials, and nanoparticles in particular (Colvin 2003, FoE 2006; 2008; 2009, Royal Commission on Environmental Pollution 2008). The environmental NGO 'Friends of the Earth' (FoE) has been particularly influential in the discourse about regulation and governance of nanoST, notably by publishing a series of reports calling for stricter regulation and monitoring of nanocosmetics (2006), nanofood (2008) and nanosilver (2009) respectively. It is argued that the novelty, smallness, potential to disperse widely and penetrate natural barriers, as well as the special properties that these particles are design to display should warrant particular attention (FoE 2006; 2008; 2009, Wickson 2009). Choi *et al*. (2009) have estimated the number of nanoparticles in use in these products to 190, and the demanded cost of risk-assessment (if these were to be done) of these to somewhere between US $249 million and US $1,2 billion. The Royal Commission on Environmental Pollution (2008) also suggested that this

[16] http://www.responsiblenanocode.org, (last accessed July 2010).
[17] http://nanoriskframework.com/page.cfm?tagID=1081, (last accessed July 2010).
[18] http://basf.com/group/corporate/en/innovations/events-presentations/nanotechnology/index, (last accessed July 2010).
[19] http://www.nanotechproject.org/inventories/consumer/analysis_draft, (last accessed .July 2010).

research would take decades to achieve. It is in this tension between consumer products, traditional forms of regulation and experimental approaches to governance that nanoST policy exists. Central in the discourse, as mentioned, is the notion of responsibility itself.

2.3. 'Responsible development' of nanoST

The central term in this dissertation is 'responsible development'. In the following I will problematise both parts of this term; responsibility first and then development, on a general level relating to nanoST. A more thorough discussion of the notion in relation to the particular research in this thesis follows in the next section.

The reference to 'responsible development' of nanoST has become widespread. Doubleday (2007b) describes how "[*g]overnments and scientific institutions have developed the concept of responsible development as a response to public questioning of the place of science and technology in contemporary societies*." (167). Here are a couple of examples from the European context: "*Nanotechnology must be developed in a safe and responsible manner. […] Ethical principles must be respected and, where appropriate, enforced through regulation*." (EC 2004). "*The Commission will ensure that Community funded R&D in N&N continues to be carried out in a responsible manner e.g. via the use of ethical reviews*." (EC 2005).

Despite the frequent use of the notion of 'responsibility' in reference to the development of nanoST, it is fair to question in what sense the development is qualified to be given such a label. It is striking how the development and use of nanoST lack most of the central features that most people would associate with responsibility: knowledge about consequences and what it is that is 'at stake', as well as agency and clear assignment of tasks for how to act on this knowledge. Keeping the more far fetched visions (including for instance human enhancement and molecular manufacturing) excluded, the mentioned discrepancy between scientific knowledge

about toxic effects of nanoparticles, and the amount of products with nanoparticles on the market makes a good example. Still, these challenges are rarely raised when the notion of responsibility is evoked. In this sense 'responsibility' constitutes a critical concept, pointing towards current shortcomings.

My contribution in this thesis has been to try to understand better how these shortcomings are in fact dealt with in the context of governance, by studying concrete initiatives. A number of other actors within (nano)ELSA have also worked critically with the notion of responsibility. Elise McCarthy and Christopher Kelty (2010) have studied the notion of responsibility in a nanotechnology laboratory setting in the USA and state that its "*frequent appearance not only in nanotechnology but also in phrases such as […] 'corporate social responsibility' suggests that there is broad and relatively recent cultural concern for achieving some putatively new form of it*" (McCarthy and Kelty 2010, p. 406). They point to how risk and responsibility is an inseparable pair of concepts in the environments they have studied, but that "[*w*]*hile 'collective risk' and the distribution of risks across a population are well-understood concepts, collective responsibility or the distribution of responsibility is much less well understood.*" (p. 408). Arianna Ferrari and Alfred Nordmann (2009) have raised the concern that the notion of responsibility has become so diluted that it does not mean anything anymore. Similarly, both Luigi Pellizzoni (2009) and Arie Rip and Clare Shelly-Egan (2010) has pointed to how nanoST is an example of what Ulrich Beck has called organised irresponsibility, where scientists, engineers and industry are allowed to develop new technologies while society lacks the ability to hold anyone accountable. The European project 'the Nano Observatory', which has as its objective to "*support European decision makers with information and analysis on development in nanoscience and nanotechnology*" (Malsch and Hvidtfelt Nielsen 2009, p.2), centred their first annual report on the concept of individual and collective responsibility for nanotechnology (Malsch and Hvidtfelt Nielsen 2009), and emphasis how the experimentation with approaches to governance and the re-negotiation of responsibilities has characterised the ELSA/STS/policy debates about nanoST in Europe. Funtowicz and Strand (2010) discuss the responsibility in relation to emerging

technologies and global environmental problems, and disqualifies the notion or responsibility all together, stating that "[w]*hen competent citizens in the knowledge-based society understand that neither expertise nor knowledge can be entirely value-neutral in the old positivist sense, not only the technocratic principle for action fails. They are also aware of the equivalent flaw in the sound science-informed concept of precautionary action, in which risk management may be democratised, but risk assessment is maintained as a technical task*" (Funtowicz and Strand 2010, p. 5 of manuscript, translation from Spanish by the authors). Their point is that responsibility to some extent always is dependent upon prediction of future consequences and hence ineffective as a principle of action when ignorance is widely acknowledged.

The 'development' part of 'responsible development' is also worth a short reflection in this context, first and foremost because it seems that development is taken for granted. 'Responsible development' disqualifies and excludes the question of non-development. For some, one of the most important questions to rise would be exactly what would warrant non-development, or perhaps a moratorium, as the most responsible option. The notion of responsible development sidetracks these kinds of problem formulations. Alfred Nordmann and Astrid Schwarz (2010) state that "*to be sure, throughout the history of the modern world, advisory boards have been saying 'yes' to technological development. They did so by joining the master narrative of progress, economic innovation, human betterment, intellectual enlightenment*." (p. 257). Several commentators (Craye 2009, Felt *et al.* 2007) have point to how tensions between the different objectives, such as innovation, precaution and deliberation, are implicitly present in governance, often pulling in different directions. Paradoxically, the notion of responsibility is closely attached both to the goal of ensuring innovation and growth and to the goal of precaution and protection. The problem that may arise for the authorities in this situation, in seeking to obtain their third objective of deliberation, is that the public ask for a slow down, while industrial actors for example push for incentives for innovation.

3. Theoretical position, normative presuppositions and limitation

With the background described in the two previous sections, I will now move on to present the particular concerns and theoretical perspectives that have motivated the research presented in this dissertation.

Underlying this whole project is an interest in what responsibility and responsible practice means when faced with an emerging, uncertain and potentially powerful scientific and technological development. I believe that it makes sense to see different actors representing different roles, perspectives and practices in relation to one another, as both science and society are co-produced across them. Pellizzoni (2009) describes how the narrative of co-production is in constant conflict with many aspects of the modern neo-liberal narrative as, in Latour's (1993) terminology, the categories of 'nature' and 'society' are artificially kept separated in modernity (indeed as a foundational requirement of modernity). While not being made a central theoretical point in the dissertation, this forms an initial position upon which the project is founded. The practical approach of studying different spheres of society in relation to responsible development of nanoST, and attempt to draw lines and relations between these spheres, has to be seen in relation to this.

Increasingly complex and extensive human interventions into socio-natural systems has made it apparent that one cannot obtain full scientific knowledge to inform decisions about the development and use of science and technology. In response, a search for other means of decision support and justification of action has taken place, mainly in the direction of more transparency and democracy through communication and the inclusion of concerns from a broader range of people. Approaches of governance, such as public participation, ELSA research and increased ethical reflexivity within science, have all been pushed forwards with nanoST (as described in section 2), although at the same time traditional ideas about the regulation of science are still very much alive (Craye 2009, Ferrari and Nordmann 2009). To avoid acting on a false sense of scientific certainty is undeniably a move away from irresponsible practice in many instances. It has not, however, been evident for me that the new

practices of governance are always sufficient to call the development of nanoST responsible.

It has been part of the aim of this project to understand better what responsibility really could mean in this context. As mentioned above, the notion of responsible development is frequently invoked in policy documents in relation to governance without a clear definition of what it entails. Throughout this dissertation I insist that responsible practices have to involve active consideration of what the most important issues and values are, of 'what is at stake', as well as an ongoing[20] valuation of one's own actions against this. In other words, the responsibility sought in this study is predominantly of the *ex ante* type, e.g. being responsible implies taking future consequences into account. As a point of reference in this respect, I have found Hannah Arendt's (1971) notion of *thinking* in the sense of 'being in dialogue with oneself' as particularly useful. The personal dialogue is for Arendt a requirement for moral behaviour. Her argument is, very briefly, that individuals who regularly rehearse and practise 'thinking' will develop mindfulness to when moral judgements are being made and will find it increasingly unbearable to act against their own convictions and values. Thinking hence strengthens the ability and motivation for making moral judgements. To act responsibly involves being aware of what one considers to be 'serious' and to reflect upon what it entails to take this into account in all actions. It is with this idea about responsibility that I have wanted to examine the approaches of governance.

What is it, then, that is in need of being taken seriously? The answer to this requires

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[20] In the tradition of vision assessment and forecasting (which is outside the scope of this thesis to deal with), Dupuy and Grinbaum (2005) argue that the role of nanoethics is to subject the 'metaphysical research program' of nanoST to an Ongoing Normative Assessment (ONA). They describe ONA as a practice or a 'way of life'. I find this concept and their argument for the need for normative assessment of emerging technology to be *ongoing* valuable. Elsewhere (Kjølberg *et al* 2008), we have criticised the founding of a normative assessment in a consensual idea of a desired future state, and I argue here for basing an individual ONA of own actions, so to speak, in own values, rather than an assessment of nanoST as a whole based on a collective consensus of a desired future.

the kind of individual and private reflection and thinking that Arendt writes about, and will of course be different for each individual. Deliberation and dialogue are however crucial in lifting it above the personal and private level. Respect for the biosphere as well as fair distribution of goods and 'bads' between humans in all parts of the world and across generations are central values for many, as reflected in the importance given to principles such as sustainability and precaution lifted up by international conventions and statements (such as for instance UN 1992; 2000). Hans Jonas (1984) is one example of someone who ties the notion of responsibility to our ability to imagine our own actions in relation to consequences for the conditions of humans far away and in the future. He is concerned with the increased ability, in the technological age, to inflict harm upon subjects we do not intuitively relate to morally. For him, the imperative of responsibility is the continuation of decent human life on earth. For me, too, the values of respect for the biosphere, fair distribution and sustaining human life in the future are fundamental, and the natural ideals against which to evaluate actions and choices. In the case of nanoST development this means that for me, responsible practice needs to involve the consideration of broad, indirect as well as direct, social and environmental consequences, in a long term perspective and with the acknowledgement that changes may be irreversible. It involves attempting to see the many and complex relations between different development trends.

Although governance practices like public participation often involve these kinds of considerations, they provide no guarantee for precaution and sustainability. There are many aspects to this. It has to do with a natural and reasonable plurality of values in the public (Rawls 1993), as well as design of the participatory exercise and the practices for bringing the outcome of deliberation into decision making. In relation to the first of these aspects; the fact that more democratic and inclusive procedures can sometimes produce outcomes that are counter to both social and ecological sustainability has been referred to as 'the dilemma of green participation' (Delgado 2008). In various forms, this dilemma is a well known challenge debated in a number of fields, such as for instance ecological economics (see for instance Jacobs 1997). Precaution and sustainability normally involve looking beyond one's own individual

needs and seeking to include the concerns of other humans now and in the future in evaluation of one's own actions and decision today. It may also, in line with more radical ecological perspectives such as deep ecology (Næss 1976), explicitly include consideration for non-human biological entities. Although most people adhere to these kinds of values, as seen above, it is not always that they manifest in practice when faced with a particular decision situation, not even through governance initiatives such as participatory procedures. The ecological economist Arild Vatn (2005) argues that different institutional[21] settings and contexts tend to produce different kinds of behaviour. Institutions and practices inspired by neoclassical economic theory[22] tend to stimulate individualistic behaviour, and are designed, so to speak, to facilitate progress and economic growth (Vatn 2005, Jacobs 1997). On the other hand, institutions characterised by participation and interaction may stimulate collective behaviour (Vatn 2005). Not all so-called participatory and inclusive processes, however, allow for this due, for instance, to limitations in the scope and time frame of the deliberation. The aim of governance, as Craye (2009) points out, is to satisfy economic growth, precaution and democratisation all at the same time, and it is a fact that when immersed in practices and institutions programmed to create growth, the participatory exercises often face an uphill battle. The framing of the participants themselves in the exercise may also steer the process in a particular direction, by limiting the scope of what concerns are within their mandate to raise. It will always be a tension in terms of extending the open deliberation and reaching a decision (Stirling 2008), and it is not always evident that the most participatory and open process is the most responsible.

This project has taken shape with these paradoxes and challenges in mind, seeing that nanoST has provided practical experience to many of these theoretical debates. Indeed,

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[21] Institutions in this context include informal norms as well as formal rules and structures.
[22] The term 'neoclassical' is not unambiguous. Here, I use it to signify the assumption of rational agents who maximise profit and have access to full information (no information cost).

a major challenge with respect to the objective of obtaining responsible development of nanoST is to give content to the concept of 'responsible' in this context. This challenge is not the same as the general need for an understanding of the concept of responsibility as such, for instance by philosophical analysis. Accordingly, while there is a vast literature on the relationship between moral (individual) responsibility, determinism and free will, and the methodological problems involved in assigning collective responsibility, this is not dealt with here. The current context of the development of nanoST is that the need for acting responsibly *ex ante* as well as *ex post* is generally acknowledged. The problem is to specify what *ex ante* responsibility means in practice within the institutional context, and the governance, of emerging science and technology.

For me it has been particularly useful to follow Pellizzoni (2004) who distinguishes between four ways that the notion of responsibility is used in the context of environmental policy: care, liability, accountability and responsiveness. While care and responsiveness for Pellizzoni (2004) are the dimensions of responsibility that are apparent *ex ante*, liability and accountability represent responsibility *ex post*; after the event. In the context I am concerned with here, it is therefore the two first that is of interest. Pellizzoni (2004) also distinguishes between two different grounds of justification for responsibility; care and liability are 'push factors' ('in-order-to motives') in this respect, while responsiveness and accountability are 'pull factors' ('because motives'). In different words, the motivation for care and liability are rooted in the person who seek to be responsible, while responsiveness and accountability are motivated from outside. In the latter case the person tries to be responsible because some body (person, institution, public) ask it of him or her. So even when responsiveness, in Pellizzoni's words, "…*entails readiness to rethink our own problem definition, goals, strategies, and identity*" (p. 557), the motivation to do so comes from outside. I argue in 'paper IV', following Pellizzoni, that the notion of responsibility found in the ideas of governance has most in common with that of responsiveness; to answer to questions and concerns and be in dialogue with other sectors and actors in (for instance) nanoST development.

René von Schomberg (2007) also provides a thorough analysis of the particular challenges related to responsible governance of emerging technologies. He suggests public debate, transdisciplinary deliberative technology assessment and foresight activities, as well as the constitutional change needed to implement these kinds of approaches, as solutions to what he sees as the major ethical challenge of today; the *"…imbalance in the relation between the individual's responsibility for a particular and temporal role and the collective responsibility which is represented by the simultaneous fulfilment of great number of roles for the long-term.*" (p. 10). von Schomberg emphasises the importance of communication and deliberation between people with different roles, and argue for more deliberative practices, not only in the public, but also between different political levels and sectors. He uses the example of nanoST to illustrate how deliberative procedures are vital for responsible development in a situation where there is impossible to assign responsibility at an individual level, or even to one particular sector. In a later texts he explicates this, stating that "*the European Commission is committed to promoting public debate on nanotechnology, and believes that public policies need to be responsive to evolving public opinion*" (von Schomberg 2010, p. 6). He continues to state how "*a more permanent form of deliberation is necessary for enabling an ongoing process of collective responsibility"* (von Schomberg 2010, p. 11). This is beyond doubt a very important aspect of responsibility. The ability and occasion to communicate and coordinate is evidently a condition for any kind of agency and collective coordinated action. The recent, perhaps rather one-sided, focus on deliberation and communication (what I see as responsibility in the form of responsiveness) may however, in my mind, have overshadowed other important elements.

The backdrop for Arendt's (1971) analysis of moral judgement is the individual's ability to reflect on the limitations and content of responsibilities associated with their professional role (specifically analysing the Nuremberg trials after WWII). The emphasis on responsiveness may fail to constitute the individuals as active and empowered to challenge and change roles. One aspect that may be lacking in the current notion of governance is therefore the aspect of responsibility that Pellizzoni

(2004) calls care. He describes *care* as the way responsibility was envisioned in (environmental) policy before the 'discovery' of environmental problems, when the ability to know what the citizens needed and the capacity to act accordingly was taken for granted. I will be using the notion of care, however, not to reinsert this notion of perceived control, but rather more in line with how it is used in everyday language. It involves the capacity to include the perspectives of others in one's own decisions, not because they ask for it, but because one is concerned, as well as the capability of evaluating to what extent one's actions are consistent with one's own values. Felt *et al*. (2007), insist on reflexive learning as "*awareness, in an ethical and reflective intellectual sense, of the limitations of our knowledge, thus modesty in the claims we make with it, is another crucial learning dimension of a mature knowledge society"* (p 64). For them, awareness of 'the other' is emphasised as an important part of this. While *responsiveness* easily leads to defence (even in the better designed deliberative settings) on behalf of the role, *care* seems as a good condition for reflexive learning. Central in Arendt's argument is the individual's own feeling of coherence between beliefs and actions and sense of personal wholeness across a person's professional identity and role, the public and the private person.

von Schomberg (2007) points to how individuals today hold many different roles and uses this to argue that responsibility should be associated with the role, rather than the person. I would make the argument instead for a strengthening of the occasion and capacity for a person to reflect on the actions required by the different 'roles' in relation to their own central values. This would contribute to hold the different roles together, so to speak, and ground them in the individual sense of moral coherence and responsibility as care. It increases the ability of the individual to question the job description and assignment associated to the role. This is in no way an attempt to diminish the value of deliberation and communication, rather the individual 'thinking' is an important addition which in my mind may be a necessary skill to rehearse and cultivate along with the collective ones. The practicalities of this raise evident challenges related to the institutional framework for this kind of 'thinking' and potential critique, as well as agency and the actual ability to ask questions and actively

challenge the institutions and authorities. Rip and Shelly-Egan (2010), express it well: *"Individual ethical reflection runs up against institutional and moral division of labour, both in the nature of the reflection and in the boundaries set on action based on such reflection*" (p. 37). Based upon this they argue with Beck (1994) that a 'reflexive modernisation', where institutions are confronted with the consequences of their actions, and hence forced to reflect on the way they function, is the direction on which to seek for answers to this challenge. It is unfortunately beyond the capacity of the present dissertation to explore this further on an institutional level.

Before the introduction moves on, I would like to sum up the main argument in this section. There is no doubt that nanoST has offered increased opportunities to explore deliberation and communication as means to achieve responsible development. This has strengthened the aspect of responsibility that is associated with responsiveness, and is unquestionably important. I argue, however, that another aspect of responsibility has been largely neglected; namely the aspect of care. Responsibility as care necessitates personal mindfulness and the capacity of the individual to see actions in relation to own values, no matter which of its multiple roles the action is assigned to.

4. Reflections on methodological challenges

4.1 The institutional context of the PhD project

I will first outline the setting that has been the context for, and also informed, the research of this PhD project. This thesis has been conducted in close association with the Research Council of Norway (RCN) NANOMAT-funded project *Interdisciplinary Studies of the Social and Ethical Implications of Nanotechnology* at the Centre for the study of the Sciences and the Humanities (SVT) at the University of Bergen (UiB). The RCN-project, which was finalised in December 2009, had four work packages; 'broad-scoped mapping', 'scientific literacy', 'ideology in discourse', 'quality and uncertainty', as well as some case studies, into which my work had an important and natural place. The interest in my thesis has however been somewhat narrower, as

outlined above.

The RCN project made up the 'nanoethics[23]' component of the platform for nanoresearch at the UiB from its initiation in 2005. The nanoplatform includes environments working at the nanoscale from the Departments of Chemistry; Physics and Technology; Molecular biology and Biomedicine. The 'nanoethics' group was hence naturally integrated into many of the structures of the emerging nanoresearch environment at the university, such as seminar series, internal conferences and the program board for the bachelor and later also master program in nanoscience. The nanoethics group was to operate in close association with the nanoresearch environment and collaborate with it whenever possible and useful. Nanoresearchers from UiB were invited to all the projects workshops. In the project description for the RCN-project, there was a particular emphasis on the need to deploy a broad scope in ELSA for nanoST and to combine scientific imagination and critical search for sources of uncertainties and ignorance (Strand 2001). The close association with the nanoresearch community at the UiB has shaped the direction of the research that has been undertaken in the RCN-project and in the work with this dissertation. The research for this thesis was therefore performed within a framework of what one may call 'associated ELSA research'. The association, or even integration, of ELSA researchers with actual nanoresearch environments has become increasingly popular and has a dual objective of making ELSA more relevant and to install reflection and ethical awareness into the nanoST laboratories, in line with the trends outlined in section two above. As more opportunities have arrived for ELSA to be co-located, co-funded and collaborative with nanoST research, there has been an ongoing learning process, which I see this project as a part of. In Norway, the call for ELSA to be more relevant has been specified by the three concepts 'recontextualization of science, reflexivity and interactive knowledge production'. (RCN 2008). Integrated ELSA has

[23] http://nano.uib.no/, (last accessed July 2010).

been described as what one wants more of in the future to address challenges of emerging science and technology, and indeed the RCN put out a call in March 2010 continuing in this direction.

4.2 Distance and proximity

The methods used in this dissertation vary across the articles and include text- and discourse[24] analysis, interviews, workshops and more philosophical kind of work. The lack of coherence, both in terms of method and scope make me reluctant draw too many strong conclusions across the four studies. The approach was chosen in order to be able to pitch the method of each of the four studies to the question and sphere that I have wanted to study. Since the methods vary between the four parts of the research, this section will only raise some general points, while the individual papers of the dissertation will have to be conferred for more detail about each method. The methods should be seen in the context of the perspectives presented in section 3, and the objective of being closely associated with the nanoresearch environment at the UiB.

Throughout the project, it has been an aim to alternate between interactions with the nanoresearch environment at the UiB on the one hand, and distance, reflection and discussion in the nanoethics group on the other hand. In preparation of the fourth paper, I also spent four months in the Joint Research Centre (JRC) of the European Commission in Ispra in Italy, to learn more about research policy in the EC. Especially through the latter stages of the research, I have also benefitted a great deal from being situated at the 'Centre for the study of the sciences and the humanities' where there is considerable expertise in political philosophy and in particular theories of deliberative democracy. It has been useful to discuss the practical experiences of participatory

[24] I am aware of the many, precise and nuanced uses of the methodology of discourse analysis across the social sciences. In the research for paper III, I use the term in a quite broad and general sense. For details about the method in the analysis please consult the individual papers.

exercises with colleagues working with similar issues from a more theoretical point of view.

Structured reading of texts was central in all the three first research tasks. These comprehensive readings allowed a broad entry to the research questions I wanted to approach. In 'paper II', which was the most comprehensive text analysis, the software Atlas.ti was employed to structure the texts, as well as a tool to search for characteristic representations and analyse the discourse of nanoST in the public sphere.

In 'paper IV' conversations with nanoresearchers and actors in science governance formed the central part of the empirical work. The conversations served as a means to understand better how the notion of responsibility was understood by nanoresearchers. Being conducted at such a late state of the project, this research task greatly benefitted from the close relationship we had developed with the nanoresearchers at our university at that point.

4.3 Research ethics considerations

The approach taken in the RCN-project involved collaborating with nanoresearchers, and the relations with many of them have existed on several levels. They have been collaborators and colleagues, but also informants and 'objects of research' to some extent. This kind of approach demands continuous awareness of the potential for border crossing and misuse of trust. It is for this reason, for example, that the conversational partners in 'paper IV' have been de-personalised and the results are presented as a collection of typical positions. The possibility for exchange of ideas, views and perspectives was part of the reason for the close association of the nanoethics group with the nanoresearch environment. I have sought to be clear about it whenever I have intended to use information from interactions with the nanoscientists as data. It is, however, evident that ideas and exchanges of opinions may have taken place informally that have shaped and given ideas to the direction of the research.

It is also worth reflecting on the fact that in this project we have to some extent studied our own field. To a certain degree my analysis, discussions and conclusion in this thesis include critical discussion of nanoELSA. The fact that I am a part of one of the sectors that I have studied, leads to challenges both in terms of communication and research, and warrants reflection on at least three levels. First, on what level can ELSA in fact provide a critique of nanoST, when, as in the current project, it is integrated into the nanoresearch environment? Can it for instance conclude that nanoST should be abolished altogether, and the resources spent elsewhere? On a second level, to what extent am I qualified to evaluate the degree to which my own field is responsible? Finally, I have been forced to evaluate to what extent I, myself, is a responsible nanoELSA researcher. Even though none of the papers explicitly include such an analysis, it has been a question of recurring consideration for me, and also my colleagues in the RCN-project. A discussion of the challenges of integrated ELSA is included in section six of this introduction. On a general level, I believe that the advantages in most instances outweigh the disadvantages, and so also in this particular project. The increasing awareness, and continued discussion, of the role of ELSA kind of research is an important factor in itself in shaping it as a responsible actor.

Another aspect that deserves to be commented on in this context is the fact that I, as well as the two other researchers in the RCN-project, have chosen to be actors in the political reality of nanoST in Norway. The RCN-project has for instance been involved in several commentaries in Norwegian newspapers along with colleagues at the SVT (Fjelland *et al*. 2006, Kjølberg 2008b, Slaattelid and Kjølberg 2009) and participated in a public hearing organised by the Norwegian Board of Technology in 2007. The expression of opinions in other fora than scientific journals and conferences was seen as a natural extension of our research and engagement in the development of nanoST. It is however necessary to reflect on how this kind of intervention may have affected the research, especially with the close association with the nanoresearchers in mind. The expressions in public have exposed to a larger extent beliefs and values that I and my colleagues hold, as researchers as well as citizens, on the issues that we have been working with in our research. It may be argued that this could be a problem in for

instance the research that involved conversations with nanoresearchers on similar topics, as our personal perspectives on the matter may have been known to them. I do not believe, however, that the conversational partners would have any reason for presenting perspectives that were either more or less in line with ours in this phase of the project.

5. Presentation of paper I-IV

5.1 Paper I: Social and Ethical Interactions with Nano: Mapping the Early Literature

In this paper Fern Wickson and I studied the early literature in the field of SEIN (Social and Ethical Interactions with Nano). The empirical research consisted of a text study where a total of 244 papers, reports and book chapters, spanning the time period from 1994 to 2006, were read and analysed. We were interested in how ELSA approached the emerging field of nanoST, and observed a field in the process of coming to terms with its own mandate and mission. In addition, we had an interest in what issues and topics gained attention, and the 244 texts were systematised according to what we saw as four key categories of literature; Governance, Science, Perception and Philosophy. One of our main findings was that 40% of the texts had governance as their main focus, and that 60 % of the texts dealt with governance in some way or another. One explanation we proposed was that the dominating interest in governance was linked to a desire for a useable return on the investment in such research. Most of the texts clearly raised questions from more than one category. This observation led to a discussion of the importance and added value of SEIN research to cross these four categories. We argued for interdisciplinarity, but also encouraged transdisciplinarity in the sense of collaborative extension beyond academia. We concluded that while research and questioning within each of the categories was important, the cross-category literature provided a potential for SEIN to develop into a more creative and integrated field able to capture, represent and address the complexities of real life social and ethical interactions with nanoST.

In 2008 we were invited to rework this article into a book. Accordingly we worked to revise the presentation of this work into what became the anthology 'Nano meets Macro: Social perspectives on nanoscale sciences and technologies' (Kjølberg and Wickson 2010). Through the process of working with this book, we abandoned the notion of categories and developed a presentation based upon four 'nodes of interest'. The category 'science' became the node where nano meets macro 'in the making', 'perception' became 'in the public eye', 'governance' became 'in the tough decisions' and finally 'philosophy' became 'in the big questions'. This far less rigid concept was a much better illustration of the original idea, allowing the image of attractors organising questions and issues rather than rigidly separating them into categories. Although this improved presentation did not alter our conclusions, it is relevant here because it serves to bring across our original idea in a better way.

5.2 Paper II: Representations of Nanotechnology in Norwegian Newspapers — Implications for Public Participation

The public sphere and the conditions for public debate about nanoST was the focus of attention in the second paper. Few other projects have studied newspaper representations of nanoST, none other in Norway, and to my knowledge my work is the most recent on the issue. The newspaper media was a way for me to access the public sphere, and get a sense of stories, perspectives and representations about nanoST that are available for those who does not particularly seek out information about new technologies. The research interest started from the notion that for the public to engage in an issue, such as nanoST development, they need to experience somehow that there is something at stake. The newspaper media was chosen as the object of research both as an important provider of information and as an arena for uninvited public debate. The aim was to perform an analysis of what kind of representations and perspectives that existed on nanoST in Norwegian newspapers. The empirical research was a structural reading of all texts in Norwegian newspapers referring to nanoST between January 1st 2000 and December 31st 2007. The main

findings are: 1) That the coverage of nanoST is rather low, with a total of 225 texts making claims or providing factual information on the topic in this period, and 2) That there are three dominant representations of nanoST; nanoST is positive, nanoST is important for the future, and nanoST is under control. The claim that it is too early for public engagement in nanoST because the public is not 'ready' is discussed in light of these findings and the notion of 'ready' problematised, especially in relation to the practice of organised public engagement. The main conclusion is that the dominating representations fail to constitute nanoST as a matter of concern, and that more voices and viewpoints about nanoST are desired in the public sphere.

5.3 Paper III: Public Engagement coming of age: From theory to practice in STS encounters with nanotechnology

In this paper Ana Delgado, Fern Wickson and I make and analyse the claim that tensions stemming from unresolved (and sometimes unarticulated) theoretical conflict manifest as problems for the emerging practice of participatory approaches. Specifically, we argue that these tensions need to be seen in relation to each other in order to make informed choices about the design and conduct of public engagement in nanoST. Our proposition is that for public engagement to prove successful, basic questions related to why, when, who, where and how should be openly confronted. The question of 'why' is related to whether participation is argued for in terms of instrumental, normative or substantial rationales, *sensu* Stirling (2008). 'When' is related to the discourse of upstream and downstream engagement. The question of 'who' is related to the debate about the extension of expertise, and the criteria for involvement. 'Where' is related to the discussion of local grounding versus global models for participation. The question of 'how' is related to uninvited contra invited participation. We suggest that while all these discussions are present in Science and Technology Studies (STS) at the moment, they are very rarely seen in relation to one another, and rarely in relation to practical experiences. We show how choices in relation to each one of these questions have consequences for the available choices in

the others. The choice of public participation of nanoST to be conducted upstream is used to show how this limits the available choices for the questions of who, where, why and how.

5.4 Paper IV: Conversations about responsible nanoresearch

In this paper I am interested in the notion of responsible nanoresearch, and how this is experienced and interpreted by nanoresearchers. The European Commission recommendation on a code of conduct for responsible nanosciences and nanotechnologies research (EC-CoC) (EC 2008a) is used as a frame for a series of conversations with nanoresearchers on this topic, which constitutes the empirical part of this work. The conversations showed a range of responses towards the EC-CoC, and broad variation in the nanoresearchers' views on what responsibilities belong to their role. This finding is presented in the form of six characteristic positions, which are then used as a foundation for a discussion on what responsible nanoresearch could mean in the context of nanoST. Three different interpretations of the notion of responsible nanoresearch are suggested and discussed. The first is consistent with a traditional social contract between science and society, where there is a clear separation between the responsibilities of researchers and that of, for instance, politicians. The second emphasises the importance of communication and deliberation and the responsibility of researchers to respond to questions and concerns from society. This interpretation is most consistent with the EC-CoC. In the third interpretation, sensitivity towards own values and moral choices is added. It is suggested that this is as important as dialogue and communication for nanoST research to be truly responsible.

5.5 The four papers in the larger context of the RCN project

As mentioned in section three, the present PhD project has been conducted in close

association with the RCN (NANOMAT) funded project *Interdisciplinary Studies of the Social and Ethical Implications of Nanotechnology*, based at the Centre for the Studies of the Sciences and the Humanities (SVT) and running for approximately the same period of time. Being part of a larger project has allowed me to take part in a number of related research activities not included in this dissertation. The close collaboration with the colleagues in the project and the possibility to take part in the shaping and direction of other research packages than the ones included here has been formative for the development of my own thinking and research. I will therefore say a few words here about some of these other research tasks. In 2008 Fern Wickson, Roger Strand, Gian Carlo Delgado-Ramos and I published an article on the governance of converging technologies, where we compared the NBIC (Nano, Bio, Information technology and Cognitive sciences) report (Roco and Bainbridge 2003) from the USA with the European CTEKS (Converging Technologies for the European Knowledge Society) report (Nordmann 2004) (Kjølberg *et al*. 2008). Wickson and I published a book chapter describing our teaching experiences of using nanovision to stimulate PhD students in nanoscience to reflect upon ethical and social aspects of their own work (Wickson and Kjølberg 2009). Other central papers in the project that I have not been directly involved in are for instance Wickson (2008) on the views on nature implicit in the narratives about nanoST, Nydal and Strand (2008) on the importance of positive nanoethics, and Tore Birkeland and Roger Strand (2009) on the politics of nano-images.

It has also been an objective to communicate our research more widely. Popular communication has included a commentary in the regional newspaper 'Bergens Tidende' (Fjelland *et al*. 2006), as well as an article in the newspaper 'Aftenposten Innsikt' about images of the nanoscale (Slaattelid and Kjølberg 2009). The work with 'paper I' of this thesis was, as mentioned above, used as inspiration for the anthology 'Nano meets Macro: social perspectives on nanoscale sciences and technologies' (Kjølberg and Wickson 2010). The research for 'paper II' on representations of nanoST in Norwegian newspapers have also been published in various other forms: as a popular paper in Norwegian in 'Norsk Nytt Tidsskrift' (Kjølberg 2008a), as an

opinion piece in Norwegian in the weekly newspaper Morgenbladet (Kjølberg 2008b), and as a book chapter in the anthology 'Nano meets Macro' (Kjølberg 2010).

The reason for the choice of the four articles presented here as those to make up my thesis is that I see these as having a particular thematic unity in the interest in responsible practice and the new approaches for governance.

6. Discussion and conclusions

As explained above, my main interest in this project has been to explore in what sense new practices of governance, pushed forward for nanoST, can lead to responsible development, as is commonly claimed. In the previous section, I described how this led me to study the nanoELSA literature (paper I), then the conditions for and the practices of uninvited (paper II) and invited (paper III) public engagement, and finally nanoresearchers' understanding of responsibility and the EC-CoC as a means to negotiate the notion of responsibility in nanoresearch (paper IV). While the research in the first three papers may be characterised as more of an open exploration, the last paper attempts a more substantive analysis of what responsible development and practice would entail in the context of interest in this thesis. There are two overall conclusions that I want to present here and discuss against other central contributions and debates in the field. The first is that new approaches to governance have indeed provided an important step in the right direction towards more responsible practices. The second is that a neglected aspect in terms of realising a more responsible development is mindfulness in the sense of an ongoing negotiation of given 'instructions' and actions against personal values. While these two conclusions certainly are related, I will present them separately below, mainly to show the emphasis on the practices (the role, sphere or sector), and the individual respectively.

6. 1 Conclusion one: Governance of nanoST has led to a more responsible development

In short, the research for this thesis points towards the conclusion that nanoST has indeed seen a shift in the direction of a more responsible development, through new approaches to governance. Parts of the ELSA and STS environment were, as pointed out in section two, quick to declare nanoST as a unique opportunity for the field to prove that it could make itself more relevant. The field has to some extent used this opportunity to develop into a significant actor in the search for responsible practices in science governance[25]. Similarly, a number of governmental and non-governmental organisations, as well as concerned scientists and parts of industry, expressed optimism related to the prospect of discussing ethical and social issues at an early stage in the development of an emerging technology. As mentioned in section 4.2, the four studies for this PhD have been limited in scope, both geographically and time-wise, and I am hence reluctant to draw too many strong conclusions. With this in mind, the empirical research for paper I, III and IV all point in the same direction, and I conclude that nanoST seem to have developed ELSA research, European science policy and nanoresearch towards a more responsible development of emerging science and technology. Not the least has the focus on deliberation and communication across these sectors led to a better understanding of the challenges associated with the governance of emerging technologies. The negotiation of 'responsible development' is still ongoing across these sectors, which by itself is an important factor in a new, more reflexive approach. The study for 'paper II', of the newspaper coverage of nanoST in Norway, however, showed no indications of a negotiation of the responsibilities of the media or of actors to provide more nuanced representations to the public sphere.

In the following, I will discuss this conclusion in relation to three debates that I see as

[25] An example of increased influence is for instance the appointment by the EC of central STS scholars in the expert group who published 'Taking European Knowledge Society Seriously' (Felt *et al.* 2007).

particularly relevant and interesting examples of this ongoing negotiation: first, the debate about the political dimension of ethics, secondly, the debate about tension between different objectives for governance, and finally, the debate about the prospect of nanoST to bring about negotiation of the traditional division of labour between science and society.

6.1.1 The politics of ethics

My conclusion that recent experiences with new approaches to governance has led to a more responsible practice is partly due to a timely opportunity for the field of ELSA to re-think and negotiate its own mandate. This has involved a reflexive discussion of the practices of governance themselves. In 'paper I' this came across in how the literature was seen to engage reflexively in the question of what nanoELSA should be all about. In 'paper III' this was seen in how the move from theory to practice for public engagement has exposed tensions – and the emerging readiness for reflexive learning based on the combination of theory and practice. The first discussion that I address is therefore focused on ELSA research.

The prospect of early research, deliberation and reflection about potential ethical and social issues to actually circumvent negative consequences is tightly related to the broader theoretical discussion about scientific uncertainty and plurality of values, and the challenges this implies for deciding what is socially desirable and for reaching such a state. In the research for this thesis, the employment of new approaches to governance is, as seen above, intimately related to this discussion. In taking uncertainty and the plurality of values into account, it is obvious that even a more 'responsible development' does not necessarily lead to a good result, or to a good result for all. Uncertainty tied to implications and applications of nanoST will always hold the possibility open for surprises. ELSA research, with increased focus on deliberation and reflection about ethical and social issues within and between spheres and levels, may prepare us for surprise, but not make us immune to surprise.

Deliberation also opens up for confrontations between values, some of which may be reasonably irreconcilable. 'Responsible development' of nanoST can therefore never mean a guarantee of good nanoST for all. Rather it involves acknowledging precisely how giving this kind of guarantees is beyond our reach. The broad focus and debate about governance of nanoST has initiated processes were this is beginning to be recognized more widely. A term that is closely related to 'responsible development' is that of 'social robustness' derived from the notion of 'socially robust knowledge' coined as part of the theory of mode 2. Socially robust knowledge implies knowledge that has been exposed to early and continuous scrutiny from a broad range of actors. The idea is that when something (a piece of knowledge or a technology) is subjected to this kind of a process, one has a chance to consider up front what it is that is 'at stake' in a possible surprise, and how it may affect people and groups with different values and different interest. It is unfortunately still not uncommon, however, to see both 'responsibility' and 'socially robustness' used in policy documents (some examples were given above) as an achievable good state that we will reach through approaches such as public participation. Sarah Davies *et al*. (2009) argue that "…*current efforts in 'responsible development' – whether in ethical analysis, public engagement, or new forms of governance – while impressive, are still dominated by limited and limiting modes of thought. They will require reconfiguration in order to fulfil the promise of socially responsible nanotechnology*" (Davies *et al.* 2009, p. 3). While I would be reluctant to say whether a reconfiguration may ever be able to 'fulfil the promise' of a socially (or perhaps even more so, an environmentally) responsible nanotechnology, I fully support the statement that the effort so far has been 'impressive', as well as the importance of a continued reconfiguration. In line with this, responsible practice is a process, which may or may not lead to a better result. The achievement of the more politically involved ELSA seen for nanoST, is that it has begun introducing these kinds of idea to other sectors in nanoresearch.

The perhaps most common objections against what one may call 'political ELSA' are the two closely related arguments that it 1) ELSA loses critical distance by being involved (politically) in the processes, and 2) the involvement does not make any

difference. In either case, ELSA research ends up as a facilitator for a development in which more powerful actors can show how they 'take ethics seriously', while everything else stays the same. Kearnes and Rip (2009) point to the danger of an assigned role for professional ethics as something that enables technological development rather than constraining it. The challenges of the inclusion of ELSA has also been addressed in the context of the danger that deliberation keeps 'opening up' issues, without the ability to 'close' them down (Stirling 2008). Davies *et al.* (2009) critically engage with the scope and limitation of participatory methodology, and point to how public concern with nanoST relates to and taps into fundamental cultural fears that need to be taken seriously in responsible science policy. These concerns are not always on the agenda of policy makers, who often seek efficiency in terms of reaching decisions within quite limited sectors, and restricted by specific political goals. If the issues raised by deliberation and ELSA research are not taken into account anyhow – is it then responsible?

The practical experiences certainly lead ELSA into new dilemmas. Both 'paper I' and 'paper III' address the ELSA community directly with these kinds of questions in mind. In both papers, however, I remain optimistic on behalf of ELSA to deal with these new opportunities and new dilemmas. Despite the limited will and/or ability of all actors in nanoresearch to take it into account, the duty of responsible ELSA consists in continually insisting on a number of issues simultaneously that are not necessarily particularly popular in politics: issues such as the lack of knowledge upon which to base decisions, the inability of promising that decisions will lead to what is good, and the necessity of considering not pursuing all technological possibilities when irreversible change of structures and values might be at stake. The existence of these issues challenges traditional ideals of responsible science policy as related to control (cf. Funtowicz and Strand 2010), and give support to the need for ongoing negotiation and reconfiguration of science policy at a fundamental level. In concluding that nanoELSA is moving in a more responsible direction, I suggest that there is an emergence of attempts to enter this political minefield. Irrespectively of the achieved success of these attempts so far, I believe that this is the responsible thing to do for

ELSA.

6.1.2 The tension between innovation, democratisation and protection

The second point that I want to discuss my conclusion against focuses on science policy. While I have not studied the sphere of science policy *per se,* it has been the natural backdrop for all the parts of the research, and in particular for 'paper IV'.

As mentioned in section two, Craye (2009) and Felt *et al.* (2007) have brought attention to how science policy serves multiple and often conflicting objectives in that it aims to stimulate innovation (assist competition and growth of the knowledge economy), invite deliberation (democratise science and/or build public acceptance and trust) and provide protection of the citizens against risk and adverse effects of technology (often invoked by the precautionary principle). The dilemma for science policy is that in this mixed mandate it is both assigned with the responsibility to bring about the potential in science for economic growth (Kearnes and Rip 2009) and new useful (possibly life saving) technological invention, while at the same time it is responsible for addressing the concerns of the public related to its risks and adverse consequences. It is therefore a constant implicit negotiation between different objectives in the governance of science. It seems fair to say that the aim of innovation is currently often given priority, and approaches such as ELSA research and public deliberation are allowed to bring forward concern and questions as long as they do not challenge the prospect of economic growth (cf. the notion of ethics 'enabling' technological development in the previous section).The sense that innovation is given priority by default anyway, is a fair objection to the claim that nanoST see a more responsible development. One may argue (and many have) that initiatives like the EC code of conduct is little more than empty words and that deliberation among actors in nanoST development (even if some of them are decision makers) hardly makes any difference to policy. I would still argue that the EC code of conduct represents an important step in the right direction towards responsible practices for science policy by

exposing the conflicting objectives. The fact that among the seven principles, sustainability, precaution, inclusiveness *and innovation*, are put out – unprioritised – as what collectively represents responsible nanoresearch, reveals the challenge currently facing science policy. This makes it a lot harder to give innovation priority without explaining why it is more important than for instance sustainability in a particular situation. To a much larger extent, then, science policy is forced to deal explicitly with the prioritisation of the principles in a given context, and nanoresearchers and other stakeholders are invited into these kinds of prioritisations.

The negotiation of responsibility that is envisioned for nanoresearch in the code is admirable, and opens up new spaces and possibilities for responsible practice. 'Responsible nanoresearch' as consisting of seven unprioritised principles prepares the ground for discussion about what the principles of sustainability, meaning and precaution really entail, and when they may be compatible and not with for instance innovation. To what degree nanoresearchers are willing to enter this new space of possibilities and engage in discussions of this kind, is the topic of the next section.

6.1.3 The division of moral labour between science and society

The third point that I want to discuss in relation to the first conclusion – that the practice of governance of nanoST has led to a more responsible development – focuses on nanoresearch.

To some extent, there seems to have been a tendency to assume, in nanoELSA and science policy, that nanoresearchers all subscribe to a traditional division of moral labour between science and policy. Davies *et al*. (2009), for instance, found that nanoresearchers had problems relating responsibility to their own research, and that "*…standard justification and division of moral labour remain prevalent – particularly the repertoire that scientists do science, while society and ethicists deal with any ethical or social implications*" (p 4). As part of the same project, Ferrari and Nordmann (2009) conclude by welcoming initiatives such as the EC-CoC as a way to

enter a reconfiguration of the division of moral labour. There are reasons to believe that the notion that scientists, both within and outside of nanoST, are still quite traditional when it comes to ideas about the relationship between science and society.

My research for 'paper IV' can be seen as a small attempt to look for indications of whether the reconfiguration Ferrari and Nordmann (2009) hope for from the EC code of conduct may be seen to take place. Using the code as a frame for conversations about responsible research, as described above, I found that when confronted with the code the nanoresearchers expressed great interest and ability in discussing issues related to responsibility, and that they had a high degree of awareness and reflexivity related to the issue of broader social responsibilities, such as deliberation. I found that several of the nanoresearchers had socially argued reasons (often quite optimistic on behalf of technology, but socially argued nonetheless) for the research they did and had a high degree of reflection about social responsibility related to this. The traditional sense of division of moral labour co-existed with views that went quite far in assigning broader social responsibilities to nanoresearchers.

In our conversations with nanoresearchers, however, there was a sense that they felt patronised by the sensation that the creators of the code of conduct in the EC assumed that they did not reflect about the social consequences of their research at all. There was also a sense that while the topics raised by the code were familiar, the terminology was alien, escalating a feeling of resentment against the document. Similarly, McCarthy and Kelty (2010) point to how "*... it is also clear that social science researchers have perhaps missed the fact that EHS* [Environment, Health and Safety] *research is itself an attempt to respond to demands for 'ethical' science, 'responsible' science, or 'safe' science, and not only a technical pursuit*." (p. 410). Although one of the objectives for the EC-CoC is increased communication between sectors, the document may for some have led to higher barriers. Despite this, I believe that the EC-CoC and similar measures, is indeed seeing an emerging negotiation of the traditional division of labour, also on the part of nanoresearch. The willingness and ability to

enter this negotiation can be seen as a sign of a tendency to move in a more responsible direction.

Summing up the first conclusion, there have been a number of initiatives realised with the aim of steering nanoST development in a more responsible direction. The level of reflexivity and willingness to debate the notion of responsibility itself, makes me conclude that despite widespread pessimism related to what these kind of approaches may achieve in practise – the attempt in itself constitute a more responsible practice. There is of course the danger of governance boiling away in endless deliberation. The following section (6.2) relates to this danger: how deliberation is not enough, and how something is wanted in the debate about responsible development of nanoST.

6.2 Conclusion two: Responsible practice involves questioning the instruction

The second conclusion I want to put forward is the importance of mindfulness as a requirement for an ongoing questioning of given 'instructions' against personal values. In my view, this is a neglected aspect of (*ex ante*) responsibility across all the spheres that I have studied for this dissertation. This is not to suggest that mindfulness does not take place. However, it is not given the emphasis it deserves in the current debates in ELSA and science policy. These debates are mainly focussing their attention on the importance of deliberation and communication. Individual questioning should not replace deliberation and communication, but I believe it would serve as an important supplement in the debate about how to approach responsibly the development of emerging technology.

Section three argued that the focus on deliberation represents an aspect of responsibility that is dominated by what Pellizzoni (2004) has termed responsiveness. When actors representing different disciplines, roles or sectors are asked to respond to external concern and question, they may easily end up defending the sector or role. In a situation of emerging technology, where development happens fast and the possibility of surprise is ever present, this preservation of roles and job descriptions

may not always be the kind of responsibility required. This is where mindfulness and responsibility as care may lend a hand, precisely because it is motivated from the individual itself. The notion of mindfulness and 'thinking' *sensu* Arendt (1971) was elaborated above. Mindfulness as a state of consciousness, and 'thinking' as an ongoing inner dialogue may be crucial in order to remain responsible when the conditions can change more rapidly than the instructions and institutions are able to adapt. Again, mindfulness cannot guarantee the outcome of 'good' nanoST. Rather, it is a way for individuals to remain responsible actors in the midst of an uncertain, complex and fast developing reality.

In this sense, my proposal is not too different from Funtowicz and Strand's (2010) argument for replacing the notion of responsibility with that of *commitment* in contexts in which attempts at control are futile and the main problem may be that of lack of agency. I would add that the differentiated and efficiency-orientated modern society and the many-faceted life as citizens and professionals also in many instances stand in the way for 'thinking' about how our actions relate to our values. Mindfulness, starts by recognising the morality of actions – and that they may actually have a right and a wrong (according to our own values). The focus on 'thinking' does also resonate with Funtowicz and Strand's (2010) argument that action should be grounded in *praxis* (in the political life) rather than in technical expertise. It is a way to reconcile personal values with the professional role, be it as decision makers, nanoscientist or ELSA researcher.

This conclusion is mainly derived from the last research task of this thesis, and for the sake of clarity, I begin here with nanoresearch (the sector that I studied in 'paper IV'), before I will show briefly how it applies to ELSA research and the public sphere.

6.2.1 The value of mindfulness in researchers' questioning of the instruction

ELSA/STS researchers have, as described in section two and three above, questioned the 'instruction' of the traditional social contract of science for some time already, in

encountering its potential to generate harm, risks, surprises and hazards in addition to producing goods. One of the objectives of a document like the EC-CoC is to draw nanoresearchers in to this kind of reflexivity and involve them in deliberation of what kind of responsibility research has when the traditional social contract is declared too simplistic.

The EC-CoC opens up for negotiation of the traditional responsibilities associated with the roles in research by stressing the need for deliberation and communication between actors – both as part of the description of the content of responsible nanoresearch (especially in the principle of inclusiveness) as well as an factor in how the code should be implemented. Communication between sectors may however have a limited potential for negotiation of responsibilities, because the sectors (or roles or disciplines) themselves are made the platform for the deliberation. This is exemplified for instance by how the request (for nanoresearchers) to enter into communication is suggested from another sectors (for instance ELSA research or science policy), and already creates an imbalance that may affect deliberation. Faced with an emerging technology, where the situation may change rapidly, deliberation between sectors and spheres risk ending up as defence of roles and institutions that are not adequately apt to tackle the current challenge. The negotiating of researchers responsibility that have been requested (by for instance Ferrari and Nordmann 2009), would therefore benefit from grounding in individuals sense of responsibility as care and mindfulness of moral choice – which allow for a potential to sometimes question the job description and the role itself.

In my research, I found that the EC-CoC indeed served as a good platform for conversations about the division of moral labour and the limitations of the responsibilities of both nanoresearch and ELSA research. It was striking however, how we easily ended up 'hiding' behind our respective professions, even though much of the understanding of the challenges of the limitations of responsibility was shared. This closed down further discussion of what was really at stake and how to go about approaching mutually identified problems. It is interesting to compare this with other

ELSA/STS researchers' experience of negotiations of responsibility in nanoresearch, who have engaged in more integrated engagements with nanoST researchers.

Doubleday (2007a; 2007b; 2007c) draws on experiences from being a social researcher in a nanoST laboratory as early as in 2004. He shows how the nanoresearchers already then were "*negotiating contradictory demands of the funding agencies, national and European science policies. Such demands include expectations that the laboratory will produce internationally recognised research; foster interdisciplinary modes of working; contribute to the development of technologies and their application; consider potential environmental, health and safety risks; engage in public dialogue; and consider the social and ethical implications of its own research*." (Doubleday 2007b, p. 171-172). His employment was the solution implemented by the laboratory to meet these demands, and his task envisioned as, among other things, to mediate between the laboratory and the public. Doubleday concludes that the scientists indeed engage in negotiations of responsibility, but rather than relating these to public concern, the negotiation was relatively traditional and mainly contained by the walls of the laboratory. With him there to serve as the link to society, the division of moral labour, destabilised by the competing demands, were again back to normal. The approach seems to have been to respond to external demands in an as efficient way as possible, and for the social researcher the gap between their different agendas became problematic (Doubleday and Viseu 2010).

As mentioned above, the theory of 'midstream modulation' aims both to develop the reflexive capacity of researchers in their daily practice in the laboratory, and the ability to engage with other actors in policy. In the STIR project, social researchers are hence integrated in laboratories to cultivate the capability of the nanoresearchers to recognise own decisions and relate these to certain goals "*whether goals are explicit or implicit and initiated from within or without* " (Fisher 2006, p. 492). This undoubtedly involve a sense of mindfulness, and awareness of how even the small and routine research tasks may involve decisions. Sometimes these are motivated by external goals, while sometimes they are the result of own inclinations and choice. It is not however evident

that midstream modulation capacity increases the ability to question the instruction. "*For laboratory scientists, thinking and talking about the broader dimensions of their work in an integrated way need not entail a sacrifice in productivity*." (Fisher *et al.* 2010, p.1018). Fisher (2006) clarifies that "*from the standpoint of developing midstream modulation capacity, the point is not which principles should be used or whether any should be used at all but how to get to the stage at which principles and strategies make sense to midstream agents in the first place*." (p. 493). The focus on micro decisions does not necessary achieves (or even attempt) to place the laboratory work into a larger social and environmental context.

McCarthy and Kelty (2010), have studied "*one group's attempt to become responsible*" (p. 408) in a nanoST laboratory in Texas, USA. Not asked for by any external authority or public pressure the researchers themselves experienced a need for more research on the potential risks of nanoparticles. While externally partly argued for in terms of fear of consumer backlash and distrust, McCarthy and Kelty (2009) found that internally these discussions were mainly motivated by other kinds of arguments. They found that the researchers took on "*both the responsibility to protect science (from the public, from de-funding, from 'backlash'), and the 'social' responsibility to protect the environment and biology through scientific research*." (p. 409), and describe it precisely as a negotiation of the sharp split between science and society. These nanoresearchers may be seen to negotiate responsibility from a perspective of care rather than in form of responsiveness to external questioning, and do indeed question the instruction.

These examples may serve to showcase different responses to the (external or internal) call to negotiate the notion of responsibility in nanoST research communities. A valid objection to the argument that one should question the instruction may be that those who do in effect risk excluding themselves from the field. Investing time and attention in questioning the instruction may without doubt imply a risk of losing momentum in a highly competitive sector. Showing that one is responsive, however, has become an advantage in order to for instance attract public funding. It remains to be seen in what

direction further negotiations of responsibility through for instance the EC-CoC will develop: to what extent for example the principle of sustainability (which in my opinion require questioning the instruction) are really put up on the same level as innovation and excellence in science policy.

6.2.2 Responsible ELSA/STS research questions the instruction

In this subsection, I will describe briefly how the second conclusion plays out in relation to the field of ELSA. I hence draw in the research for 'paper I' and 'paper III'. The argument is related to the discussion above about the politics of ethics in the sense that the evolution of ELSA to be more political has involved a questioning of its own instruction.

In 'paper I' there is an argument for the value of cross-disciplinary and cross-category ELSA research based upon a recognition of the ability of this kind of work to better address complex and multifaceted issues related to the interactions of emerging technology with social and environmental systems. These are issues that cannot always be satisfactory addressed within the frames of traditional lines of questioning, disciplines or even within the frames of academic inquiry. In retrospect, what we valued in these texts was exactly the ability to not only function as an enabler, but challenge the 'instruction' of dealing with the ethical and social issues up front to smoothen the path for nanoST development. For practitioners in the field of nanoELSA (or any field that deals with ethical and social aspects of nanoST), challenging the instruction implies reflecting on questions related to the role assigned to this kind of work in the larger picture of nanoST development. In 'paper I', we found that nanoELSA in fact is a highly reflexive field in this respect.

In 'paper III' my colleagues and I directly address the increased involvement of ELSA in arranging public participation, and the need for an ongoing negotiation and evaluation of what purpose it serves – especially with an eye to the practical

consequences of the choice of deliberating issues 'upstream'. The need for a questioning of instructions is perhaps even more obvious here, because 'instruction' in this context is more frequently not a metaphor, but in fact a real instruction from policymakers or industry to investigate public concern in a certain way. When invited to organise participatory exercises, questioning the instruction should for example involve challenging the framing of the public that has prevailed in many of these exercises. Macnaughten *et al.* (2010) are among those who point out that "*public engagement activities, then, are too often marked by mixed motives and confused practices*" (p. 25). Several contributions emphasise the need to use the practices of public participation for nanoST as a continued learning process (Davies *et al.* 2009, Stilgoe 2007, Gavelin *et al.* 2007). As pointed out in section three, responsibility as care is a good condition for reflexive learning. Likewise, mindfulness is important when faced with new opportunities for involvement.

Nordmann and Schwartz (2010) have however warned against 'the lure of the yes' that the invitation for 'ethics' to be involved from the beginning creates, and exemplify this by showing how "*caught between frustration and possibility, the* [Canadian ethics] *Commission issues a vague injunction to search the right way out of the predicament and to pursue what is generally known as the responsible development of nanotechnology*." (p.256). They continue: "*Closely in line with other reports and recommendations, the Commission's position paper avoids even the possibility of the normative 'no' of ethics and the law but joins the concert of 'yes'-sayers – yes to responsibility, yes to the invitation to determine what nanotechnology can be, yes to shaping transitions from imagined possibility to real societal benefits, yes to the participation with other stakeholders, academics, artists in the global project of doing nanotechnology right, and thus: yes to the nanotechnologies of which one does not know what they are* […]" (p. 257). Nordmann and Schwartz (2010) use this example to question the ability for responsible ethics/ELSA in the entanglement with policy and research, and argue that the success of achieving a discussing of ethics (with no corresponding agency to act) before the technology has taken shape, has filled the

'nanospace' with empty and pleasurable talk.

The real challenge for ELSA researchers today may be to remain mindful of own values in a time of general success. The risk of losing momentum and opportunities in a highly competitive field is perhaps as valid for ELSA research as it was for nanoresearch in the section above. Another factor, especially valid for the kind of ELSA research that is closely integrated with nanoresearch, is the fact that 'questioning the instruction' may let someone down. When ELSA research is integrated into nanoST laboratories it is founded on relations of mutual trust. If the assumed or explicit instruction is that ELSA will enable the technological development in a responsible manner, starting to question whether this is possible may become increasingly difficult for the ELSA researchers, as it may feel like violating the premises of the relation. The same is true when accepting invitations to teach ethics in science programs, or be the key note speaker at a technology convention; if nothing else, there is an emotional cost involved with offending the host. Despite signs that there is in fact increasing willingness to negotiate responsibilities also within nanoresearch, the instruction for ELSA is probably still more often than not that 'a little bit of ethics is good, as long as it does not interfere with the way we always have done things'.

Accordingly, responsible ELSA research should ask unpopular questions, and questioning the instruction is as important for ELSA as it is for nanoresearch. In their analysis of 'nanoethics in the real world' Ferrari and Nordmann (2009) conclude that taking the identified concerns seriously "*calls for a move from conversational to more deliberative modes of engagement, and calls for new, more explicit and reflective ways of organizing responsibilities*." (Ferrari and Nordmann 2009, p. 53). I would emphasis that mindfulness and the ability to question the instruction is the best approach I can imagine to overcome the 'lure of the yes' and start identify those instances when the most responsible thing is to step away from the conversational and deliberation mode and start getting more impatient.

6.2.3 Questioning the standard accounts of nanoST in the public sphere

In the second paper I criticise the black and white representation of nanoST in the public sphere, and argue for a greater diversity and more nuance in the stories told about nanoST in Norwegian newspapers. The representations in newspapers are important as a basis for uninvited public engagement, and I point to the inability of the one-dimensional framing to facilitate discussion about serious, complex issues related to nanoST development and its multiple interactions with society and the environment.

We are faced with yet another highly competitive sector where the instruction may be to create a catchy headline or to deliver a story within a short deadline. Lack of time and resources is used to explain, and sometimes even defend, the current stereotypical and simple framing found in the media. Finding unusual angles, searching for alternative sources and asking deeper questions involves developing a better understanding of the field, something that require more time and resources. Journalists do however have a responsibility to provide insights and information to the public, and responsible journalism should question the instruction to provide the quick and easy angle. Scientists and other actors in nanoresearch share the responsibility to provide more representations in the newspapers in the form of letters to the editor and commentaries. Again, it may be a matter of mindfulness to when and how stories and angles deserves to be presented to the public, and to when these kinds of expressions need to be prioritised. It may even involve a questioning of the instruction of fast turn over and efficiency in academic life.

Summing up the second conclusion, I believe that mindfulness is crucial in striving for responsible development of nanoST. As a supplement to deliberation between roles, grounding responsibility in an individual 'inner dialogue', as does Arendt, allow for an ongoing questioning of instructions and institutions, something that is of importance when faced with a scientific and technological development that may change more rapidly than the instructions and institutions can adapt.

7. Final discussion and need for further research

Finally, I would like to indicate some critical points regarding the conclusions of the thesis as well as possible need for further research.

In the dissertational work, there have been benefits but also costs of directing the four individual studies methodologically directly towards the four quite different spheres that I wanted to study. The necessary limitation in scope (due to the time frame of a PhD project), both geographically and time wise of the studies, as well as the fact that the individual studies do not overlap in this respect, make me reluctant to draw too many strong conclusions across the four research tasks. This is perhaps particularly the case for conclusion number one. More empirical research is called for on the development and evolution of new approaches of governance, and the extent to which they succeed in terms of the claims and promises of ideals such as 'responsibility' and 'social robustness'. In accordance with the objective for the present project, I would like to see this be combined with a continued analysis of what these notions mean in the context of nanoST. Another line of research that I would like to follow up in this respect is to extend the studies of ELSA literature and newspaper coverage of nanoST to see if trends have continued after 2007 and 2008 respectively, and to expand the latter geographically.

Along the same line, a disadvantage of the present project was the limited sense in which I was able to insert more connections between the research tasks, as proposed in paper I for the entire field of ELSA of nanoST. I imagine this as for instance arranging workshops with representatives from across science policy, nanoresearch, ELSA research and the public sphere (both citizens and the media) to work together with central issues raised in the project. This could particularly have benefitted and strengthened the analysis that led to the second conclusion. Outside the scope of the PhD, the theoretical and constructive part of the project calls for more developing. Analysing the practicalities and possibilities of facilitating deliberation and reflection, and for mindfulness in different (occupational) settings is only one of many interesting research tasks in this respect. These kinds of questions could benefit from research

approaches even more closely integrated into the nanoresearch environment. Particularly it would have been useful to spend more time in the laboratories, something that the frames of this project did not allow for. More interactions with the nanoresearchers in their daily work would have allowed me to learn more about nanoresearch and could have opened up for more spontaneous reflections about responsible practice.

I also find it promising to pursue the theoretical interests in this thesis in closer collaboration with political philosophy that work with many of the same research problems from a more theoretical angle. The notion of *ex ante* responsibility for emerging technology and how the perceived responsibilities of research may be presently negotiated is a research path that I would like to pursue more. It would have been particularly interesting to follow this up in integration with both political philosophy and natural researchers. It would have been interesting to see if the destabilisation of division of moral labour found in nanoST differs between groups such as a) nanoresearch and other fields of research, b) age groups, or c) different research cultures, such as for instance Scandinavia compared to other parts of Europe or other continents and regions.

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