Title: The Governance of Nanotechnologies and Nanosciences: promotion vs. regulation

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Degree: PhD

## Declaration

I, Kajsa-Stina Longuère, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Kajsa-Stina Longuère
Leighton Buzzard, 14/12/14

## Abstract

This is a qualitative empirical study of the governance of nanotechnologies and nanosciences that explores decision-making and the decision-making processes in the light of the emergence of a novel technology and scientific field in Sweden, Finland and the UK. The study, which took place between 2008 and 2011, particularly utilised Gibbons et al. and Rip's models for science governance, the Mode 1/Mode 2 theses, and Arie Rip's Strategic Science, alongside thinking around the Knowledge-based Economy as a springboard to examine a selection of characteristics related to organisational diversity and social accountability in decision-making. The data was collected through 42 semi-structured interviews held with 46 actors involved with nanotechnologies and nanosciences related decision-making in the three countries. Additionally, a case study utilising interpretative phenomenological analysis was conducted to capture more detailed accounts of the experiences of three interviewees concerning their participation in decision-making.

The main conclusions drawn from this study is that the decision-making processes and policy outcomes were very different in the three countries, despite their similarities in terms of socio-economic characteristics, geographic location, and the importance of R&D to their economies. The differences were caused by the structures of their respective science governance systems, past controversies, and, possibly, cultural characteristics. The novelty of nanotechnologies and nanosciences, did not affect policy-outcomes, and more organisational diversity and social accountability did not make them more robust. However, the study found support for a more balanced discussion that included both regulatory issues and the promotion of nanotechnologies and nanosciences in the UK as opposed to both Sweden and Finland, which could be related to more organisational diversity and social accountability as noted for the UK.

Exploring Gibbons et al. and Rip's models of science governance showed that neither model is generally applicable to all three countries, and that there is a need for flexibility in order to capture national differences in science governance. The Strategic Science model came across as being more easily applicable in these circumstances.

## Acknowledgements

As I started this project a dear friend told me “everyone blows a fuse at some point during their PhDs”. Two laptops down, one Finnish-English dictionary in the bin, three NVivo breakdowns, and a MERS-CoV and an Ebola outbreak later, and I have to say that nothing could be closer to the truth. In rushing (or skipping) to the printer tomorrow, I will be thanking a very long list of people. First and foremost, Professor Brian Balmer, for your incredible patience and kindness, and for seeing me through it all, my sincere thanks – I could not have had a better supervisor. Professor Steven Miller, for keeping my Postup topped up and for all support and insights into science communication that I could not have done without. A big thank you goes out to the rest of the STS department as well, and in particular to Norma Morris, Melanie Smallman, and Marta Entradas for all support and occasional agony aunt services. UCL’s Disability Services also get a mention and a thank you, as I would not have been able to do this without their help.

I also want to thank my Oxford colleagues and anyone else currently or formerly involved with ISARIC, for their patience and support as I tried to juggle this around my day-job. And to all of the interviewees that took part in this study, thank you very much, it really could not have been done without you!

Very importantly, I want to thank my wonderful husband Matthieu, my parents and brother, the rest of my awesome family, and all of my fabulous friends for their love and support during this project.  I owe you seven years (yes, 7) of catching-up, with interest.

Finally, my much-beloved late great-aunt Toini was one of my keenest supporters and a wonderful source of coffee, biscuits, and giggles while cycling between interviews in Helsinki. A very special ‘Kiitos’ goes to her.

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## List of Abbreviations

| | |
|---|---|
| AF | Academy of Finland |
| BBC | British Broadcasting Corporation |
| BIS | Department of Business, Innovation & Skills |
| BSE | Bovine spongiform encephalopathy |
| CIA | Chemical Industries Association |
| CST | Council for Science and Technology |
| CV | Curriculum Vitae |
| DA | Discourse Analysis |
| Defra | Department for Food, Environment, and Rural Affairs |
| DH | Department of Health |
| DTI | Department for Trade and Industry |
| EA | Environment Agency |
| ECT Group | Action Group on Erosion, Technology, and Concentration |
| EFSA | European Food Safety Authority |
| EMEA | European Medicines Agency |
| ENI | Environmental Nanoscience Initiative |
| EPSRC | Engineering and Physical Sciences Research Council |
| ERA-NET | Networking within the European Research Area – ERA |
| ESRC | Economic and Social Research Council |
| ESS | European Spallation Source |
| EU | European Union |
| FP7 | Framework Programme 7 |
| FSA | Food Safety Authority |
| GDP | Gross Domestic Product |
| GMO/GM | Genetically Modified Organisms/Genetically Modified |

| | |
|---|---|
| HM Government | Her Majesty's Government |
| HSE | Health Safety Executive |
| HSL | Health and Safety Laboratory |
| IMEC | Interuniversity MicroElectronics Centre |
| IPA | Interpretative Phenomenological Analysis |
| IVA | Kungliga ingenjörsventenskapsakademien (Royal Swedish Academy of Engineering Sciences) |
| KBE | Knowledge-based Economy |
| KEMI | Kemikalieinspektionen |
| KTN | Knowledge Transfer Network |
| LNP | LINK Nanotechnology Programme |
| MHRA | Medicines and Healthcare Products Regulatory Agency |
| Mini-IGT | Mini Innovation & Growth Team |
| MNT Initiative | Micro and Nanotechnology Initiative |
| MoE | Ministry of Education |
| MRC | Medical Research Council |
| NERC | Natural Environment Research Council |
| NF | Naturskyddsföreningen (Swedish Society for Nature Conservation) |
| NGC | Nanotechnologies Collaboration Group |
| NGO | Non-governmental Organisation |
| NIA | Nanotechnologies Industries Association |
| NIDG | Nanotechnology Issues Dialogue Group |
| NLG | Nanotechnologies Leadership Group |
| NNRC | National Nanotoxicological Research Centre |
| NPK | New Production of Knowledge |
| NRCG | Nanotechnology Research Coordination Group |
| NSF | Nanotechnologies Stakeholder Forum |
| NSI | National System of Innovation |
| NSIG | Nanotechnology Special Interest Group |
| OECD | Organization for Economic Co-operation and Development |
| RCEP | The Royal Commission on Environmental Pollution |
| R&D | Research and Development |
| RDA | Regional Development Agencies |
| REACH | *Registration, Evaluation, Authorisation, and restriction of CHemicals* |
| RS/RAE | Royal Society & Royal Academy of Engineering |
| SAICM | United Nations' Strategic Approach to International Chemicals Management |
| SME | Small and Medium Enterprise |
| SN | Svenskt Näringsliv (The Confederation of Swedish Enterprise) |
| STEM | Science, Technology, Engineering and Medicine |
| STPC | Science and Technology Policy Council |
| STS | Science and Technology Studies |
| Tekes | Teknologian ja innovaatioiden kehittämiskeskus |
| TSB | Technology Strategy Board |
| UNESCO | The United Nations Educational, Scientific and Cultural Organization |
| UNITAR | The United Nations Institute for Training and Research |
| VA | Vetenskap och Allmänhet (Public and Science). |
| VR/NFS | Vetenskapsrådet (Swedish Research Council) |
| VTT | Teknologian tutkimuskeskus (Technical Research Centre of Finland) |
| WPMN | Working Party on Manufactured Nanomaterials |
| WTA | World Transhumanist Association |

# Section one: Introduction, Theory, and Methodology

*This section will provide the foundations upon which this study is conducted and guided. The first Chapter offers an introduction, while Chapters 2 and 3 set out the theoretical and methodological frameworks that guided the field study, case study and conclusions drawn in Chapters 4 to 10.*

## Chapter 1: Introduction, Perspective, and Demarcation

> *This chapter serves as an introduction to the research project and aims to outline its objectives, structure, theoretical perspective and choice of methodology. The final sub-section will provide a demarcation of the thesis, as it could have turned into more than one doctoral project.*

### 1.1 Objectives – why are nanotechnologies interesting?

Using both political science and science and technology studies (STS) as stepping-stones, the aim of this research project is to conduct an in-depth study into the governance of nanotechnologies and nanosciences, with particular focus on regulation and promotion. During the course of the study, the title changed from 'the governance of nanotechnology', which became too narrow a distinction in the light of the many technologies that could be considered 'nanotechnology'. 'Nanosciences' were also included in the title as the distinction between nanotechnologies and nanosciences proved rather blurred and as the add-ons to the 'nano'-prefix, such as 'fabrication', 'medicine', 'pharmacology' etc. multiplied – the title needed to take all uses of 'nano' within science, medicine and engineering under it wings. Therefore, the term 'nanotechnologies and nanosciences' will be used frequently throughout this thesis to signify the research into all things 'nano'-scaled, unless otherwise specified.

The lucidity of the subject matter established, what make nanotechnologies and nanosciences interesting? Generally, change (or the lack of it) is of great interest when studying science from the realms of social science. Adding a bit of political- and/or STS-related sociology to that, the societal changes or the way in which researchers, scientists, and policy-makers experience the emergence of a new technology or scientific discipline sets the scene for very

interesting research to be conducted. Though there are many potential paths to explore, as the literature review in Chapter 2 will outline, this thesis is particularly interested in how scientists, researchers, policy-makers, industrial representatives and others involved with the development of national strategies related to new technologies perceive the tasks ahead, and the balancing act of promoting and regulating something that remains partially unknown. The topic and the associated uncertainty is also of great interest with the governance of biotechnology in mind, and the lessons drawn and, possibly, learnt with regards to dealing with potential controversies.

Alluding to it by involving more than just politicians, only scientists, or exclusively industrial parties, and instead pointing towards the collaboration of many in decision-making related to knowledge, the study will draw on theorising as sketched through the mode2 thesis (Gibbons et al. 1994, Nowotny et al. 2001) and Arie Rip's Strategic Science (2000, 2002 & 2004). The study is also focusing on three European countries, Sweden, Finland and the UK, and aims to provide an international comparison. The three countries are interesting as they, though they are quite similar otherwise, have approached nanotechnologies and nanosciences rather differently, at least as far as the discourse related to promotion and regulation is concerned. This could be due to their policies being influenced and shaped by their differing social, cultural, institutional and political settings, which is something this study seeks to explore further.

When this study was embarked upon, in 2007, most articles and books published on nanotechnologies and nanosciences within social science were descriptive and there was room for deeper empirical research. Of what was published, most articles remained concentrated around a relatively small number of topics, and primarily targeted risk assessments and public engagement. This left regulation and strategy/policy-development largely untouched and ripe for exploration. That is not to say that risk assessments and public engagement activities and events are not important when discussing policy-formulation, on the contrary. This study is also claiming to

be ‘a first’ when it comes to empirically evaluating, exploring, and comparing decision-making as here described, in the three countries chosen.

Further, regarding the study of science governance more generally, this should be considered an attempt to combine the traditions of political science and STS, which may, hopefully, go beyond this specific case study. Despite the obvious similarities in trying to understand policy and what shapes it, there does not seem to have been much interaction between these two disciplines. Science, knowledge and technology should be of interest to political science due to their haven taken centre-stage in the modernity that today’s decision makers try to govern. Turning the coin, the methods and analysis tools of political science should be of interest to anyone trying to understand what is shaping science policy. Science governance is here being defined as an expression that *“(…) refers to science’s entanglement with the larger – invariably conflicted – interest in society, typically in matters of technology that have serious impacts on individuals’ lives, the environment and/or the economy”* (Fuller, 1999:7). Both Gibbons et al. and Rip’s models fit well with this definition in that they outline plurality in governance, interaction, and a broader take on the development of emerging technologies and sciences through their Mode1/Mode2 thesis and Strategic Science notion.

Particularly, with regards to this study, the combination of disciplines will hopefully assist in exploring the dynamics and relations between different actors, e.g. academia, government, industrial representatives, and civil society being brought to the decision-making table. Secondly, today’s knowledge society does not only call for more informed citizens, which indeed should be required of government officials and politicians as well, but also for a more open and transparent policy-making process. Consequently, examining the process of governance itself is of great interest. Thirdly, the topic chosen for the study gives an opportunity to examine a process on-going right now, which may bring forth issues and aspects of the policy-making process that may otherwise be forgotten and/or overlooked.

Arie Rip (2004) has claimed that Nanotechnology could be an example of Strategic Science in the working, and Gibbons et al. (1994) and Nowotny et al. (2001) suggested that the Mode1/Mode2 shift was an occurring trend when they first wrote about it in 1994, which would imply that their predictions for the Mode 2 thesis would be entirely or partially applicable to the governance of nanotechnologies and nanosciences in 2008-2011. That is not to say that the study takes the Mode2 shift for granted; rather, finding and/or evaluating whether such as shift has indeed occurred, and on which or who's terms, is an aim in itself. The thesis will also consider objections against the Mode1/Mode2 thesis that have been raised by for instance Hessels and van Lente (2008) who have pointed out a number of conceptual problems and the lack of empirical evidence, and Rip, while in contrast other scholars such as Wood et al. (2008), have noted that nanotechnologies and the governance of nanotechnologies may indeed be an example of the Mode1/Mode2 transition.

The motivation behind focusing on the regulation and promotion of nanotechnology is that while often portrayed – particularly by policy-makers themselves as this study shows, as opposing one another, they may also not actually be entirely contradictory. Also, understanding how they are balanced or portrayed in decision-making may highlight interesting observations with regards to the interests that underpin decision-making. Both promotion and regulation are of vital importance to all negotiating parties (in terms of intellectual property rights and assuring funding, for example), and both are suitable for exploring openness and secrecy in policy-making and how the parties relate to openness and secrecy observed. Another reason for bringing them up as 'opposing' factors in governance, when applicable, is for the sake of discussing innovation governance vs. risk governance. Whereas the promotion of technologies and R&D may be perceived as a fundamental element of innovation governance, risk governance pays greater attention to regulatory, ethical, and social concerns. However, as already mentioned, regulation does not necessarily oppose promotion, as a precautionary approach may actually benefit the spreading and acceptance of a technology by making it 'look' safer. Hence, merely setting promotion and regulation up against one another would make the comparison overly simplistic. The study

will also look at various public engagement activities initiated in relation to nanotechnologies in the three countries, if initiated at all, and discuss science communication and its occurrence and its place within innovation and risk governance more generally.

This project will benefit STS and political science scholars by shedding light on where the two disciplines may cross paths and where a joint effort might be useful to pursue areas of common interests. Other disciplines such as Economics, Business and Management, and Economic and Social Geography may also find the effort to explore multi-actor collaboration that includes academia, industry, government and society of interest.

### *1.1.1 Thesis structure*

The study is divided into three sections that contain nine chapters that are supported by three appendixes, a reference list, and a list of acronyms.

The *first section* contains three chapters that aim to set the scene for the fieldwork and case study presented in the second section. This chapter, *Chapter 1*, serves as an introduction to the study and seeks to clarify why this particular research topic has been chosen for the thesis. It also aims to describe the theoretical perspective chosen and through which the subject has been perceived and later analysed, and the methods used for the fieldwork, case study, and analysis. The first chapter also aims to set the limitations for the study through including a *demarcation*, which is necessary due to the vast amount of data collected, which could have resulted in more than one thesis should the study not have been limited.

*Chapter 2* seeks to engage more closely with theory, and will include a literature review and the findings of a pilot field study. Though a rather long chapter, the reason to include all three sections under the same heading is that all three components were of equal importance to the formulation of research question, choice of methodology, the research undertaken, and its resulting conclusions. The chapter includes a separate section identifying and

outlining the research themes and questions for the study. The interview questions are included in Appendix I for reference.

Having identified the themes and hinted at the use of methodology, the second chapter will be followed by *Chapter 3,* which is entirely dedicated to methods. Starting off with justifying the choice of methods with regards to the theoretical discussion in Chapter 2, the subsequent subsections will discuss the use of semi-structured interviews as a suitable technique for this study, and the choice of interviewees and countries. The chapter will also give further insight into the mixed qualitative methods and used of Interpretative Phenomenological Analysis (IPA) for a case study and how this adds value to the research findings presented in this study. The methodology chapter will also discuss the operationalization of the research themes further, and the potential limitations and difficulties encountered 'on the ground'. The chapter is also supported by Appendix II, which offers information about the coding matrix used for this study.

The *second section* includes four chapters that aim to capture narratives for each of the three countries, the field studies conducted, and the IPA case study. *Chapter 4* will be dedicated to the UK field study and contains both a narrative based on a document review done conducted in the UK with regards to policy papers and other materials that set the scene for the UK fieldwork. The narrative will be followed by the UK fieldwork, which will be structured in accordance to the Themes Matrix presented in Chapter 2. The chapter will end with a summary of the main points drawn out of the UK field study. *Chapter 5* and *Chapter 6* will present the Finnish and Swedish fieldwork and follow the same structure as Chapter 4. *Chapter 7* is a short chapter that aims to present and analyse the data derived from the IPA case study. The chapter is supported by a list of themes, which is included in Appendix III.

The *third section* of the thesis contains the last three chapters that aim to bring together the cross-country comparison, a theoretical discussion, and the conclusions of the study. *Chapter 8* offers a cross-country study based on the data analysis conducted in chapters 4-7 and refers back to the Theme Matrix

in Chapter 2, which is also replicated by country in the empirical chapters. *Chapter 9* will discuss the results of the data analysis and cross-country comparison in the light of the theoretical framework presented in Chapter 2, while *Chapter 10* will list the main conclusions drawn in this thesis, reflect on the study overall, and end with an outline of potential future study that could be undertaken with this study as a springboard.

## 1.2 Perspectives

This is first and foremost an empirical study, but rather than being a 'report', it is aiming to explore theoretical claims that underlie Gibbons et al. and Rip's thoughts that form their respective models of science governance, through empirical research. Apart from capturing 'reality' in nanotechnologies and nanosciences policy making in the three chosen countries, this study will attempt to offer explanations for any differences found, and examine to what extent the Mode1/Mode2 theses or Strategic Science accommodate for different national contexts. A more in-depth theoretical discussion will be offered in Chapter 2, but some contemplation is necessary before describing the methodological approach chosen for this study.

### *1.2.1 Thinking around knowledge production*

As part of the aim of this study is to observe decision-making related to nanotechnologies and nanosciences through both the lenses of political science and STS, a combination of perspectives and methodologies is called for. This study makes no particular claims at being rationalist, essentialist, determinist or constructivist. However, it does consider 'the social' and 'science' to be created, altered and shaped simultaneously, e.g. through 'co-production'. An idiom – or a 'way of thinking' about complex situations or occurrences, rather than a theory, the *co-productionist idiom* perceives the natural world and social world as developing and being produced in parallel (Jasanoff et al., 2006). Following this line of reasoning, *"knowledge and its material embodiments",* here nanotechnologies and nanosciences, *"are at once products of social work and constitutive of forms of social life; society cannot function without knowledge any more than knowledge can exist*

*without appropriate social supports."* (Jasanoff et al., 2006:2ff)
Nanotechnologies and nanosciences and the knowledge associated with them are not hanging transcendentally in thin air, out of reach to anyone trying to make sense of them. Rather, following Jasanoff et al.'s reasoning, they are embedded in a host of social practices, norms, discourses, institutions, and identities – i.e. in anything considered 'social' – which 'make sense' of or interprets them. Co-productionism is in that sense a very inclusive idiom, and in terms of knowledge production, it fits rather well in with what Nowotny et al. and Gibbons et al. (the same group of scholars who changed the first author when publishing two books on knowledge production collaboratively) discussed with regards to the *mode1/mode2 thesis*, as mentioned above, according to which institutions involved with knowledge production – academia, industry, and government have found common ground in the production of knowledge by increased integration and collaboration in modern society. The social interactions that are of particular interest to this study relate to the decision-making about knowledge, which is also – in the true sense of co-production, directing knowledge. R&D policy-making targeting nanotechnologies and nanosciences is, as is claimed here, both shaping and being shaped by the sciences and technologies they seek to address. The former applies, for instance, in relation to the funding allocated to knowledge-production and the regulatory frameworks set up for scientists and researchers (and other parties) to follow. The latter, implies that decision-making regarding knowledge cannot happen efficiently without knowledge. If a national nanotechnology strategy is to be outlined and 'signed-off' by decision-makers, scientists and researchers working with nanotechnologies and nanosciences research, whether within academia or industry, are likely to be consulted as experts or advisors ahead of the 'sign-off'. Rip (2004) made similar claims when outlining the Strategic Science model in that a more varied spectrum of actors are involved, and knowledge production is taking place simultaneously to governance and decision-making.

Then how is this co-production or simultaneous development to be operationalised into something reasonably measurable? When looking into potential theories or concepts from the annals of political science and in

discussing knowledge with politicians and others involved with knowledge- and science-related policies, I cannot get away from the use of the concept ‘knowledge-based economy’, and more recently ‘knowledge transfer’, evidence-based decision-making and similar terms. Knowledge is often considered a resource by governments and their agencies - a resource in financial terms. Hence, discussions related to a new technology and emerging scientific discipline upon which industrial endeavour that, if managed correctly, can fill the coffers of the Treasury, will often take place within a context influenced by interests and concerns related to innovation and economic development. Nanotechnologies and nanosciences are no exceptions in their share of this particular ‘social discourse’ of co-production. In order to form an understanding for the relevant policy negotiations and the resulting policies – and to any other emerging technology for that matter, it is therefore necessary to look into what determines innovation policies and the underlying interests that shape the policy outcomes.

There are various sources of innovation indicators available, such as through the OECD (OECD Main Science and Technology Indicators, undated). However, most indicators of economic development and innovation seem to be of a quantitative nature, and do not bring the full scope of innovation and knowledge production into the picture as many of the social aspects, such as the production of social capital and trust as built up through formal and informal networking. The intention here is to put previous research on the governance of nanotechnologies and nanosciences into a more solid context, and then particularly look at the production of said social aspects such as social capital and trust. What role do they play in the formulation of ‘nano’-strategies, and the co-production of knowledge?

### *1.2.2 Measuring the ‘social’*

Measuring or describing the ‘social’ is rather like trying to describe what ‘art’ is. An infinite number of explanations, theories, and opinions could apply. But having narrowed down the search to ‘decision-making’ and particularly looking into discussions and networking among academics, government

representatives, industrial representatives, and invited or engaged civil society organisations - social capital as produced, or not produced, during networking seems an interesting alternative. Social capital is here defined to be the collective or economic value that collaboration between multiple partners such as the ones listed above would amass through their networking. In other words, and as the word 'capital' might suggest, it could, potentially, be used as a measurement for 'the social'.

As will be discussed in Chapter 2, finding appropriate measurements for social capital has proved challenging, but by researching literature as related to the characteristics and measurement of Knowledge-based Economy (KBE), where social capital has been listed as a potentially adequate measurement, a set of questions were found that could serve this purpose for this study. The questions were originally developed to measure the social capital as experienced in local communities, which could suit this study well as the nanotechnologies and nanosciences decision-making environment could be considered a 'community' that sees actors gather to interact around a topic of mutual interest.

### *1.2.3 Research themes*

Going through everything that is said, done, and meant by all involved with nanotechnologies and nanosciences' policy-making in three countries is a very laborious task – hence, it was of importance to impose further restrictions and limitations. A literature review was initiated early on during the project, which took articles, books and other works published before 2008 into account. The idea behind the review was to attempt to flush out potential research themes that would form the basis for research questions. The full review is accounted for in Chapter 2, but the main conclusion was that there were not many empirical research projects (such as this one) done with regards to policy research on nanotechnologies and nanosciences, and definitely none that compared the countries chosen here. Another finding was that very little was said about two of the chosen countries, Sweden and Finland, whereas significantly more work had gone into exploring

nanotechnologies and society in the UK. The lack of information on potential themes that had been brought up in studies into UK nanotechnologies and nanosciences policy rendered Finland and Sweden interesting for further exploration and comparison. Though *either* Sweden *or* Finland could have been compared to the UK, including both Sweden and Finland was interesting due to there being a very well defined national nanotechnologies and nanosciences strategy in place in Finland, while Sweden did not have a strategy or policy at all, despite their many similarities and collaborative efforts in other areas of R&D. One of the themes that were flushed up through the literature search was, for instance, the role of past controversies and how this had an impact on the science communication and public engagement effort that could be seen in the UK as this study was about to begin. Such efforts did not happen in Sweden or Finland – why not? Another difference noted was how articles on regulation and ethics emerged in the UK, while it did not in Finland or Sweden. Indeed, so little emerged in Finland and Sweden on the social and political science side of nanotechnologies and nanosciences that a pilot research study had to be initiated in order to determine which research themes and questions to pursue.

As expected, the pilot study results, also accounted for in more detail in Chapter 2, showed a rather different picture in Finland and Sweden to that in the UK. The mood in discourse was the other way around – risk, regulation and communications were not discussed, while innovation, economics and knowledge transfer were topics that continuously re-appeared. Another interesting finding, that showed a difference between Sweden and Finland, was the reoccurring reference to the lack of a nanotechnologies and nanosciences strategy in Sweden, whereas Finnish interviewees often referred to strategy discussions, though very much focused on innovation and void of regulatory or risk-related discussions or action points. The latter, with the UK focus on risks and regulation makes comparing all three an interesting study. As actual publications on nanotechnologies and nanosciences and society proved scarce, if not downright non-existent in Sweden and Finland, the pilot study was based on a series of interviews and research into the context of decision-making in each country.

In short the study brought forth four more themes of potential interest for further exploration through the of controversy, the lack of science communication and/or public engagement, the perception of innovation and innovation systems, and the lack of strategy altogether.

### 1.3 A Co-productionist methodology

Co-productionism lends itself well to the qualitative research methods chosen for this study. Qualitative methods are used in both STS and Political Science, but more frequently in the former. Political Science does, often – not always, seek to address large questions based on large populations for which quantitative research where independent and dependent variables are clearly defined and all answers backed up by the 'strength of numbers' and comparison with alternative variables easily facilitated. The results are often easier to generalise, than those derived from more in-depth studies of behaviour or decision-making based on qualitative methods. It is simply put more time-consuming to produce large data sets using qualitative methods. Fortunately, however, PhD students are blessed with this one factor – *time*, without which this rather large and incredibly time-consuming qualitative study of decision-making would never have taken place. Though the choice of methods will be discussed further in Chapter 3, the general rationale for choosing the qualitative route is the belief that a quantitative approach would be likely to result in the loss of detail and data. In investigating something as complicated as the decision-making made by individuals from very different backgrounds and contexts that are suddenly brought together, the lack of consideration for elements such as the tacit knowledge produced by research groups in their home environments, would likely expose the drawn conclusions to criticism and questioning. The actual knowledge produced in laboratories or during ad hoc networking situations, for instance, is rarely picked up in surveys, and cannot be translated into figures or numbers.

Using a co-productionist standpoint in describing and explaining nanotechnology policymaking, while also looking into aspects of normativity

and carefully draw predictions for the future, will not provide basis for generalisations. Nevertheless, the findings will be supported by robust conclusions resting on great attention to detail, which in turn will facilitate a fruitful discussions and future predictions.

### *1.3.1 Interviews, interviewees, and questions*

The qualitative way ahead will rest on a set of semi-structured interviews, held with decision-makers in Finland, Sweden, and the UK. Laying the cornerstone to path ahead, Norwegian psychologist Steinar Kvale uses two metaphors to describe the interviewer – that of the *miner* or of the *traveller* (Kvale, 1997:11f). While the miner digs out, isolates, and analyses essential, quantifiable and 'unspoilt' bits of information and knowledge from his or her interactions with the interviewee, the traveller is on a journey alongside the interviewee, discovering their stories, attitudes, and knowledge as they travel along. Rather than considering knowledge as 'given', the traveller leans on a more postmodern constructivist notion of knowledge by which the conversation may not only shed light on pre-existing knowledge or information, but also advance knowledge though discussion and inspired criticism (Kvale, 1997:12). As we shall see, this thesis is very much the 'travellers' study, a notion that proved particularly useful when perceiving the research matter through the spectacles of co-productionists. The reason for this is that the policymaking environment seems as if caught up in the midst of the buzz caused by a new emerging technology. Hence, interviews were being held with interviewees who were still trying to make sense of the situation and the new knowledge and related policy issues raised by the technology. Another issue that made the 'traveller's' task an easier option was that the group of interviewees, spanning over three countries, were anything but homogenous. Their cultural, social-economic, lingual and professional differences demanded a need for flexibility, especially as the *essential and quantifiable* bits of information that a miner would go for were not always apparent or readily available for extraction. The traveller's perspective also lends itself well to the researcher researching co-production in that the study itself becomes co-productionist. As the interviews progressed, the interviews

themselves became part of the ‘social’ as per discourse. The linguistic and cultural differences also quickly ruled out any attempt at the originally intended exclusive use of *discourse analysis* and the searching for words and emphasis on communication process, and lured this traveller into the path of *phenomenography, phenomenology*, and *reflective phenomenology*. More commonly used as means for qualitative analysis within psychological or educational research, these methods allows for the interpretation of meaning, knowledge, and understanding, facilitated through the discovery of regularities, themes, and patterns as discerned during the interaction between the interviewer and the interviewee. This is not to say that the interviews were embarked upon without structure, or pre-existing ideas. As Miles and Huberman (1994) put it with regards to qualitative studies being either too tightly coordinated designs or too loosely structured – *“[t]he solution may well lie in avoiding extremes.”* (Miles & Huberman, 1994:18). The full semi-structured research design and analysis framework will be accounted for in chapter 3, alongside the design for an IPA case study that makes up the phenomenological part of this mixed qualitative study.

So with a semi-structured guidebook at hand and under continuous revision, interviewees and interview questions were identified following initial research in the shape of a literature review – and more importantly in the shaping of methodology: the pilot study. The pilot study was crucial in that it would have been impossible to achieve useful results had people in exactly the same professions been chosen in all three countries, due to the difference in decision-making processes. Looking at those seated around the nanotechnologies and nanosciences strategy table, the line-up was not the same in all three countries, as some of the interviewees, for instance, wore more hats than one, while some hats were represented in one country, but not in another. Their relationship to the themes was also often as different as their relationship to one another, further underlining the necessity for the development of a semi-structured set of research questions. Connecting this with the analysis framework – a conversation had with someone who had been involved with a public engagement exercise related to the funding of nanosciences in the UK, for example, was fundamentally different from a

conversation with someone who did not understand what was meant by ‘public engagement’, in Finland.

An anonymised table of the interviewees, 46 in total, providing details of their institutional alignment in their respective decision-making systems and the year of their interview are provided in chapter 4, 5, and 6. With the very large number of interviews - 42 in total, and each interview taking roughly 1 hour, the extensive amount of material will not be accounted for in the Appendixes. The most relevant parts of each interview will be included in the analysis and results accounted for in Section two and Chapter 8 when necessary.

### 1.4 Demarcation

When embarking on this study and the identification of research questions, a literature review (see 2.2.1) was written based on available materials pre-dating the collection of empirical material 2008-2011. Hence, when writing up this thesis in 2014, more research will undoubtedly have been published related to the questions asked or otherwise in relation to the governance of nanotechnologies and nanosciences. These themes will be brought up within the part of chapter 9 that considers future potential research of interest following this study. The reason not to mix the two reviews is that this study is directly based on what I had read by the time of the first interviews in 2008 when the themes and research questions were being decided upon.

It was also possible to choose between a very large number of countries for inclusion in the study. The reasoning behind going with Sweden, Finland and the UK is three-fold. Firstly, as described above much of the literature actually focused on the UK for various reasons. There was more academic interest here, and with interest follows funding for research, and there had been controversies related to emerging technologies in the past – this while nothing, or not much, was written in Finland and Sweden, nor has BSE or GMOs been met the same way in either country, when compared to Britain. There was controversy over nuclear power, and even a referendum on the topic in Sweden in 1980, but this past experience still yielded no results when

searching for articles related to the responsible development of nanotechnologies and nanosciences. Secondly, the lack of empirical studies into the mode1/mode2 thesis – a study that was initiated through a grant from the Swedish Research Council, made this study of even more interest. Being a native Swedish-speaker with Finnish as a second language made the choice of countries feasible. And finally, at the very beginning of the study it seemed as if there was much public interest for nanotechnologies and nanosciences in the UK, while nothing happened with regards to public engagement or news stories in Finland leaving the public seem entirely disengaged. Nanotechnologies and nanosciences seemed to have hit a level of 'medium' public interest in Sweden as there had been some events related to technologies and sciences on the nanoscale as arranged by VA - Vetenskap och Allmänhet (Public and Science). However, as the field study conducted in Sweden eventually showed, there were not much public interest at all for nanotechnologies and nanosciences in Sweden.

## Chapter 2: Theoretical mapping and research questions

*This chapter will lay the theoretical foundations for the study by discussing the theoretical focus that has triggered the research question, and the literature review and pilot study that, in addition to the theoretical focus, influenced the choice of research themes and interview questions. The chapter will end with a section that aims to tie up the theoretical focus for the thesis, which will be referred to in the empirical chapters and the conclusions.*

### 2.1 Theoretical framework and mapping

This study seeks to investigate the governance of science and the 'reality' within which emerging technologies and scientific fields generally are governed by exploring the governance of the emergence of nanotechnologies and nanosciences in particular. The actors here assumed to take part in the governance of nanotechnologies and nanoscience, e.g. the scientists, public officials, industrial and corporate representatives, and NGO representatives interviewed for this study, operate within their own realities – each of which could have been equally interesting to study by themselves. Questions could be formed along the lines of: 'How do electrical engineers relate to discussions concerning health and safety and regulation within nano-fabrication and manufacturing, in comparison to chemical engineers'? Or, "how do industrial actors frame the perceived risks versus the perceived innovative gains of nano-fabrication and manufacturing"?

This study is, however, more interested in the space where realities meet to form (or often failing to form) a sense of 'collective' reality.. Though often called *modern* or even *post-modern* in discussions related to the mode1/mode2 theses, knowledge-economy, and knowledge-society, there is little novelty about 'collective reality' as scientists have never been entirely secluded from other actors. Governments, wealthy monarch supporters, industrialists, or other financially and legislatively powerful actors, have all been interested in reaping the fruit of the labour of science. The office of Astronomer Royal, established by King Charles II in 1675, was, for instance, not merely meant to advance our understanding of the stars and their positions, but also *"so as to find out the so much desired longitude of places*

*for the perfecting of the art of navigation."* (The Official website of the British Monarchy: 2014) The art of navigation was crucial to Britain's prominence as a seafaring nation, and consequently, the building and maintenance of the British Empire beyond the British Isles. Apart from their own individual reality, the King and Astronomer Royal most probably met in a collective reality that could be considered 'common ground'. Their perception of that 'common ground' are likely to have differed greatly though, depending on their very different identities, values, and concerns. Understanding the reality within which both of these potentially differing interests figured is important in order to understand the development of both the basic and applied science taking place within, outside, and above the Office of the Astronomer Royal.

More than three hundred years later this assumption remains: in order to understand how academics, researchers, government officials, industrial representatives, or NGO or civil society organisations, who take part in decision-making processes relate to nanotechnologies and nanosciences, perceive their roles in such decision-making contexts and the discussions themselves or any part of them, one needs to understand the reality – or common ground, within which interaction takes place. The matter is here approached using a combined effort between political science and science and technology studies, where scholars have had plenty to say about the reality of knowledge production as can be related to decision-making, or decision-making in a knowledge-informed or focused reality.

*2.1.1 Modernity, new knowledge, and the new production of knowledge*

As for political science, it is rare for established political parties to produce election manifestos without including a reference to 'knowledge' or the need to invest into the future, encourage innovation or otherwise support financial growth, or support learning and education and support the production of knowledge. Assuming they win elections, when the same parties form a Government, they are likely to dedicate at least one Minister to science, innovation, Higher Education, or with such a portfolio under a less obvious name, whose task it will be to overview the investment into the creation of

more knowledge to feed the economy and financial interests of the nation. The 'reality' has been called *knowledge society* (UNESCO: 2005), or *knowledge society* and *knowledge economy,* as discussed by the European Council in 2000 in their devising of the Lisbon Strategy that sought to highlight economic growth and jobs for the 10 years ahead (European Council: 2000). *Information society*, which is also included in the Lisbon Strategy, is an earlier term also used to describe a reality where information is considered key to economic, social and cultural achievement (Webster, 1995), but, the concept was later critiqued by Webster for being unsatisfactory term as there is little clarity with regards to what makes an information society; the use of the term information is imprecise; and he finds the tendency of Information Society theorists to assume that quantitative increases in information results in qualitative effects with regards to social changes, insupportable (Webster 2002). Another critic was Manuel Castells, a sociologist who – though he admits to having used the term (Castells, 2000:10), championed another term *network society* (Castells, 2000, Castells & Cardoso (Eds) 2005), and Castells, 2006). Claiming that knowledge and information have always existed and been important, Castells boils down the novelty of modern uses of it to a change of technological paradigm, with the advancement of microelectronic-based, information or communication technologies and genetic engineering (Castells, 2000:9-10). However, none of the interviewees interviewed for this study, or the policy documents reviewed, paid significant attention to either information society, knowledge society, or network society as concepts on which to peg 'reality'.

Instead, moving beyond the notion of 'society' and into the part of political science's dictionary more specifically targeting desired policy outcomes (e.g. such as economic gain) through policy choices, the knowledge-based economy (or KBE) has been given more attention by both interviewees (in two countries) and policy-documents. It also resonates more closely with theoretical works within STS, as will be shown when the mode1/mode2 thesis (Gibbons et al. 1994), Strategic Science (Rip, 2002 & 2004), and the co-production of knowledge (Jassanoff et al, 2004) is discussed in section 2.1.2)

*2.1.1.1 A knowledge-based economy*

The literature on innovation and innovation policy is substantial to the point of it being difficult to navigate through, an opinion shared with Jan Fagerberg in his guide to literature on innovation (Fagerberg et al. 2006). A multitude of different concepts are to be found under its many branches, and KBE could be considered a relatively recent addition.

In the early to mid-1990s the concept of KBE, was, Godin argues, intended to make up for the limitations of a concept that preceded KBE as 'concept-of-the-day' within macroeconomics: National Systems of Innovation (NSI) (Godin 2006:17-18). There are numerous definitions of NSIs, depending on whether the definition rests on institutional analysis or the more theoretical focus on knowledge and the learning process (Godin 2006:18). The definition used here leans towards the latter, according to which a NSI is *"constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge…and are either located or rooted inside the borders of a nation state"* (Lundvall 1992:2, OECD 1997, also cited by Godin, 2006:18). The limitation in this and other definitions is, according to Godin (2006:18), the lack of suitable statistical indicators for measuring *"…the dynamic system of knowledge development and acquisition."* (Godin 2006:20, OECD 1995). Or, in other words, knowledge production – as it is often called in STS.

The need for a more suitable concept resulted in the 'knowledge-based economy'. Though the subject of debate, one 'systematic definition' that has been repeated continuously by the OECD – a research think tank that feeds policy-makers – claims KBEs are "*economies which are directly based on the production, distribution and use of knowledge and information."* (Godin 2006:17 OECD 1996:7) However, with regards to measuring the concept, though new datasets were collected (by OECD for instance) and set up into new constellations that were more appropriate for measuring KBEs, Godin argues that the OECD in selling new types of statistical products make use of existing information rather than producing new data and designing new surveys (Godin, 2006:22). Moreover, the indicators included focus primarily

on the production of knowledge rather than the diffusion and distribution of it. Hence, Godin concludes, the KBE is simply a rhetorical concept.

Nevertheless, rhetorical concepts are used and do influence decision-makers and in turn science and innovation policies, and – in the light of this study, the reality within which such policies are created. As Godin puts it, the KBE-concept is intended to make policy-makers more interested in science and technology issues and relate them to the economy (Godin 2006:22). A large set of statistics to go with any concept gives it a level of credibility, which decision-makers may transfer towards credibility for their policy decisions.

Measuring diffusion and distribution of knowledge that may be compared between countries (which OECD seek to do), is both expensive and time consuming. A conclusion also drawn by Fagerberg and Srholec when analysing the capabilities in economic development with the objective to investigate the reasons for differences in economic development between countries (Fagerberg & Srholec 2008). Fagerberg and Srholec identified four different types of capabilities, listing the development of the “innovation system”, the quality of “governance”, the character of the “political system” and the degree of “openness” of the economy (Fagerberg & Srholec 2008:1418) for analysis. However, though the innovation systems and governance were shown to be of importance for the level of economic development, they had to exclude the social aspects of governance – such as social capital – from the governance variable, despite noting their potential importance, due to the lack of quantitative data and surveys measuring social capital (Fagerberg & Srholec 2008:1421). Further, though the objective was not to explore the distribution and diffusion of knowledge, per se – the production – or as they put it, the ability to develop and exploit knowledge for commercial purposes, was partially included under the concept of ‘technological capability’. However, it is a likely assumption that had commonly accepted useful indicators of diffusion and distribution existed; a broad study on economic development would be likely to include them.

*2.1.2 'Reality' for nanotechnologies and nanosciences policies*

The KBE concept sets a backdrop for the way in which OECD and also other international organisations, and governments that receive information from institutions like OECD, perceive the reality within which strategic goals for the future and economic prosperity operate. There is something new or at least an attempt to achieve new thinking or revival behind every buzzword. Modern or new realities are likely defined as modern or new due to their following on from something old-fashioned or old. The shift, real, perceived, or partially real, has been much discussed within Science and Technology Studies, where emphasis has also been on the opening up of science and knowledge production, and not limited to the space for knowledge in society, governance, or other 'non-academic' contexts.

The thinking and theorising behind the potential shift has influenced this study through the general lack of support through empirical data to support theory. From an STS-theoretical point of view, the most interesting lines of thinking have been pinned down by Gibbons and Nowotny et al though the mode1/mode2 theses (Gibbons et al. 1994, and Nowotny et al. 2001), Arie Rip through his thoughts around Strategic Science – especially as he considers nanotechnologies and nanosciences a potential example of a shift towards Strategic Science (Rip, 2004), the Triple Helix model that brings academia, industry, and government together (Etzkowitz and Leydesdorff, 2000), the thinking behind Jasanoff et al.'s co-production of knowledge (Jasanoff et al., 2006) where science and society outputs are produced alongside one another.

*2.1.2.1 Mode1/Mode2: The new production of knowledge*

The new production of knowledge (NPK), also referred to as the mode1/mode2 theses, was written by a group of six authors in 1994 – here referred to as Gibbons et al for all references to their 1994 book The New Production of Knowledge, and Nowotny et al. for references to the sequel that a part of the group wrote in 2001, called *Re-Thinking Science: knowledge and the public in an age of uncertainty*. The authors aimed to describe what they considered a shift in knowledge production towards a more 'socially

distributed' system from Mode1 – which was intended as a phrase that would summarise the more old fashioned, or 'Newtonian' way in which certain cognitive and social norms had to be followed within scientific practice in order to be considered knowledge production (Gibbons et al. 1994:2-3). Its features are identified by their contradictions, listed as the five main elements of Mode2 knowledge production: production of knowledge in the context of its application, transdisciplinarity, heterogeneity and organisational diversity, emphasis on social accountability and reflexivity, and the need for quality control that go beyond the quality control offered by peers when they review or criticise the work of colleagues (often of the same disciplinary background). Quality review here also refers to questions related to the social, cultural, and economic quality of research (Gibbons et al., 1994:3-8). By knowledge being produced in the context of application, the authors mean that the production line had moved out of traditional scientific institutions and institutes such as universities, governmental research institutes, and academies, into a more heterogeneous environment where, Hessels and van Lente adds, there is less need for knowledge transfer (Hessels & van Lente, 2008:741). The applied, heterogeneous environment further encourages transdisciplinary approaches to knowledge production, corresponding to *"a movement beyond disciplinary structures in the constitution of the intellectual agenda, in the manner in which resources are deployed, and in the ways in which research is organised, results communicated and the outcome evaluated"* (Gibbons et al. 1994:27). The quote hints at the third element of Mode2- that of organisational diversity and heterogeneous practice. Not only is knowledge production taking place elsewhere than merely within academia but, argue Gibbons et al. it is also taking place in collaboration between a diverse set of actors who are linking together in novel ways and with more flexibility than before within new societal contexts (Gibbons et al. 1994:6). Finally, the inclusiveness and the importance of the context of application for new knowledge production feeds a need for social accountability and reflexivity in that more insight into the way in which knowledge is developed, or knowledge itself, is likely to produce an increased need for transparency and accountability with regards to the consequences of knowledge production, for instance.

By this token, chemists, biologists, engineers, and cognitive researchers could be expected to get together, perhaps with input from industrial partners and civil society, to develop the science necessary to solve problems identified within their 'Mode2' reality – or context of application. Indeed, this seems a rather likely 'fit' for nanotechnologies and nanosciences.

The 'sequel' to NKP*,* Nowotny et al.'s *Re-thinking Science*, was written as a follow up of the previous book (Nowotny et al. 2001: viii), and – as pointed out by Hessels and van Lente, can be considered a response to the critique received for *The New Production of Knowledge* (Hessels & van Lente, 2008:742). Indeed, the first chapter of the book gives some background to the criticism received (Nowotny, 2001:1-4), though, in their systematic review of the Mode2 notion, Hessels and van Lente provide a more substantial list of criticism. Their review, which included more than 1000 articles that cited NPK, particularly picked up on criticism with regard to the descriptive or empirical validity of the concept, its theoretical strength, and its political value (Hessels & van Lente, 2008:750).

With regards to the empirical and descriptive validity of the Mode2 shift, Hessels and van Lente account for criticism with regards to the lack of stability in the concept of context of application (Weingart, 1997), that the distinction between basic and applied research has never existed in a clear cut fashion (Godin, 1998), and Hicks and Katz (Hicks & Katz, 1996) bibliometric test of claims with regards to the growth of networking and collaboration made in NPK, which is an argument also discussed in the Re-thinking of Science (Nowotny et al. 2001:4), but find little to contradict NPK at this point (Hessels & van Lente, 2008:750). The NPK claims of greater transdisciplinarity and Heterogeneity, have been criticised by Godin (1998), who criticises the distinction of disciplinary and interdisciplinary research and Weingart (1997), the latter of whom additionally pointed out a difference between the intentions of specific programme-based research calls and the actual research and where it takes place, *"[i]n the best case, the different research results are referred to one another in the end. In the worst case, the transdisciplinary program titles, formulated for purposes of political legitimation with specific*

*contexts of application in mind, camouflage normal disciplinary research"* (Weingart, 1997:598 – referring to Weingart et al., 1990). Further, the extent of heterogeneity is being contested by Godin and Gingras (2000), Weingart (1997), Tuunainen (2005)[1], and Hicks and Katz (1996), but Hessels and van Lente does not find arguments compelling enough to fully contradict NKP-claims with regards to either Transdisciplinarity or Heterogeneity (Hessels & van Lente, 2008:751). While the notions of reflexivity and social accountability receive less attention by critics, quality control is more contested a concept, (again, Weingart, 1997 and Godin, 1996 have opinions on the matter, Hessels & van Lente, 2008:752); the uniting factor is that further empirical investigation is called for with regards to all three concepts (Hessels & van Lente 2008:752).

It is not a surprising claim as neither Gibbons et al. nor Nowotny et al. based their conclusions on an empirical study. Further related criticism relate the generalisation implied by Gibbons et al. in their description of a Mode2 shift, with particular emphasis on how it should not be generalised to all scientific disciplines or academic research generally (Weingart, 1997; Godin 1998; Albert, 2003; and Shinn, 2002; referred to by Hessels & van Lente, 2008:753). Terry Shinn's argument is particularly important to this study as he claims that NPK does not take national settings into due consideration, and that national science policies are of much importance to R&D taking place within national borders, despite globalisation and increased cross-national interaction and collaboration. (Shinn, 2002:610). Tuunainen has made a similar pointer towards the importance of the local setting within which research takes place (Tuunainen, 2002). Shinn would rather see a move away from the 'either/or scenario', into one where both global and national systems and contexts are considered (Shinn, 2002:611). A third line of criticism regarding the descriptive and empirical value of NPK lies with the previously implied historical perspective, in that Mode2 is claimed not to be a novel state of knowledge production (Rip, 2000; Etzkowitz and Leydesdorff, 2000; Pestre,

[1] Juha Tuunainen's article is of particular country specific interest too as it describes the challenges to transdisciplinarity and heterogeneity in a Finnish University department. One of the four conclusions reached was that the organizational structure in place did not facilitate transdisciplinarity.

2003; accounted for in Hessels & van Lente, 2008:753). As in the example of the Astronomer Royal and understanding the movements of the heavens in addition to getting Royal ships across the seas in the right direction, science has tried to answer difficult but practical questions for a very long time.

Though Nowotny et al. claim that NPK was never intended to serve as a social theory (Nowotny et al. 2001:3), the second set of criticism accounted for in Hessels and van Lente's review touches on exactly that. Both Rip (2002b) and Godin (1998), do not consider all 5 elements to constitute a 'whole' Weingart (1997) adds that he finds all elements bar quality control only to exist in policy-relevant research (Hessels & van Lente, 2008:753). Finally, Shinn criticises NPK for its lack of consideration for sociological theory with regards to the claimed shift from Mode1 to Mode2 in time (Shinn, 2002:611) – criticism that Hessels and van Lente do not consider entirely fair, especially as the Re-thinking Science effort of Nowotny et al. does attempt to dwell further on sociological theory, and the social (Hessels & van Lente, 2008:754; Nowotny et al. 2001:3).

The third theme among critics of NPK is, according to Hessels and van Lente, related to the political value of the concept, which may be linked to criticism related to its descriptive and empirical limitations as Shinn, for instance, calls NPK a political commitment rather than a theory presenting data (Shinn, 2002: 604). Overall, critics seem to consider NPK a programme or a prescriptive framework, rather than the descriptive tool they (seem to have) expected (Godin, 1998; Weingart, 1997; in Hessels & van Lente, 2008:754).

Hessels and van Lente has done this study a great service in offering a summary of critique, especially as the number of articles discussing NPK between 1994 and 2007 added up to over 1000[2] (Hessels and van Lente,

[2] Though it would have been interesting to repeat the Scopus search for the years between 2007 and 2014 to get a more accurate figure, it is not possible to replicate the search without knowing the exact search terms. An attempt at repeating the Scopus search on 8 July 2014 resulted in less articles than 1000, when using the terms 'New Production of Knowledge' AND 'Mode2'. For the first term only, 13941 articles were found, but many of them proved irrelevant.

2008:741). Apart from offering an insightful backdrop to the 'reality' this study seeks to capture, their review is also suggesting a research agenda, and with the empirical nature of this thesis, their call for further empirical study of the concepts that are contested and criticised is rather tempting. It is in this light, though without making the proving or disproving of the Mode2 shift a primary objective, that the research questions, themes, and direction of this piece of research have been formulated and sought out.

Published at the time of the formulation of the research questions for this study, the review has also been more important to this study than articles subsequent articles. Interestingly, however, an unspecified number of the original authors behind NPK, the Re-Thinking of Science, and other scholars met at Noors Slott, Sweden, in 2011 to reflect on the ideas developed in the aforementioned books. Reflecting on the proceedings in their article following the event, Michael Gibbons, Camille Limoges, and Peter Scott, identify the most generic line of criticism to be that of the lack of evidence for NPK (e.g. empirical evidence) (Gibbons et al. 2011:361). The authors conclude by stating that they do not believe anything was overlooked, except possibly the strength of major traditional institutions of science and knowledge (Gibbons et al. 2011:371), in so far as academic institutions to a large extent remain embedded in Mode1.

#### 2.1.2.2 Strategic Science

Though they published a review article in 2011 regarding NPK, Gibbons et al. do not mention many alternative theories to NPK – however, they do mention that of Strategic Science, and particularly Arie Rip's contribution (Gibbons et al. 2011). The authors do, for instance, call for further research into the regime change from basic science to strategic science (Gibbons e al. 2011:371), and commend Rip's analysis in that it, in their view, is further highlighting the relevance of the notion of Mode2.

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Using both terms, the result was limited to 693 articles, which is less than the number recorded by Hessels and van Lente, and therefore a questionable result.

There are quite rightly some significant similarities between the Mode2 notion and Strategic Science. Strategic Science is, to Rip, a regime where basic science gives room to the development of science that is relevant to academics, industry, government, and to society as a whole (Rip, 2004:157-158, and as referred to by Hessels & van Lente, 2008:744[3]). *Strategic Science* is nothing new, argues Rip, rather *strategic research* has been discussed since the 1970s as a term to signify applied research with a long-term perspective, combining *relevance* and *excellence* to inform and implement strategy (Rip, 2004:155). Pointing towards Irvine & Martin's work on strategic research (Irvine & Martin: 1984:4) and Vannevar Bush's 1945 Report to the US President that underlined a shift towards relevance in science, Rip makes the case for strategic research actually being *basic* – or *excellent* - research that has a strategic aim – e.g. it is *relevant* (Rip, 2004:156). The so-called 'shift' from Mode1 to Mode2, Rip argues, is far from clear-cut; in fact, the modes overlap (Rip, 2004:156). Hessels and van Lente agree with Rip in saying that, Irvine and Martin's contribution is different from Mode2 reasoning, in that the Mode2 shift foresees a reality where the distinction between basic and applied science has disappeared – while there is overlap rather than a loss of one or the other (Hessels & van Lente, 2008:743).

In describing Strategic Science and putting it into a modern context, Rip discusses innovation and the move away from a linear model of innovation to a lateral model, *"(…) where innovations and their effects on wealth creation and quality of life are not limited to a linear innovation chain"* (Rip, 2004:157). Innovation oriented and expertise and decision-oriented strategic research, Rip argues, see innovations and their impacts originate from new, lateral connections, and increasing social and intellectual mobility of key actors involved with innovation, research, expertise, and strategic decision-making (Rip, 2004:157). This line of reasoning chimes well with one of the five components of Mode2 as outlined by Gibbons et al. (see above), namely 'organisational diversity'. Further, Rip argues, the need for relevance and the

increased involvement of various different actors in decision-making, innovation, and research opens science up for public scrutiny. Calls for new modes of accountability and interaction sees scientists (eager to secure both credibility, trust, and funding) become increasingly active through press conferences, social media, and otherwise make and maintain connectivity with society than before (Rip, 2000:34). This latter point is quite similar to that made by Gibbons et al. with regards to social accountability as a factor in a Mode2 world.

Rip's bringing in decision-making into the discussion is very interesting for this study, as it opens up a door for the STS-Political Science orientation that this study actually adopts – and because it, in addition to his reflections regarding lateral innovation, connects well with the move from NSI to thinking around KBE and a re-modelling of innovation systems. The theoretical connection aside, it is also interesting as Rip actually gives nanotechnology as an example of a scientific field to which the Strategic Science regime could apply (Rip, 2004:158). There is, Rip argues, a very important role for scientific expertise in decision-making under uncertainty, and a push for 'sound science' (Rip, 2002:103, 2004:156), a point which many interviewees interviewed for this study – in all three countries, made frequently.

#### *2.1.2.3 Triple Helix, Post-academic science, and the co-Production of Knowledge*

Many of the scholars, other than Rip, who have offered critique towards the Mode1/Mode2 framework, have offered other ways of describing modern knowledge production, or the assumed 'shift'. Though accounting for all of them go beyond the scope of this study, three additional lines of thinking have been helpful in designing and developing the theoretical alignment of this thesis.

*The Triple Helix model*, as described by Henry Etzkowitz and Loet Leydesdorff, for instance, aims to capture the increased interaction and merging between Academia, Industry, and Government, which in at its most

interactive form creates tri-lateral networks and hybrid platforms and organisations (Etzkowitz & Leydesdorff, 2000:111-112). The objective here is, they claim, to create innovative environments where university spin-offs, tri-lateral initiatives for knowledge-based economic development, and strategic alliances, government laboratories, and research groups meet (Etzkowitz & Leydesdorff 2000:112).

As Hessels and van Lente points out, Triple Helix model is not a theory or making a descriptive claim (Hessels & van Lente 2008:747-748), rather it is a research programme that has generated a number of articles, its own Association (The Triple Helix Association, chaired by Henry Etzkowitz), and a conference series.[4] It does, however, fit reasonably well with the Mode2 thesis, and perhaps especially with regards to the element of transdisciplinarity. The Triple Helix was also mentioned in interviews by some of the interviewees themselves when discussing the interaction between academia, industry, and government.

*Post-academic science*, as researched by John Ziman, is a framework that is not entirely out of line with NPK, but its main elements, or forces, are more directed towards the financial aspects of science and knowledge production. Outlined in two bodies of work, *Prometheus Bound* (Ziman, 1994) and *Real Science* (Ziman, 2000), the essential forces of post-academic science can be summarised as being; increased collaboration among scientists and researchers, and the consequential increased transdisciplinarity in research; the size and expense of science, which has grown larger over the centuries, and has become too expensive to fund using traditional – often governmental means; the increased emphasis on the need for 'value for money' and stating the utility of the knowledge produced; the strife and competition for funds often replaces the competition for scientific credibility and research groups move more towards money-making than before; and, finally, the academic-industrial ties have strengthened as other sources of funding have lessened (Ziman, 1994; Ziman, 1996; Ziman, 2000; also accounted for by Hessels &

[4] The website of the Triple Helix Association, available online: http://www.triplehelixassociation.org/ [08/05/14]

van Lente, 2008:746). Ziman also criticises the Mertonian norms, by which Robert Merton argued that science was governed, e.g.: communalism, universality, disinterestedness, originality, and scepticism (Merton, 1973:pp 267-278) in that the changes that have caused and fed the post-academic world is, according to Ziman, rendering Merton's CUDOS out-dated in favour of principles related to the sociological features of 'contemporary' academic research (Ziman, 1996:68).

Ziman's 'value for money' argument is interesting in that it seems to suggest a need for 'relevance' as described by Irvine & Martin and Rip, above, and also that the endorsement of other stakeholders than academics and scientists themselves is an important factor in contemporary research. Hence, public scrutiny and social accountability could be forces in play within Ziman's Post-Academic world too.

Finally, *the co-production of knowledge* is labelled an idiom by Sheila Jasanoff rather than a theory, in that it does not aim to provide prediction, but a framework through which to interpret complex phenomena in a way that will be as inclusive as possible (Jasanoff in Jasanoff et al., 2006:3) and more tractable and thereby encouraging dialogues with other frameworks for political and social enquiry (Jasanoff et al., 2006:37). Aiming to avoid the technoscientific and social determinism of science, the authors seek to highlight the intertwined relationship between scientific methods and the social context within which science and knowledge exists (Jasanoff et al., 2006:3 & 20). The 'reality' here would suggest that neither is superior to the other, and that they, in their equal state, the domains of nature, facts, objectivity, reason, policy, and culture, values, subjectivity, emotion and politics, should not necessarily be separated from one another either - as opposed to realist ideology (Jasanoff et al. 2006:3 & 20) The main objectives of the idiom are fourfold and listed as being *description* – of science in society, and vice versa; *explanation* – for the co-productionist disregard of linear models of scientific progress; *normativity* – in researching and analysis emerging orders of knowledge production; and *prediction* – in that it aims to predict such orders and set out a plan of action (Jasanoff et al. 2006:275-

282). Jasanoff et al. do not discuss the Mode2 shift nor do they seek to offer critique to Gibbons et al. or Nowotny et al.'s discussions. Though the authors do not pay particular attention to the process of knowledge production per se, their contribution is of interest to this study both as the co-productionist idiom seems a fit in a Mode2-Strategic Science world that relies on increased engagement and transdisciplinarity, and because the first two objectives of the idiom fit well with its research aims. The rejection of a linear model of scientific progress is also of interest in the light of Rip's rejection of linear innovation. It is worth noticing that Jasanoff did not aim to look at all of science in quite the same way as Gibbons et al. however. Whether or not this piece of research will be able to offer insight into the *normativity* by which nanotechnologies and nanosciences policies are co-produced is less certain, while *prediction* with all certainty will not be reflected upon here.

### *2.1.3 Operationalisation and research question*

The authors of NPK, KBE, and the other theories, framework or idioms explored here offer a range of features to explore further, though they do not necessarily offer insight in how to measure a Mode2 switch, Strategic Science, or the features of co-production. Indeed, it would be interesting to explore all listed features of NPK, e.g. context of application, heterogeneity, transdisciplinarity, accountability, and quality control, in relation to decision-making, but this would make this a much larger study than intended. Instead, the choice of features needs to be made on the basis of the research question, what is possible within the remit of this study, what themes emerge out of the literature review and pilot study, and the provision of credible measurements.

As for the literature review and pilot study that are accounted for in the second half of this chapter, the features out of the five Mode2 indicators listed above that seemed interesting to look into were 'organisational diversity' or heterogeneity, social accountability, and quality control. They were all also entirely or partially chosen with Rip's Strategic Science thinking in mind. With regards to what was possible to do, quality control was excluded due to the

complexity in producing the right interview questions and finding interviewees that might be able to answer them in all three countries. As for the research question, how to capture a part of an assumed novel way in which to conduct science governance and looking at both organisational diversity and accountability, it became interesting to explore how actors – assuming that they were included in policy-making, related to their own role and that of others. The following question was therefore produced:

*How do decision-makers perceive their own roles and the roles of others in nanotechnologies and nanosciences policy discussions?*

At its core the question asks how those involved (e.g. academics, politicians, government officials, industrial and corporate representatives, civil society organisations, and anyone else who may be expected to sit around the table) deal with the assumed shift that a co-productionist would assume have occurred in a policy-making setting, and not solely in labs or nanofabrication facilities. A transdisciplinary gathering of experts is likely to meet, how do they get on? And do they trust one another and are they 'equal' enough for everyone's voices, concerns, and opinions to be heard during complex policy-discussions? The question as generic as it is broad, could be explored with regards to a number of different research-themes, but as the novelty and the reception of such novelty of a new technological advancement is of interest, it has been narrowed down to incorporate a 'subordinate clause', which is also supported by the literature review through adding:

*(…) particularly in relation to the balancing of promotion and regulation*.

Using the potential differences in organisational diversity and social accountability as a means to create a background through which the question is perceived also lends the 'level' of organisation diversity and social accountability explanatory power with regards to explaining the variations, if any, in the responses to the research question. This does, however, depend on finding a reasonable way to measure organisational diversity and social accountability.

Looking at what to measure becomes interesting here, or rather, how to measure interaction or at least explore it qualitatively. A concept that does come to mind is that of social capital, which was disregarded by Fagerberg and Srholec above due to the lack of quantitative measurements of the social aspects of governance, to which social capital belongs. The definition of social capital as used here is that it is the collective or economic value that collaboration between multiple partners such as academia, industry, government, and others involved with decision-making as related to nanotechnologies and nanosciences policy nationally in the three countries, would amass through their networking. The resource can be measured as trust, community and shared values, for instance. In other words, and as mentioned in the last chapter, the word 'capital' might suggest, it could, potentially, be used as a measurement for 'the social'.

#### *2.1.3.1 Trust and social capital*

Albeit STS scholars have not discussed the term "social capital" per se, the essence of it has been discussed by, for instance, Harry Collins, in his work related to tacit knowledge, scientific networks and networking (Collins, 1974). When investigating and discussing the 'social circles' of scientists and referring to the writings of de Solla Price (1963) who connected social circles to the notion of 'Invisible College'[5], and Mulkay (1972) who called scientists' social circles *"the social location of distinctive sets of 'technical and cognitive roles'"* (Collins 1974: 166), Collins suggests that they are characterised by "*the greater density of relations between its members than between members and non-members"* (Collins 1974:166). Some relationships are more significant than others, and finding such networks of relations depend on the methods used to search for them. Collins notes that empirical research can

[5] Historically, the invisible college was a predecessor to the Royal Society (UK) within which a group of the UK intelligentsia gathered to share ideas and their research with one another, without clearly defined organisational structures. The term, as it is used here, refers to later work by Crane and de Solla Price within the sociology of science, merging, in Collins' words, the sociology of science and information science (Collins 1974:166). Collins argues that the information science approach does not take the sociological discourse regarding the boundaries of networks, or tacit knowledge, into consideration as the 'groups' are defined by the information flows running within and between them rather than the actual nature of the group and what it does or perceive itself to be by all members of the group (Collins 1974: 167).

but identify the existence of operationalisations of a relationship, not the actual relationship itself (Collins 1974:166), meaning that the true nature of a relationship is visible to its subjects alone, and cannot be passed on, objectively, to an observer, phenomenologists would partially disagree with this Collins, as will be discussed in Chapter 3. That said, it is likely that the actors involved in a relationship interpret it differently to other actors with whom they share the relation, which may be due to underlying personal interests, hierarchical position, their varying socio-economic circumstances, etc. Collins, when discussing Crane and the use of quantitative methods such as surveys puts emphasis on the tacit knowledge that comes with interaction. Questionnaires do not, in Collins' view, take the intangible cognitive influences that come with group identity into consideration (Collins 1974: 167). The rules that surround human interaction, be it between scientists or other actors, go beyond what has been pinned down in the descriptions of organisational structures or the terms of references that come with a research position and may be impossible to define. Collins gives the example of the symbol 'x' which may be used in various different ways by mathematicians, who, depending on the context, would know what kind of x they are discussing (Collins 1974: 167-168). The term 'nanotechnology' may likewise be used by scientists, politicians and other actors alike, though they may speak of completely different things. Whereas a biochemist may rather use a more specific term that is related to their research, on creating cilia through nanoscopic polymer structures, it may not be what another scientists working in the lab next door has in mind when he/she is discussing 'nanotechnology' – nor may it be what a decision-maker has in mind when discussing the allocation of research funding.

Social capital, as a concept, fits well with Collins' discussion, and received a lot of attention in the 1980s and 1990s, particularly within sociology, political science, and civic engagement. Though it, as a concept, did not seem to generate much attention within the STS community of scholars, the increasing focus on public engagement with science and technology, for example, is a good argument for paying more attention to the notion social capital.

With many more researchers contributing to the broad study that is social capital, John Field particularly mentions "three central founding theorists of social capital" (Field 2008:1), standing out for their somewhat differing contributions, as being Pierre Bourdieu (1983), James Coleman (1988) and Robert D. Putnam (2000). Comparing the three, Field (2008) notes that while Bourdieu took an essentially Marxist stand point through which social capital was perceived as another means for the powerful elite to secure its prominence by networking, Coleman opted for a more optimistic view by not taking the potential misuse or abuse of social capital into account in focusing on the functions of social capital and by arguing that all groups is society would benefit from it (Field 2008). E.g. Coleman claimed that all entities would contribute and cooperate to their mutual advantage, and thereby he dismissed the more realistic notion of a power struggle where actors seek to fulfil their goals and nurture their interests, which may be done at the expense of 'the common good' should it be necessary. Entering the discussion ten years later, and building on Coleman's work, Robert D. Putnam in his much-cited book *Bowling alone*, interpreted social capital to be a 'value' or 'output', of social networking and the norms of reciprocity and trustworthiness within networks and between individuals that make part of them. Hence, social capital is related to 'civic virtue', which is the most effective when embedded in social networks. The result, of such networking, is increased individual and collective productivity (Putnam 2000). Putnam compares this to human capital[6], for instance, through which a college education boosts productivity. Not only did Putnam draw on a wide variety of theory and write for a wide audience, he caught the public mood in the United States at the time, while, more importantly, basing his writing on broad, in-depth, empirical research on social capital in the US (Smith, 2007). Putnam's interpretation of social capital satisfies the criticism of both Bourdieu and Coleman in that it does not exclude the potential for abusing social capital to one's own advantage and for the sake of maintaining or improving the power balance, while it does allow

[6] Human capital, like the Knowledge-Based Economy and NSI, has also proven difficult to measure quantitatively. It is mainly measured through indicators such as GDP, literacy, figures for employment, mortality rates etc., which does not take social interactions fully into account but rather centre on the properties of individuals, as Putnam puts it (Putnam 2000).

for a broader scope than what Bourdieu envisioned by including social entities from all segments of society.

Apart from within academic circles, the social capital concept has been taken up by various international organisations, such as the World Bank, the OECD, and the UK Office for National Statistics has, for instance, developed an online guide for social capital[7], outlining the use of social capital as a quantitative measurement and underlining and its effects on various societal issues in Britain such as crime, housing etc.

As for social capital in a science and technology governance, Woolcock and Narayan, when discussing it in relation to economic development, claim it aids in bridging the divides between scholars, practitioners and policymakers (Woolcock and Narayan 2000), and hence, facilitates the cooperation and dialogue between them; it could therefore be a considered bridging element between academia, industry and government within a Mode2 context. Indeed, such cooperation, or 'transdisciplinarity' as Wiek et al. choose to call it, is essential, not only for the creation of knowledge in a contemporary society, as the theories, frameworks, and idiom discussed earlier in this Chapter seem to agree on, but also for sustainable governance (Wiek et al. 2008) – which, in turn, relies on both formal and informal arrangements (Kemp et al. 2005). There seems, with this in mind, to be ample support for the potential use of social capital as a measurement of nanotechnologies and nanosciences policies and governance.

When conducting an on-line search for suitable approaches towards social capital for this study, a search for 'social capital' and 'New Production of Knowledge', 'social capital' and 'Mode2', and 'social capital' and 'knowledge-based economy' turn up very few results when used as keywords, so this study has stretched a bit further in order to find relevant literature. The discussion below is based on 'social capital' and 'economic development' as

[7] Office for National Statistics, available online: http://www.ons.gov.uk/ons/guide-method/user-guidance/social-capital-guide/the-social-capital-project/guide-to-social-capital.html [18/07/14]

keywords, as it is, often, a desired outcome in policy-discussions or an important factor when regulatory discussions are being had. It is also the purpose of the KBE as an aim with innovation policies; hence, perceiving economic development and KBE in the same light is not too far fetched.[8]

In their review on the topic, Woolcock and Narayan (2000) identified four approaches taken towards social capital among economic development scholars, and found that of the 'communitarian', 'networks', 'institutional' and 'synergy' approaches. The *communitarian* approach focuses on local organisations and associations on a smaller scale, and the view holds that social capital has positive effects on the welfare of communities, the denser the communities the better (Woolcock and Narayan 2000, p. 229). However, as Woolcock and Narayan point out, communitarians have, when concentrating on the micro level, overlooked the effects that isolation may have on these communities. An east London gang may bond very well amongst themselves and share a sense of community, but the lack of bridging with other communities such as families, schools, and other groupings of young people may cause friction that could be considered a cost rather than a gain, i.e. increased levels of knife crime, for instance. Likewise, a tightly knitted group of scientists may enjoy the freedom of concentrating solely on the list of tasks assigned to their laboratory, while they are likely to miss out of the flow of new ideas and perspectives that come through cooperation with other labs or the wider scientific community.

The *network* approach emphasizes both the vertical and horizontal links between people and networks within organisations, firms and other associations (Woolcock and Narayan 2000). Drawing on research by Gittell and Vidal (1998), Woolcock and Narayan refer to two types of relations within networks; 'intracommunity ties' which has been called 'bonding', and 'extracommunity ties', that have been called 'bridging', terms that are also used by the ONS in their user guide (ONS, 2014), and by Putnam (Putnam, 2000:22). The presence of one does not necessarily necessitate the other,

[8] The research on KBE and social capital that has been found is primarily targeting firms and other commercial entities (Wu et al. 2008, for example).

and the various different combinations of these two dimensions of networks produce a wide range of outcomes that may be associated with social capital. Followers of the network approach do, according to Woolcock and Narayan, consider social capital to be a double edged sword in that though it may create productive and economically sound outcomes, the ties created may also have negative economic consequences through members' sense of commitment and obligations. Further, the 'good' that is to be achieved in the networking process may be extracted on the expense of someone else or some other network or cause – which may or may not prove to be a 'loss' in the long term (Woolcock and Narayan 2000). This ties in with Putnam's argument that though social capital can be both a private and a public good, it will ultimately depend on the nature of the network and the context in which it operates (Putnam 2000). One could, for instance, argue that the increased level of knife crime in London could be a result of social networking among young gang members living in urban communities. Changing the gang and knives for a group of policy-makers and portfolios, it would be possible to find an increase in policy-outputs through their networking, but whether both arguments for promotion and regulation are heard depend on the group and the content of their portfolios.

The strength in the network approach lies in the possibilities of engaging in detailed policy-discussions due to the ease through which the approach may be used to gather empirical evidence and make assessments. However, it is less suitable for researchers concentrating on larger communities, such as 'society', states, or similar, Woolcock and Narayan claims.

Where the network approach fails, the institutional approach picks up. The *institutional* approach holds that the political, legal and institutional environment has a large impact on the vitality of networks and civil society. While the network approach seeks to explain what is researched with social capital, the institutional view claim social capital to be dependent on the quality of the formal institutions - that shape the context within which social capital is produced (Woolcock and Narayan 2000). For instance, macroeconomic factors such as 'trust', 'rule of law', 'accountability' and the

like are seen as important for the creation of social capital, rather than the outcomes of social networking. However, as Woolcock and Narayan point out, the macroeconomic emphasis within the institutional view is, though beneficial for identifying macroeconomic policy concerns (the level of democracy or corruption, for instance), failing to address microeconomic issues that affect individuals or individual communities (Woolcock and Narayan 2000), or indeed mesoeconomic concerns that affect the institutions themselves.

The gaps in the network and institutional approaches led to a merger, of sorts, into what has been called the *synergy* approach, which, due to its greater empirical support, "*lends itself best to comprehensive and coherent policy prescriptions."* (Woolcock and Narayan 2000, p. 225). The fundamental idea in the synergy approach is that initiatives and strategies are based on dynamic professional relationships and ties within and among public administration and civil society. The synergy should both be illustrated through mutual and supportive relations between public and private networks – referred to as 'complementarity', and by the nature of the relations that connect the public and public officials - also called 'embeddedness' (Woolcock and Narayan 2000). Conclusively, societies with high levels of complementarity and embeddedness are characterised by 'good' or 'sustainable' governance, and the challenge is to *"transform situations where a community's social capital substitutes for weak, hostile, or indifferent formal institutions into one in which both realms complement one another."* (Woolcock and Narayan 2000, p. 238) Though Woolcock and Narayan emphasise 'dynamic professional relationships', this study is merely using the professional relationships as a starting point, as formal relationships are not carried out in complete isolation from informal, or private, relationships and vice versa. Further, rather than being labelled a dependent or independent variable, social capital is claimed to be a 'mediating variable'.

However, in agreement with Fagerberg and Srholec (2008), Woolcock and Narayan (2000) conclude by stating that finding an accurate measure of social capital, is impossible due to the multidimensional nature of social capital; that the nature of social capital changes over time with the balance shifts in

relations; and, as there is no cross-country, long term data set available that measures social capital. All but discouraged by the stated 'impossibility' to find an accurate measure of social capital, this study takes on a qualitative approach to identify questions and themes that will be as accurate as possible, in line with the synergy approach and search for complementarity and embeddedness.

*2.1.3.2 Measuring complementarity and embeddedness*

Woolcock and Narayan has, despite the above mentioned concern with accuracy, been involved with the writing of a guide on the use of qualitative analysis when researching social capital in context (Dudwick et al. 2006) which suits this study well in that it is context-specific. Though, their report, which was produced for the World Bank, is intended or at least directed towards community based research and the policy-making community is not mentioned in this context, this study will still utilise the tools provided, if slightly modified, treating the policy-making environment as a community in its own right. Partially through key-informant interviews, a term used by Dudwick et al. to signify the formal or informal leader of a community, or a community member with a key perspective that is of use to the study (Dudwick et al. 2006:11), six dimensions will be explored and listed in Table 2.1 below: *networking*; *trust and solidarity*; *collaboration and cooperation*; *communication*; *social cohesion and inclusion*; and *empowerment* (adapted from Dudwick et al. 2006:12-28).

TABLE 2.1: EXPLORING THE SIX DIMENSIONS OF SOCIAL CAPITAL
*(based on Dudwick et al. 2006)*

| **Dimension** | **Operationalisation** |
|---|---|
| 1. Networking | |
| *Assumption* | Understanding how nanotechnologies or nanosciences policies related formal and informal, horizontal or vertical networks work and whether they enable collaboration in order to achieve shared goals. |
| *Questions* | a. What resources are available to you and to the community?<br>b. What do policy-discussions look like - is everyone, including yourself, equal in discussion or interaction?<br>c. What are the main obstacles, if any, to interaction and collaboration?<br>d. What formal and informal groups or networks exist in the |

| | |
|---|---|
| | policy-making community?<br>e. What brings the group(s) together, and under whose leadership?<br>f. Describe your role in decision-making discussions<br>g. What do you get out of collaboration and/or discussion?<br>h. How do you perceive the other people around the table?<br>i. How often to you meet, and do you meet in other circumstances too? |
| 2. Trust & Solidarity | |
| *Assumption* | Trust here relates to the extent to which decision-makers feel that they can rely on other parties around the table, or other external organisations, and whether they either trust others by choice, or if the level of trust is dependent on the pre-existing relationships between different parties. |
| *Questions* | a. What is the group size and demographic?<br>b. What is the history of the group or community, have there been any mishaps, disagreements or controversies?<br>c. How well do group-members know one another?<br>d. How socially heterogeneous or homogeneous is the community?<br>e. Are there any local norms for interaction between group members and stakeholders?<br>f. Do patterns of mistrust and suspicion exist between or among groups?<br>g. Are there relevant cleavages and what is their history? |
| 3. Cooperation | |
| *Assumption* | The aim here is to explore how well policy-makers work with others in the community and how they respond to challenges. |
| *Questions* | a. What are the most pressing problems in the policy-making community, and how are or should they be solved?<br>b. What cultural, social, or norms influence collaboration and problem solving?<br>c. Can you give an example of a conflict, if any – and how was it resolved (if at all)?<br>d. Would you say that social, cultural, or legal constraints limit the participation of specific groups (e.g. NGOs, Civil Society, Industry, Academics)? |
| 4. Communication | |
| *Assumption* | Information and communication is central to open and transparent collaboration, and the feeling of 'equality' around the policy-making table. |
| *Questions* | a. Do you feel that you are kept informed of the interests and views of others?<br>b. How do you communicate in and outside of decision-making processes, and do you communicate with affected parties outside of that context?<br>c. Do you feel as if your opinion and voice is heard by others? |
| 5. Cohesion & inclusion | |
| *Assumption* | Team-building exercise, meeting during other meetings or events that are not necessarily directly related to policy-making is likely to increase a sense of cohesion and inclusion. This assumption is connected to the previous four assumptions. |
| *Questions* | a. Are there any non-nano related activities or events during which you meet and connect with the other decision-makers?<br>b. Are there any recurring conflicts or disagreements in your networks or groups, and if so – who participates or |

| | |
|---|---|
| | mediates such conflicts?<br>c. What are the patterns of inclusion and/or exclusion in participation or consultation? |
| 6. Empowerment | |
| *Assumption* | Empowerment is explored through the sense of satisfaction, personal efficacy, and capacity of group and network members to influence the outcomes of the decision-making processes. |
| *Questions* | a. What are the traditions or norms of the decision-making community within which you are active, and how do they affect you?<br>b. If you disagree with the policy-outcomes or outcomes of decisions, to what extent can you make your disagreement heard?<br>c. Who are the most influential in decision-making related to nanotechnologies and nanosciences, and who are the least influential – and why? |

The questions and assumptions have been edited from Dudwick et al.'s work in order to fit this study. That said, as the study aims to utilise semi-structured interviews, they serve more as a map for the interviewer than reflect the actual questions asked during the interviews. The full set of research questions, accounted for in the end of this chapter include all dimensions accounted for, though as several questions for different dimensions are the same or very similar, they have been combined cross dimensions, eliminating the risk for repetition, and will reflect the themes and contexts identified through the literature review (2.2) and pilot study (2.3).

It is also worth noting that the dimensions and respective questions, when asked, seem appropriate when considering organisational diversity and social accountability, as will be made more visible through the Themes Matrix included in the end of the chapter. With regards to the themes for this study, they were identified through a literature review and a pilot study, and the first point of call is to turn the attention to what social scientists had written about nanotechnologies and nanosciences by the time this study was setting up shop.

## 2.2 Pre-2008 Literature review

The number of written works on nanotechnology in society is increasing steadily. Having dug deep and wide, I have come across quite a few articles and lesser books spread over a rather large area discipline-wise. It turns out

that; not only has social science had something to say about nanotechnology, but nanotechnology has had a say about social science – or rather, society as it is understood by scientists[9]. Nevertheless, a couple of scientists seem to have tried out the corduroy jacket of social science and carried it well, such as Richard Jones – a physicist. However, he and his colleagues (hereafter referred to as Wood et al.) have done exactly what I was aiming to do – written a literature review on the subject (hereafter referred to as the ESRC study). It turns out we have read the same articles and drawn roughly the same conclusions. Hence, the only credible thing to do is to try to build on their work rather than plagiarizing it unintentionally.

### *2.2.1 The ESRC literature review*

The ESRC (Economic and Social Research Council) study is a follow up to a previous study made in 2003 with the same aim, and is concentrating its analyses around two axes:

a) concepts of nanotechnology
b) judgements about the economic and social consequences of nanotechnology (Wood et al. 2007:7)

I will do the same here, though focusing more on the latter of the two. It is inevitable that I will repeat much of what has been said in the ESRC report, but I will try, to the extent possible, to add more information and examples from other sources, especially from articles and books published after the release of the ESRC study.

### *2.2.2 Nano-concepts and nano-theories*

The discussion regarding the concepts of nanotechnology has mainly been held among nanoscientists and philosophers of science discussing nanoscientists and their discourse. The main issues have been, according to Wood et al.: the definition of nanotechnology; the concepts of what is

[9] It is difficult for academics to say much about another academic discipline without raising objections, the same goes for social science scholars who have opinions about nanotechnology or merely wish to describe it, of course. An example would be Jeffery Matsuura's many errors in explaining nanotechnology, which did not receive much favour in a book review.

achievable through nanotechnology and how; and lastly, the field of study and commerce related to nanotechnology (Wood et al. 2007:8). The discourse is well summarised in a book edited by the philosopher Joachim Schummer et al. (Schummer et al. 2006), which in turn consists of a collection of widely cited articles published in special issues of *Hyle: International Journal for Philosophy of Chemistry*, and *Techné: Research in Philosophy and Technology*. More than one article mentions the Drexler-Smalley debate[10], which was an exchange primarily concerning the credibility of molecular manufacturing as proposed by Drexler, and Smalley's criticism thereof. Otávio Bueno delivers a very good description of the debate in his chapter on the topic (Schummer et al. 2006). Summarised briefly, the debate concerns the differences regarding the goals, methods and theories of nanotechnology, and the conceptualization of molecular assemblers, for instance, while Drexler argues that the assemblers would be mechanical – like small robots or factories, Smalley's counter argument is that they would have to be chemical as matter on this scale is difficult, if not impossible, to control. Further, Bernadette Bensaude-Vincent makes interesting reflections drawing from the Drexler-Smalley debate claiming that there are two conflicting cultures within nanotechnology – i.e. the engineer's perspective (Drexler) and the scientist's perspective (Smalley) (Schummer et al. 2006). This is linked to the earlier eager debate between nano-radicals (sometimes referred to as Drexlerians) – who are still around though the 'grey goo' scenario[11] has become somewhat passé, and the less radical camp. Rather, as Wood et al. also point out quoting David Berube (Berube 2006:58), the science community seems increasingly more interested in less radical or revolutionary visions and more favourable towards an evolutionary view with a firm base in applied nanoscience (Wood et al. 2006:10).

In general, much of the debate seems to scratch the surfaces of many different possible directions that in turn are developed further. For instance, to

[10] Interestingly enough, the debate continues even after Richard Smalley's death, for latest input from Drexler: Drexler, K. Eric "Nanotechnology: From Feynman to Funding" in Hunt & Mehta 2006

[11] By which assembler-based replicators could turn the world and everything in it into a grey mash as they were superior to the most advanced modern organisms on earth (Drexler, 1986)

mention a few examples of particular interest to STS, one such direction is introduced by Cyrus Mody's discussion on nanotechnology and technological determinism (Schummer et al. 2006). In short, Mody wishes to encourage a discussion on technological determinism in nanoscience, which is required, he argues, due to the non-presentism of nanotechnology (i.e. that the discipline does not restrict its focus to what is presently available, but also on what will become available in terms of material and instruments) and it's roots in futurist traditions – the accentuation of both past and future sets nanotechnology apart from other traditional technologies. Another scholar to mention when considering nanotechnology's non-presentism and difference to other technologies is the German philosopher Alfred Nordmann, who has reflected over the smallness of the nano-scale, labelling the technology noumenal, due to the limits the size puts on the human imagination and theoretical resources (Schummer et al. 2006). Nordmann continues by stating that we cannot trust noumenal technologies, and hence, we need to move beyond the size matter and focus on the integration with human experience. In conclusion, Nordmann argues, nanotechnology should firstly be seen as a novel technology that is different from previous technologies, and secondly, novel fields require novel theories, and following Nordmann's reasoning, new approaches towards theorizing. A similar observation, of the novelty of nano, was made by Geoffrey Hunt, who, introducing 'nanology', calls for an end to reductionism and generalisations in theorizing in favour of a holistic approach following the principles of complex systems. (Hunt & Mehta, 2006: 44f). After all, Hunt argues, the nano-scale paves unknown ground due to the scale being on a more fundamental physical level than previous technologies, and reductionism in theorizing may cause widespread and unpredictable hazards (Hunt & Mehta: 46f).

### *2.2.3 The economic and social consequences of nanotechnology*

Regarding the second axis, Wood et al. note that the discussions have sharpened into specific areas or questions, but also, as with the philosophical discussion above, that much of the literature remains commentary, and that "it is still predominantly discussion rather than evidence-based research" (Wood

et al. 2007: 12). Moreover, these discussions, too, seem partially based in the span between radical positive and negative perceptions, as is the case with the concepts of nanotechnology as discussed above.

### *2.2.4 Positivism/Futurism*

An example of positive radicalism is to be found in James J. Hughes's article *The struggle for a smarter world* (Hughes 2007). Hughes is a sociologist, but also the Executive Director of the World Transhumanist Association (WTA), an organisation with the aim to promote the ethical use of technology to extend human capabilities – in this case, using, amongst other technologies, nanotechnology to enhance human intelligence. Arguing that the human intellect has reached as far as it possibly can amongst most people inhabiting the developed world, Hughes argues that nanotechnology could and should be used to help us enhance even further, by, for instance: creating new materials that can coexist with neurons and be made into nano-scale electrodes; the creation of brain-prostheses that facilitate the communication with individual neurons; and treating mental illnesses with nano-neural implants. While Hughes notes that a political struggle for greater liberty and equality is required in order to provide equality in the access to technology, and in social decision-making (Hughes 2007:942), he does not get involved in the ethical discussion that might have been expected following his prophesies – and the claimed aim of the WTA. Wood et al. mention another known futurist, Ray Kurzweil, who has shown support for the Drexlerian side of the concepts discussion as well, following roughly the same line of reasoning as Hughes[12].

### *2.2.5 Moving on – the social shaping of science*

However, it is fair to say that this futuristic discussion seems to remain on the stage more due to the enthusiasm of its advocates than to the audience, most of whom seem to have moved on to more specific issues or broader questions

[12] Kurzweil received the WTA 2007 H.G. Wells Award for Outstanding Contributions to Transhumanism, see source available online: http://www.transhumanism.org/index.php/WTA/more/wells2007/ [08/01/08]

regarding the nature of technology in general and the social shaping of science. Many scholars have described the history of nanotechnology, and tried to describe the technology itself to the wider lay audience, while others have presented lists describing what they consider to be the main issues in nanotechnology and in what way issues have been defined[13]. Regarding the latter, one may connect to the philosophical discussion on technological determinism above by taking a look at the on-going discussion regarding whether the issues should be labelled as 'implications' or perhaps rather as 'questions'. Macnaghten et al. do, for instance, point out that treating the issues as implications reflects the notion that the social is invariably 'downstream' from science (Macnaghten et al. 2005: 269). As an example, they continue by discussing and quoting a report published more recently as a book in two volumes by Mihail Roco and William Sims Bainbridge from a workshop held by the National Science Foundation called *Nanotechnology: Societal Implications* (Roco & Bainbridge 2007) (Macnaghten et al. 274f). Indeed, the title reflects the downstream line of reasoning employed in the book rather well, i.e. technology shapes society, not the other way around. Bruce Lewenstein, further, argues that the 'implications' label necessarily suggests that science and technology came first, but also that talking of social and ethical issues implies that science and technology only exist in a social context (Lewenstein 2005/2006). Wrapping up, Lewenstein suggests an approach that reflects the mutual interdependence of the two camps, which is a view also held by Kenneth H. Keller who describes the interactions between technology and society as bi-directional: "on the one hand, technology changes and challenges social patterns and, on the other hand, the governance structures and values of the society affect progress in developing the technology" (Keller 2007). Indeed, social shaping of science/technological shaping of society view has led to the exploration of trading zones (Gorman et al 2004) and talk of mode2 or 'post-academic' science (Vogt et al. 2007). As

[13] One listing is particularly broad and worth to keep in mind, namely Sheremeta, Lorraine & Daar, Abdallah S. "The Case for Publicly Funded Research on the Ethical, Environmental, Economic, Legal and social Issues Raised by Nanoscience and Nanotechnology (NE3LS)", Health Law Review, Vol. 12, Number 3, (2004), Available online: http://www.law.ualberta.ca/centres/hli/pdfs/hlr/v12_3/12-3-14%20Sheremeta.pdf (Accessed 08.01.08), Table 1, p. 75 -76

Vogt et al. write: *"Addressing the ethical, legal and social implications of nanotechnology will help to reverse the fragmentation of academic fields into multiple subdisciplines, end the artificial separation between pure and applied research, and bridge the gap between science and the society it serves, as well as helping to avoid a possible public backlash"* (Vogt et al. 2007:329). They claim that the multidisciplinary nature of nanotechnology will help to reverse what they call the 'Tower of Babel' syndrome, by which scientific disciplines have become impenetrable cultures by language and practices making interdisciplinary cooperation impossible, that has until now been caused by increased specialization of modern research. Predicting the future nanotechnology trading zones, Gorman et al. follow the same reasoning, even predicting that the collaborators will, eventually, create a dialect of their own, 'nanocajun', that will ease their communication (Gorman et al. 2004).

### *2.2.6 Risks and risk assessments*

Moving on to more specific issues, an issue that has received much attention concerns the potential risks and benefits of nanotechnology. There does seem to be general agreement on that the risks need to be researched more, and more attention need to be paid to, for instance, toxicology. Nevertheless, more recently, the continuous calls for risk assessments have been subject to critique as well, by for instance Macnaghten et al., who point out that it may take attention away from wider social risks and uncertainties (Macnaghten et al. 2005:281ff), and Robert Doubleday who argues that the focus of the risk discourse is too narrowly focusing primarily on environmental and health risks (Doubleday 2007a). With the risks come several discussions regarding regulation, though most of them seem aimed at describing the current situation and policies, and what the future will and should bring in terms of regulatory activities (Hunt & Mehta 2006, Matsuura 2006). Somewhat related to this discussion is also that of the wider governance of risk and risk communication (International Risk Governance Council, 2006, and Renn & Roco, 2006 – the latter of which summarises much of the report produced by the International Risk governance Council). Some of the main conclusions or risk governance related recommendations made by the International Risk

Governance Council, is that there is a governance gap between 'nano governance' and 'micro/macro governance' and that the novelty of nanotechnologies require a different take on risk-benefit assessment and risk management, while nanotechnologies innovation and development is moving ahead faster than policies and regulation (Renn & Roco, 2006: 156). The report also underlined the need for risk communication, underlining the need for communication between stakeholders in order to improve risk management performance, and to communicate risk appropriately with the 'outside world' in order to produce informed choices and informed agendas (Renn & Roco, 2006:181). The risk discussion also brings ethical considerations to the fore. Many academics, such as Hunt have discussed the ethical aspects of nanotechnology, especially in relation to the risks involved (Hunt & Mehta 2006). However, few ethical discussions have derived from the nanoscientists themselves. An attempt to fill the gap has been made, nevertheless, by Rosalyn W. Berne (STS scholar), who by interviewing a group of nanoscientists and engineers about ethics, meaning, and belief in the development of nanotechnology, concludes that more attention needs to be directed to the ethical aspects of nanotechnology research and the individual moral reflections of nanoscientists, which does not get much attention due to the 'more pressing' need for funding (Berne, 2006). Further, there seem to be a belief among the scientists that Berne interviewed that they do not know enough about ethics to maintain such a discourse, and therefore leave the subject untouched. The need for scientists to engage more with ethical and social issues is also raised as a recommended goal for the future by Renn and Roco (2006:181).

### *2.2.7 Public engagement*

Another 'hot potato' on the nano-society agenda, especially in the light of the GM controversy and the wish to avoid repeating it through a nano-controversy (Kearnes et al. 2006a), is that of involving the public and of openness. The calls for public engagement – i.e. moving engagement 'upstream' - has come from both academia and government, from the latter in particular through and following the RA/RAE Report (The Royal Society & The Royal Academy of

Engineering, 2004), which was followed up by a number of public dialogues about nanotechnology, such as the Lancaster/Demos dialogues between the public and scientists (Kearns et al. 2006b), and the European 'Nanologue'[14], the UK Small Talk[15] and NanoJury UK. Judging from the reports that have been produced from these various exercises and articles written by participating academics, the public – that is to say the members of the public that participated in the exercises - is concerned with the risks of nanotechnology, but more interestingly, scientists seem to get something out of the discussion as well, i.e. the earlier call for public understanding of science has taken a more democratic and more fruitful turn towards public engagement with science. As Andrew D. Maynard (a physicist) puts it: *"[a]s nanotechnology moves towards widespread commercialization, not only is the debate over preventing adverse consequences occurring at an unusually early stage in the development cycle, it is also expanding beyond traditional knowledge-based risk management to incorporate public perception, trust and acceptance"* (Maynard 2006:22). Trust with regards to risk is in itself an interesting study, for instance when considering the development of biotechnology. Indeed, Priest et al. (2003), when comparing the Eurobarometer with their study of similar variables in the US, suggest that there are differences in the levels of trust between countries, and that there is a 'trust gap' in operation, rather than differing levels of knowledge or education. Putting the notion of a 'trust gap' in the context of public engagement with nanosciences and nanotechnologies may therefore be of interest. Nevertheless, critique has been delivered to the emphasis on 'upstream' public engagement, lately from Rogers-Hayden and Pidgeon (Rogers-Hayden & Pidgeon 2007) who protest against the given definitions of 'upstream' and 'downstream' as being overly simplistic and essentially too linear trajectories for both society and technology, which are neither linear nor simple, but rather dynamic and mutually shaping (interdependent as described by Lewenstein above), Jasanoff et al. would seem to agree with such criticism considering their own critique of the idea of linear processes (as discussed above). Moreover, they argue, a broad exploration of perspectives

[14] Nanodialogues website, available online: http://www.nanologue.net/ [08.01.08]
[15] Smalltalk website, available online: http://www.smalltalk.org.uk/ [08.01.08]

on nanotechnologies and issues early on does not necessarily counteract controversy. Indeed, the perceived deficit in public understanding may be replaced by a perceived deficit in public engagement with science (Rogers-Hayden & Pidgeon 2007). In their conclusion, Rogers-Hayden & Pidgeon suggest involving a larger number of actors to be a potential solution to the problem.

Further, Wood et al. argues, quoting Kulinowski's reflection on that the access to sound technical data may lead nanotechnology to avoid a route along the wow-to-yuck trajectory (Hunt & Mehta 2006), it may very well be that more understanding is needed before there can be more engagement, i.e. the public needs scientific information before they are able to engage. However, hardly anything has been written on how to inform the public, or indeed what to inform them of, and how the knowledge transfer on nanotechnology between the scientific community and the public occurs or should occur. Nevertheless, the search resulted in one study that is somewhat related to the issue, namely a study on how nanotechnology has been portrayed in the British newspaper press, and the views of the scientists and the journalist who wrote the articles (Wilkinson et al. 2007). Firstly, the study found that nanotechnology has not received much media coverage at all. Secondly, scientists showed concern for nanoparticle safety while the issue received little attention by the media. Further, both journalists and scientists agreed that the great uncertainties made it difficult to communicate risks and risk assessments (Wilkinson et al. 2007).

### *2.2.8 Looking into the scientific community*

As the public and public engagement has been looked into, so has the scientific community to some extent. Maria C. Powell has explored the perception of risks among scientists. Powell argues that 'downstream' (developers of nanotechnology) and 'upstream' (researching the effects of nanotechnology) scientists perceive risks differently, as the former emphasises new, unforeseen and substantial risks, while the latter see less

risks and a narrower range of uncertainties (Powell, 2007)[16]. The risk and uncertainty frames are, Powell argues, influenced by the contrasting disciplinary backgrounds, information exposures, and different interdisciplinary interactions that the scientist are subject to. Hence, she continues, the involvement of a wider variety of scientists in the upstream nanotechnology development and policy-making exercises may secure more comprehensive risk policies.

Other scholars who have researched nanoscientists and their actions and views in detail (by interviews for instance) are Berne (Berne 2006), as mentioned above, and Doubleday (Doubleday 2007b) who has researched the accountability – towards the government as well as the public - as expressed in a nanoscience laboratory.

### *2.2.9 Nanotechnology and the developing world*

Another issue that has been emerging on the nanotech-society agenda is that regarding the impact on the developing world. Again, the participants in the discussion seem divided into two camps, one that believe nanotechnology may bring prosperity to developing countries (Bürgi & Pradeep, 2006), and one that believes that a nano-divide may be created and that developing countries will lag even further behind than they already are (Hunt & Mehta 2006). Views of the latter have been addressed by the ETC group for instance, who have written rather gloomy reports and press releases on nanotechnology[17], and by some scholars who seem to share their views, some even claiming that nanotechnology will change the current model of capitalism into mercantilism, with which the developing world will not be able to keep up (Mehta 2004). The less critical voices imply that developing

[16] To clarify the concepts of 'upstream' and 'downstream', a definition of 'upstream' when spoken of in relation to public engagement, is when dialogue and engagement take place on an early stage during the introduction of a new technology as opposed to 'downstream' which is occurring too late in the technology development process to have any influence (Rogers-Hayden & Pidgeon 2007), this may seem confusing as Powell name the developers of nanotechnology who are involved on the early stages downstream scientists, while the scientists involved with the effects of nanotechnology, and thus, are involved later on are called upstream scientists.

[17] For a listing of ETC publications on nanotechnology, please visit http://www.etcgroup.org/en/issues/nanotechnology.html [08.01.08]

countries already include nanotechnology in their agendas and that there is on-going education and training in nano-scale science and technology, and that they therefore may not lag behind, as perhaps feared (Bürgi & Pradeep, 2006). Further, regarding the alleged divide, Hassan (Hassan 2005) claims that the danger is rather an emerging South-South divide between developing countries, as some are more scientifically and technologically developed than others.

### *2.2.10 Economics and Finance*

There has been surprisingly little written on nanotechnology among economists and within finance. However, there is a handbook available for investors in nanotechnology, though it was written in 2002 and may be out of date. Nevertheless, it is a very optimistic read, though the author does admit that there are no actual nano-products to be invested in yet (Fishbine 2002). Further, an article from 2005 claims to be the first article to be published on nanotechnology in the peer-reviewed technology management research journals (Shea 2005). The article provides the management community with a brief overview on what nanotechnology is and how it will spread. Shea also hints on how the existing innovation management literature may be used in further research on nanotechnology-based innovations. Despite this first step, and another very brief nano-briefing (Bhat 2005), the management literature seems to have overlooked nanotechnology for the past couple of years. Indeed, nano-industry and it's commercialization have been better described by scholars in other fields, such as Daniel P. Thurs (Thurs 2007), who implies that industry has moved faster than scientific discoveries, surely such reflections should warrant more articles in economics and finance?

### *2.2.11 Concluding remarks of the Pre-2008 literature review*

There are general conclusions to be drawn from this literature review, and the most obvious one is that it is difficult to find in-depth analyses on specific nano-society issues as most articles written by 2008 were descriptive in nature. It seems that social science was trying to establish, and perhaps agree, on a framework through which future studies of nanotechnology and

society should be studied before getting their hands dirty. Of course, such an assumption comes with exceptions, especially regarding the risk and public engagement discussions and the social shaping of nanotechnology/technology shaping society issue (lacking a better term). Nevertheless, other important issues such as regulation remained at the descriptive stage and lagging behind, as pointed out by Renn and Roco, and the managerial/industrial inputs were largely untouched. Knowledge transfer between academia and the public also seemed untouched, which was surprising immediately following the pilot study as it was referred to as important by interviewees. It is of course possible to make the argument that knowledge transfer between academia and the public should be part of public engagement exercises, and – as claimed above, the Mode2 shift might render the concept redundant.

Connecting to Wood et al. and their conclusions, they claimed that the discursive landscape had changed between 2003 and 2007, though not dramatically. Further, futuristic contributions to the debate have lessened somewhat, which has given more room for other discussions and actors to emerge. Nevertheless, the discourse was, in 2008, still too narrowly focused on the toxicology of nanoparticles, public engagement, and environmental and health risks (Wood et al. 2007:17). In short, a small number of issues keep dominating the nano-society agenda.

As for the literature itself, a number of journals released special issues dedicated to nanotechnology, such as for instance Health Law Review, Health, Risk & Society, Area, Hyle, Techné, Science Communication etc. Further, individual articles on nanotechnology and society are to be found in both the journals of social science, and those of engineering, technology and science, which was, I believe, a clear sign of the interdependence described by Lewenstein, Keller and Vogt et al. As for published books on nanotechnology, they were few, and those that were tended to be collections of articles, such as Schummer et al. 2006, Hunt & Mehta 2006, and Roco & Bainbridge 2007, all of which are well written and valuable to anyone seeking an overview. There were exceptions however, one produced by Jones,

namely *Soft Machines: Nanotechnology and Life*, which is a good read for anyone interested in the background of nanotechnology and an introduction to nanosciences, and stood out as a good and relatively early attempt at knowledge transfer.

### *2.2.12 Themes from literature*

The literature review brought up a number of themes for further exploration that could direct some of the intended semi-structured interviews in terms of providing topics for discussion to be brought up with interviewees. Considering the lack of empirical studies and cross-country comparisons, any of the above mentioned themes could have been chosen, but those that stood out with regards to the overall research question were: firstly, the *perception of risks and ethics versus the perception of innovation and economic development, and the balancing act between the two* among decision-makers, how are both topics framed and considered by all gathered around the table? The second consideration relates to the 'trading zone' that is assumed in a Mode2 decision-making environment, what does the 'nanocajun'-speaking decision-making environment look like, and *has the involvement of a wider variety of scientists and other actors influenced policy-making exercises and produced more comprehensive risk and innovation policies?* Finally, as most of the literature included, or indeed found, originated from English-speaking countries, is public engagement and science communication receiving as much attention in Finland and Sweden – or in other words, how do decision-makers perceive the notion of 'trust gap', if applicable, and *the role of public engagement and science communication*? The last consideration also refers back to the concept of social accountability, but also to the importance of past controversies to UK nanotechnologies and nanosciences decision-making that became apparent during the literature review and whether or not similar considerations have made the trading zone invite the public into its midst in Sweden and Finland to the same extent.

## 2.3 Pilot study: Finland and the UK

As the literature review did not offer Finnish or Swedish contributions that would have been helpful in identifying research themes, a pilot study was conducted with the overall aim to, firstly, identify themes that would be of interest in Finland, and secondly, to gain some empirical insight into what was possible to achieve with regards to the identified themes in the UK. Sweden was not chosen due to time-limitations and financial constraints. Moreover, the difference between the UK and Finland seemed, on paper, rather more interesting in that the UK did not, at the time, have a defined nanotechnologies strategy, while Finland had the FinNano programmes (see below for details), while the social and ethical aspects of nanotechnologies and nanosciences development had received much attention in the UK, whereas very little had been written in Finland, by comparison.

### *2.3.1 Identifying research themes and questions for the pilot study*

The themes chosen for further exploration particularly related to elements of the Mode2 shift (assumed rather than expected) in nanotechnologies and nanosciences governance, the perceptions of regulation versus promotion among parties involved with decision-making, trust among both involved parties and wider society, and public engagement and its uses, if at all used as a means to bridge the 'trust gap'. As research into nanotechnology decision-making negotiations has been rather focused on risks, particularly in the UK until 2008, two different responses to the governance of risk are suitable when discussing its governance, namely; the *technocratic* and the *democratic* approaches (Jasanoff, 2006:749). Both approaches are possible around a Mode2 negotiating table and in an environment that encourages Strategic Science, though the democratic approach, which may be defined as more inclusive and in line with democratic principles, should prevail if all parties expect an equal share in the discussions. As for the technocratic approach, which emphasises closed discussions where experts more than any other party get their say, it leaves it up to expertise to shape risk assessments, and hence shape the regulation and promotion of the matter at hand. Moreover, the democratic approach includes citizens' perceptions and

desires, which goes in hand with the move from the deficit model (Wynne & Irvine, 1996) towards adding the public as an actor to the triple helix, the development of Strategic Science or strategic policy-making, or Mode2 knowledge production. The 'deficit model' assumes the public mind to be an empty bucket into which science should be poured, rather than an knowledgeable public that makes informed decisions in line with what can be expected in modern governance (Ezrahi, 2006:265) utilising a democratic approach, and a public that may have something to contribute to science.

The identified themes brought on the following questions:

1. Are there nanotechnologies and nanosciences policies in place, and if not – why not?
2. Who takes part in the nanotechnology policy negotiations?
3. How do they relate to the other parties around the table, specifically during these discussions, but also generally?
4. What are their attitudes, interests, and objectives with regards to collaboration, and to regulatory and promotional discussions?
5. Are ethical and social issues discussed, and if so, what kind of questions usually comes up?
6. Is the policy-making environment open or closed with regards to the access to information and communication between actors?
7. Is there a place for public engagement and science communication?
8. Is there a 'trust gap' with regards to nanotechnologies, if so/if not, why/why not?

*2.3.2 Methodology for the pilot study*

The pilot study rests partially on written documentation such as academic articles, policy statements and reports, and partially on a series of informal semi-structured interviews carried out in both the UK and in Finland. The latter part included a total of four semi-structured interviews whereof three took place in Finland and one in the UK, and were held with two senior academics in Finland, a representative for one of the nanotechnologies programmes, and a senior representative for a prominent and well-established centre for

nanotechnology research in the UK. Though informal, the interviews were anonymous. The interviews were recorded through written note taking and the notes were rewritten and printed immediately following the interviews. Audio recording was considered, but discarded as an option as it could have impeded on the intended informality of the interviews. The differing number of interviews in each country is directly related to the differing amount of information available with regards to the promotion or regulation of nanotechnologies and nanosciences between the two, and the lack of information with regards to public engagement, knowledge-transfer, or any of the other themes that UK scholars science and social science scholars had published by the onset of the pilot study. The lack of information also made it difficult to determine whom to interview in Finland for the full study, and the pilot study sought to provide a list of potential interviewees beyond the pilot study itself. What was published in Finland, by 2008, was rather narrowly focusing on economics and business studies (Granqvist, 2007; Nikulainen, 2007a, 2007b; Palmberg & Nikulainen, 2006; Palmberg, Pajarinen & Nikulainen, 2007), which have highlighted the investments in nanotechnology but left regulatory matters out of the picture. It also proved difficult to identify suitable interviewees within government bodies or industry in both countries as their involvement with nanotechnology related policy-making was difficult to make out merely through a literature search and policy review. Therefore, neither group were interviewed for the pilot study. The interviewees chosen were, instead, asked about their views on government, civil society, and industrial involvement, and further efforts were made to explore their stake and involvement through documented resources.

### *2.3.3 Results of the Pilot Study: Nanotechnology in the UK and Finland*

This section aims to provide an outline of the emerging themes derived from the pilot study, while much of the other results of the pilot study are accounted for in the descriptive country-specific summary of nanotechnologies and nanosciences policies in Chapter 4. As the interviews held during the pilot study turned out to be of very good quality and can be considered

complimentary to the other interviews held in the broader study that they were meant to pilot, they have been included in that part of the study.

#### *2.3.3.1 Nanotechnologies and nanosciences decision-making in the UK*

##### *2.3.3.1.1 Policy context, promotion and regulation*

As will be discussed further in Chapter 4, the UK government showed interest in the increased academic interest for nanotechnology (as it was referred to then) quite early on, by initiating a National Initiative on Nanotechnology in 1986. A 10-year Nanotechnology Programme, between 1988 and 1998, followed the initiative. Both initiatives were rather funding-oriented, the latter in a more hands-on way in that it was meant to distribute funds to both academia and small, medium, and larger sized companies for nanotechnology-related R&D activities. The early buzz was followed by a more than 10-years long gap in funding initiatives and programmes, and policies related to nanotechnologies and nanosciences were nowhere to be found. It took until 2003 before another funding initiative was in place, the MNT Manufacturing Initiative, again very promotion oriented and not a policy.

The main objective behind the UK government's funding initiatives was to encourage commercialisation and industrial investment, hence, create a trading zone including academia and industry, both of whom were consulted and offered expert opinion. The UK interviewee confirmed the commercial focus, a focus shared with the Centre, largely an academic department, he represented. He also pointed out that the Centre also includes city and national government representatives on its board of directors. The latter of whom were not involved with funding, but rather kept on board in a policy advisory capacity and as to keep the Centre's activities in line with the government's agenda, which he claimed was 'rather commercially oriented'. Indeed, a report published by the UK Government in 2007 confirms the statement by indicating the governments wish for more industrial involvement and a complete commercialisation by which government involvement would cease entirely (UK Government, 2007:7, 15).

As for regulation in the UK, the Royal Society and the Royal Academy of Engineering report of 2004 discussed regulations and risks, and pointed their main concerns towards engineered nanoscale materials that may fall outside existing legislation (RS/RAE 2004). The report also called for more research into the risks and exposure to potentially toxic nanoparticles stated that there is a need for more research concerning risks and the exposure to potentially toxic nanoparticle (RS/RAE 2004). A Government statement repeated these concerns, and pointed towards regulatory negotiation within the EU, rather than within the UK Government or Parliament themselves, both with regards to product labelling and regulations for industrial use, and for health and safety legislation for laboratories (UK Government, 2007:17, 22). The Nanotechnology Centre representative confirmed that regulation is lagging behind, that products are tested but not regulated, and that industry is carrying out the tests. He also felt that little was achieved when meeting the government, and that the government did not push for testing nor did they put funds towards it – *"do they really mean it?"* He further said that the government sometimes ask the Centre for someone to participate in negotiations, and that the Centre sends someone if they can spare them. As for industry, he said that the main question for companies is what to produce, and that there is not time for regulatory involvement. However, in terms of in-house regulation, he said that health and safety is of great importance, and that it is brought up at all meetings. The risks discussed, he continued, were matters related to work place safety, such as 'no chemicals are to be brought into the clean room' and that nothing produced within the Centre should be released into the outside world. Judging from the interview and the documents studied, the government wants industry to contribute more through testing, while it also states that more money needs to be spent on toxicology, metrology and international standardization (required for carrying out the testing), which are areas that require more cooperation between academia and industry as toxicological research on the nanoscale seems to be in need of new methodologies altogether (Lubick, 2008) .

*2.3.3.1.2 Collaboration: openness and secrecy*

The trading zone within nanotechnologies and nanosciences policy-making in the UK, at least when scratching the surface through a limited pilot study, seems relatively open, though particularly involving academic and commercial entities. The UK government seemed involved and represented, but reluctant to initiate a fully fledged regulatory discussion on home turf, leaving it to the EU-level, while also stating that nanotechnologies, or at least the promotional aspects of them, should be left to develop into a commercialised and non-state governed enterprise. The claimed lack of industrial collaboration is also evident, and confirmed by both the interviewee and the Government itself. The public as a collaborator, or civil society organisations were not mentioned by the interviewee.

An evaluation of the openness and secrecy in decision-making is a wide scope for this limited study. Nevertheless, it is possible to describe the situation in two aspects: the access to information, and openness and secrecy as perceived by the interviewees.

With regards to the former, it proved easy to access documents and publications in the UK, which were searchable online and available through, for instance, the websites of the research councils, government departments, various institutes and research centres, and there were online resources aiming to inform the public and encourage interaction. Industry could be more transparent however, and studying the Unilever website (Unilever 2008a) more thoroughly, a search for nanotechnology resulted in one brief mention of the word and its potential, but nothing on the potential risks, though risks related to science and technology was mentioned in other contexts (Unilever, 2008b). The Centre representative seemed to agree about the nanotechnology R&D environment being transparent, but said that the government and decision-making could be more open, though he added that there had not been much decision-making happening yet apart from decisions taken in relation to funding.

*2.3.3.1.3 Ethics, social issues, and Public engagement*

Learning from past controversies, public engagement was introduced as an important concern for the good governance of nanotechnology in the UK. It was called for in the Royal Society and the Royal Academy of Engineering Report, and a number of “upstream” public engagement exercises were initiated of which the Nanodialogues (Stilgoe, 2007) and NanoJury UK (Nanojury UK website, accessed 2008) initiative are examples. The public engagement events have not just included government (indirectly, often through the research councils) and citizens, but also academia and industry, such as Unilever. Citizens’ voices are also heard through the involvement of civil society groups such as Friends of the Earth, who published a report naming companies that have marketed products containing nanoscale materials without labelling them (Friends of the Earth, 2008). Further, as pointed out by the Centre representative, the Centre seeks to involve with citizens. Nevertheless, the actual results, outcomes or effects of the public engagement exercises were not entirely clear to him as far as their potential input into policy-making and research agendas were concerned. Further, with regards to social and ethical issues, these were not particularly discussed by the interviewee, apart from a reference to ethical discussions within the Centre itself as described above.

*2.3.3.1.4 The trust gap*

When discussing trust, the UK interviewee gave a brief account focusing particularly on trust in relation to government, and trust in relation to past controversies and the ‘grey goo’ scenario. The government and trust issue particularly referred to uncertainty with regards to the governments role in nanotechnologies, which he claimed was unclear. The latter issue sparked a short discussion about ‘grey goo’ and a scared public, marred by past controversies such as related to GMOs and biotechnologies. Also involved in research in another country (though not Sweden or Finland), the interviewee also noted that the British public and the media seemed more concerned and ‘scared’ of new technologies than the public and media in the other country. He also underlined how the media, in his opinion, tended to trigger such a public reaction rather than the other way around.

*2.3.3.2 Nanotechnologies and nanosciences decision-making in Finland*

*2.3.3.2.1 Policy context, promotion and regulation*

Briefly, Finland's approach towards developing a nanotechnology policy looks different to that of the UK, as the country set out from a different starting point by drawing lessons from past mistakes in policy-making, rather than technology-related controversies. The mistake was, according to one of the academics interviewed, in that Finland missed out of the biotechnology wave as government attempted to focus limited funding towards the development of pharmaceutical applications while Finland does not have a large pharmaceutical industry. Instead, a large number of smaller entities doing basic research were expected to create a larger entity, which did not happen. Nanotechnology investment, on the other hand, was directed to established Finnish industrial interests (Nikulainen, 2007a:13).

This rethinking resulted in the establishment of what has been called the Finnish 'nanotechnology policy' (Matsuura, 2006:106), but which are rather two coordinated programmes, both called FinNano, in 2005. Though one of the programmes focuses on basic research, the only programme discussed by the interviewees were that intended for applied research, which has seen investment from both the government and industry, and more funds overall (Tekes, 2008)[i]. Judging from the information available on its dedicated website, and other documentation, there is involvement from both academia and industry on the FinNano steering group, as well as representation from government agencies. However, the Finnish government had not, by 2008, directly written about nanotechnology. Most of what had been written thus far had been produced by a government agency with close industrial ties that also hosted the programme with the largest investment, the Academy of Finland – hosting the basic programme, and academia - nanotechnology seemed to have been left in the hands of expertise. All interviewees confirmed this viewpoint, though one of them pointed out that any project funded by Tekes (Teknologian ja innovaatioiden kehittämiskeskus – transl. Finnish Funding Agency for Technology and Innovation), has to include

representatives from academia, industry and government in the steering group. Further, regarding industry, the same academic said that he had heard an industry representative claim that industry is not interested in funding universities and academic research, but wants the universities to be involved in basic research and supply the industry with suitable employees. Nevertheless, one FinNano representative said that involving universities is important to FinNano, though the programme does not focus on basic research as it is a matter for the Academy of Finland. He added that it is possible for companies to apply for funding through FinNano without cooperating with academia, though such cooperation is important should the applicant be a larger company with more R&D funds available. All interviewees said that Finland is very pro-innovation, and interested in commercialisation. That view is in line with the Finnish national innovation system, which is considered the most dynamic (it may be regarded 'inclusive' as academia, government and industry are co-maintaining the system) but yet stable, among the Nordic countries (Gergils, 2006: 109-113).

While promotion seemed much on the agenda, regulation had fallen behind, and, according to one interviewee – it was not dealt with at all. The literature and document search seemingly confirmed this point as none of the governmental publications found mentioned regulatory or risk. Rather, the same academic claimed, the Finnish government is passively waiting for the EU to regulate, and though it is taking part in the negotiations on the regional level, it acknowledges that it is a small player in the EU, and would rather focus its efforts on developing the technology than to legislate. Further, when asked about the role of Tekes in regulatory issues, the same academic said that the policy-makers at Tekes (understood to be the people running or coordinating Tekes) are engineers and that dealing with risks is not their main purpose. This view was not entirely agreed with by other interviewees. Another academic pointed out that Finland did not wait for the EU to regulate biotechnology, which was done at the same time as promotion increased in the 1990s. The representative for the FinNano programme said that Finland is active within the regulatory discussions on the EU level, but also confirmed that FinNano had no part in such activities apart from participating in a

conference arranged by the Finnish Institute for Occupational Health (Työterveyslaitos) in 2007, which dealt with matters regarding safety and regulation. He added that the decision-making expertise, in nanotechnology, lay with Tekes but that Tekes is doing nothing in this regard. The third academic I spoke to agreed, and added that people (academics, politicians and industry) talk about regulation, but no one is doing anything, and that talking about regulation is a way to cover your back. Hence, health and safety among nanoscientists and in laboratories seems to be the main, if not the only, domestic regulatory concern in Finland. Further, the seemingly complete lack of regulatory negotiations makes it impossible to answer as to how the parties perceive one another in that discussion, and none of the interviewees seemed overly flustered about the lack of a regulatory discussion.

*2.3.3.2.2 Collaboration: openness and secrecy*

The search for written material in Finland proved a challenge, and when openness and secrecy was discussed with interviewees, two out of three considered the Finnish decision-making environment a closed community. One interviewee called it an “Old Boy’s Club” where critical ideas and opinions tended to be ignored, which corresponds with the apparent lack of critical reports and publications. He added that Tekes was not very transparent in that it made its own decisions regarding funding, for instance, without any peer review, and that it was impossible to access their archives. The reason given for that by the FinNano representative was that Tekes deals with corporate entities and many documents therefore remain confidential. Further, the proceedings of governmental bodies are closed to the public, and the few documents published, particularly by the Science and Technology Policy Council (STPC) are of a generic nature and should be considered broad guidelines rather than thorough accounts of government’s commitments. Another academic agreed, though preferred the term ‘Innovation Club’ and added that Finnish institutions are not more transparent than the legal system requires them to be; you must, for instance, report to whom public funding is given, but nothing more. You cannot get in hold of meeting minutes unless you know the right people, he continued.

*2.3.3.2.3 Ethics, social issues, and Public engagement*

The pilot study did not find any evidence of public engagement with regards to nanotechnologies or nanosciences in Finland, and Tekes and the Academy of Finland had, by 2008, not published any documents related to public engagement.. The STPC does not mention public engagement, apart from in one of its publications where a very brief recommendation was made for the public financing and research organisations to actively promote a dialogue between researchers, citizens and decision-makers (Science and Technology Policy Council of Finland, 2003:51). The report mentions an initiative aiming to bring citizens, researchers and government together, an initiative which, when searched for online, produces no results. When asked about the lack of public engagement in Finland, one of the academics interviewed said he assumed the reason to be that Finland never experienced a GMO controversy due to a less active civil society in a rather 'corporated' state with a strong central government. Further, he claimed that civil society groups take part in the policy-making process by invitation rather than through institutionalised procedures, and that the Finns assume that their voices are mediated there, and hence do not take action by other means. The FinNano representative said that Finns generally have a more positive view of technology than Britons have, and that non-governmental organisations (NGOs) are less active in Finland than in the UK. He also confirmed that there have been no public engagement exercises carried out within the FinNano programme, and that the programme rather wants to be seen as a booster of technology due to its close industrial links, nor are there any public education campaigns, and if there were any, the Ministry of Education and/or the Academy of Finland would be more likely to lead them. Public engagement efforts are interesting, he said, but there is no need for them, yet. The second academic interviewed was unfamiliar with the concept of public engagement, and made a reference to the lack of coverage of nanotechnologies in the media, which he put down to the lack of interest in nanotechnology.

*2.3.3.2.4 The trust gap*

Indeed, judging from the Finnish Science Barometer 2007, according to which 60% of the Finns feel ‘a lot’ or ‘quite a lot’ of trust for science and research (Finnish Science Barometer, 2008:14) and the lack of critical nanotechnology discussions in the media and by NGOs, a status quo approach taken by the Tekes and the Academy of Finland and academics and the government may not, perhaps, be entirely unexpected.

*2.3.4 Themes emerging from the pilot study*

Despite a number of similarities between Finland and the UK with regards to their EU-memberships and economic stability in the developed, democracy-embracing part of the world, this pilot study brought forth a number of differences in their nanotechnologies and nanosciences governance. Though policy-makers in both countries seem eager to encourage promotion and commercial input, Finland seems slightly more technocratic in the sense that a greater emphasis was put on the role of expertise, even within the government agencies, and the public and civil society at large seemed considered disinterested. The UK, on the other hand, has been more inclusive with regards to the backgrounds of expertise invited to discussions. That said, it is not possible to determine *how* inclusive the policy-making environment is without further information and the effects of such inclusiveness. There does not seem to have been a thorough Mode2 shift in either country with regards to policy-making. Though policies clearly take place within a context of application, and interviewees in both countries gave the impression of some transdisciplinarity in proceedings at least with regards to scientific disciplines included in discussions, less evidence was found for heterogeneity and organisational diversity, social accountability, and quality control, in the sense described by Gibbons et al. There were differences with regards to openness and secrecy, the perception and views on the potential use of public engagement, and the trust gap was perceived very differently between the two countries.

Further research is needed to fully get an understanding for how the different actors around the policy-making table perceive one another in both countries,

and also how external parties in Finland, for instance, perceive decision making and how policy-makers perceive the public and civil society organisations and their involvement. The latter would be particularly interesting considering the portrayed high level of trust. The role and perceptions held of the media is also an interesting topic, especially as it is often mentioned in discussions about trust.

Apart from offering insight into the formulation of research questions and discussion points for future interviews, the pilot study was particularly important in order to understand the national and local contexts within which nanotechnologies and nanosciences policy making takes place, and to identify potential interviewees in both countries. All interviewees made good suggestions about whom to contact or which organisations or bodies to focus on in the search for interviewees.

The literature search and pilot study resulted in a Theme Matrix, or a mind-map, that will be used for the study:

TABLE 2.2: THEME MATRIX

| The governance of nanotechnologies and nanosciences, according to the interviewees for this study: | | | |
|---|---|---|---|
| | UK | Finland | Sweden |
| **Organisational diversity** | | | |
| a) Inclusion | | | |
| b) Interaction – trading zones | | | |
| c) Openness and transparency | | | |
| **Social accountability** | | | |
| a) Trust (among the public) | | | |
| b) Public Engagement | | | |

## 2.4 Formulating interview questions

In searching for the appropriate measurements, e.g. interview questions, that could shed light on how nanotechnologies and nanosciences policy-making in Finland, the UK, and Sweden has been approached and the balancing act

between promotion and regulation, the approach have been threefold. Firstly, the concept of ‘reality’ was explored, and accounted for in this subchapter, through theories more or less grounded on empirical data. Social capital was considered an interesting measurement that could be useful in measuring organisational diversity and social accountability. Secondly, putting social capital as a measurement into context, a literature review (2.2) was initiated with the aim to highlight potential research themes to pursue. Thirdly, a pilot study (2.3) was conducted, with the intention to explore some of the themes that emerged in the course of the exploration of reality and through the literature review, and their feasibility in forming the basis for interview questions (2.4). The pilot study showed that there are differences in the way the themes manifest themselves in Finland and the UK, and that the context within which questions are asked is important to understand in order to ask sensible questions.

The standard set of questions, which are included in Appendix I, are building on those found for measuring social capital and put into context to suit this study on the basis of the themes identified through the literature review and pilot study and as represented in the Themes Matrix above. Taking the context within which the interviews were conducted into consideration resulted in slight tweaking of the questions to suit the national characteristics and events in Finland, Sweden and the UK. Interviewees may also in some cases choose not to answer a couple of questions, enter into a deeper account of some of the questions while disregarding others, or bring forth additional questions for discussion and/or reflection; the semi-structured approach allowed for this and the number of interviewees alongside the back-up of literature and document review for each country aims to provide at least partial responses to all questions listed above.

## 2.5 Is nanosciences and nanotechnolgoies governance strategic and/or mode2-shifted?

The Themes Matrix reflects what this study seeks to measure, e.g. organisational diversity and social accountability, as reflected in the works of

Gibbons et al. and Rip. The study will, however, also aim to draw conclusions on the basis of the data presented in the empirical chapters with regards to the use of nanotechnologies and nanosciences governance as an example of Strategic Science and/or the visible shift towards a Mode2 model, and whether it is possible to make generalisations based a comparison between the three countries investigated here.

While the 'monstrous alliance' – or rather the increased number of actors involved with science and decision-making, and any indicators of public scrutiny and accountability in the governance of nanotechnologies and nanosciences (Rip, 2000:3-34) will be explored through the use of the Themes Matrix, each empirical chapter will also in its concluding section reflect on any references to *relevance* and *excellence* found in each country. For instance, does the discourse and resulting policies put nanotechnologies and nanoscience investments and development into a context that seeks to meet a future need? And/or is science advanced in its own right? One could put excellence and relevance as opposing one another as being 'applied' or 'fundamental' – but, Rip argues, the combination of the two keeps occurring in history and in modern science (Rip, 2000:33). Though it does not appear in the same way in all academic disciplines, it occurs often enough to justify the claim that strategic research, or strategic science, includes both components (Rip, 2000:33).

However, tying the above to Rip's criticism of the Mode 1/Mode 2 thesis, Gibbons et al. speak of relevance and excellence as two more clearly distinct items that do not overlap in the way that Rip would describe them to. They also consider there to have been a clear shift from Mode 1 to Mode 2, while Rip sees the two items interact and co-exist over time – e.g. not just in modern times. It is therefore interesting to explore which of the two frameworks that seek to make sense of science governance that best fit nanotechnologies and nanosciences governance in the three chosen countries – and in what way they fit or do not fit. This will also lead into a discussion about innovation and whether or not the findings of this study can contribute towards useful observations with regards to the presence of a

potential lateral rather than linear model of innovation in each of the three countries.

Following the theoretical discussions in the empirical chapters of this thesis, Chapter 8 will draw the discussions together for a cross-country comparison that aims to set out the foundation for the theoretical conclusions drawn in Chapters 9 and 10. The key theoretical conclusion made is that Mode2 and Strategic Science fit the UK science governance model better than that of either Finland or Sweden, but that the national differences found between the three countries would be better captured by the Strategic Science model due to there being more flexibility in this model than that of Mode2.

## Chapter 3: Methodology – qualitative over quantitative

*The aim of this chapter is to describe the method by which this study was conducted. It will first set the context for which a mixed methodology was applied and why; then explain the basis for the choice of a mixed methodological approach and give the background and motivation for both discourse analysis and phenomenology. The chapter will finish with a glimpse into the practical application of the methodology and a note on the ethical considerations made with regards to data collection.*

### 3.1 Descriptive methods: interviews

Looking at the tables of interviewees as included in Chapters 4, 5 and 6, it would almost appear that the interviewees chosen for this study were chosen randomly. They represent very different professional backgrounds and hierarchical positions within each decision/policy-making system looked into, though not necessarily with the same groupings being represented in all three countries.

The be-or-not-to-be of set nanotechnologies and nanosciences strategies further complicated the choice of interviewees. While it was 'easier' in Finland in that it was easy to find interviewees associated with the FinNano Programmes, finding interviewees in Sweden relied partially on talking to 'the right people' during the pilot study, who would, by snowball sampling (Kvale, 1997), direct me in the right directions on my interviewee hunt, and partially on just picking interviewees almost by random using the Finnish system as a road-map. The roadmap approach implies looking at who in Finland were represented on the boards and steering committees, and finding Swedish academics, officials, and other representatives with similar CVs or terms of references. What could have been a risky strategy in that there are differences between the two countries with regards to innovation/regulatory systems and decision-making structures and processes proved to work out in the end. The interviewees chosen in Sweden turned out to have a lot to say, and many underlined how they were the right people to talk to. That said, some were surprised at having been contacted and were either reluctant or hesitant to be interviewed. Their reluctance, when examined in greater detail,

was related to the decision-making structure and/or their perceived professional or hierarchical role, as perceived by themselves more than imposed by others or the structure that they identified themselves as working within. A rather interesting topic for the study, this will be discussed further in Chapter 4 alongside the account of national differences and research themes.

Finding UK interviewees was easier thanks to the many reports, meeting minutes and other written sources documenting current affairs within nanotechnologies and nanosciences policy-making and policy discussions; this as most of them contain a list of experts that were either included in the relevant committees or working groups, or those having been consulted for the writing up of the documents in question.

In the end, the interviews – carried out in 2008 - 2011, gathered 46 interviewees in three countries. Their professional backgrounds are noted in Table 3.1.

TABLE 3.1: INTERVIEWEES

| **Professional background** | **Finland** | **Sweden** | **UK** | **Total** *Per profession* |
|---|---|---|---|---|
| **Academia** | 8 | 7 | 5 | **20** |
| **Government** | 7 | 4 | 2 | **13** |
| **Industry** | 1 | 2 | 3 | **6** |
| **Other** | 2 | 2 | 3 | **7** |
| **Total *Per country*** | **18** | **15** | **13** | **46** |

Some interviewees did consider themselves representatives for more than one profession, such as a government employee in Finland who was also an active academic, and an industrial representative in the UK who also flagged his academic seat and interests. They have been sorted into the professional background or belonging that corresponded to their role in policy-discussions, but when needed – reference to their dual positions have been made when their accounts are discussed in Chapters 4-7. Further, 'Other' as marked in Table 3.1 refers to interviewees who could not be placed in any of the three

other categories. They were representing either NGOs or other civil society organisations, or consultancies and think tanks that did not want to associate themselves exclusively with either of the three roles, but had relations with all three and aimed to produce and/or provide evidence-based advice in policy-making.

Having been approached by email, introduced to the research topic and methodology, and – when requested, supplied with a standard set of research questions beforehand, the interviews were held either in the offices of the interviewees, or in other locations suggested by the interviewees themselves. One interview was held over the phone (see 3.7 for further details). All interviews apart from two were recorded and transcribed. As I am partially deaf, all interviews in English and Swedish were transcribed with the help of a transcription service, though due to lingual issues and the complex technical terminology used during the interviews, the recordings were listened to once or twice when needed, and the transcriptions corrected accordingly. Each interview lasted for between 45 minutes and an hour and a half.

### 3.1.1 Coding framework

The interviews were coded and analysed using NVivo. A full coding framework is included in Appendix II, though the main themes used for the full coding framework are also provided in Table 3.2.

TABLE 3.2: SIMPLIFIED CODING FRAMEWORK FOR DISCOURSE ANALYSIS

| Theme | Nodes | Child-nodes |
|---|---|---|
| Role | Self | Academia |
| | | Industry |
| | | Government |
| | | NGO |
| | | Dual roles |
| | | Other |
| | Others | Academia |
| | | Industry |
| | | Government |
| | | NGO/Civil society |
| | | Public |
| | | Other |
| Organisational diversity | Inclusion | Decision-making |
| | | Advisory capacity |

| | | |
|---|---|---|
| | | Excluded |
| | Interaction | Formal |
| | | Informal |
| | | Domestic |
| | | International |
| | Openness | Secrecy |
| | | Club/Network |
| | Transparency | Decision-making |
| | | Decisions |
| | | Documents |
| Social accountability | Trust | Public |
| | | Towards others |
| | Public engagement | Own involvement |
| | | Science communication |
| | | Purpose |
| | | Limits |
| | | Examples |
| Topics | Promotion | Innovation |
| | | KBE |
| | | Commercialization |
| | | Business Interest |
| | Regulation | Risks |
| | | Health and Safety |
| | | Domestic legislation |
| | | International legislation |
| | | Guidelines |
| | Research | Basic/Applied |
| | | Collaboration |
| | | Subjects |
| | | Infrastructure |
| | | Social and ethical implications |

The coding framework included four themes related to the roles of the interviewees, e.g. how they referred to themselves and others, a number of nodes as related to organisational diversity and social accountability (see Theme Matrix in Chapter 2), and 'topics' which relates to specific topics that were discussed or that otherwise came up in interviews. A number of child-nodes were attached to the nodes, and in some cases, grand-child-nodes became necessary. Statements were quite often coded to more than one node, such as for instance in a quote from Jari's interview:

*"After our discussion all these organisations, er, identified nanosafety as a very important issue, but none of them was ready to take an overall responsibility for safety in nanotechnology." (Jari, 2009)*

'Nanosafety' was found under 'Topics' -> 'Regulation' -> 'Health and Safety' -> 'Nanosafety'; 'Nanosafety' was also found under 'Topics'-> 'Research' ->

'Basic/Applied' -> 'Both basic and applied'. The whole quote also fell under 'Organisational diversity' -> 'Inclusion' -> 'Advisory capacity' -> 'Not heard' – as shall be discussed in the IPA case study in Chapter 7.

### *3.1.2 IPA case study*

Apart from the analysis of the interviews on the basis of discourse analysis and the above motioned coding framework, some of the interviewees provided very rich accounts that this study aim to capture through the use of interpretative phenomenological analysis (IPA), and a case study on the basis of IPA methodology as described in this chapter. The case study includes three extracts of three interviews held with one interviewee in each of the three countries. The choice of interviewees for the case study is justified in the beginning of Chapter 7 where the IPA case study is presented. The IPA Master table of themes has been included as Appendix III.

### *3.1.3 Other materials: policy documents and content analysis*

The interviews were crucial for the study, but not the only data of importance. Textual accounts as portrayed through reports and policy papers were also found, more so for the UK and to some extent – Finland, than in Sweden however. These are also referred to in the analysis and they have been particularly "screened" for the themes deriving from the research questions, the themes as identified through the literature reviews and any secondary themes or other interesting features portrayed through the interviews as included in the coding framework above. Some of the documents have also been spoken about during interviews, or – in five cases, interviewees have presented documents during interviews for consideration and for further detail on points raised or mentioned.

## 3.2 Methodology: planning and 'reality'

As touched upon in the introductory chapter, the methodology originally chosen for this study was discourse analysis (such as described by Potter in Hardy & Bryman, 2003). It was, at first, quite wrongly and possibly naively

believed that the cases would be more similar between the countries, and that the interview situation would be similar enough, despite the lingual differences used to go ahead with a 'one methodology fits all' approach. Had this been the case, clear-cut categories, themes, and 'flagged' words used by interviewees would have guided the 'traveller' straightforwardly in the right direction in the search for answers to a pre-defined set of research questions. Alas, as the interviews progressed from the drawing board into live and recorded events, the ambition quickly out-stepped reality.

The assumption of relative homogeneity between interviewees and the interviews themselves was one made based on a wrongly held perception of similarities in decision-making culture and the policy-making environment in three northern European EU member states that interact very frequently. Though Finland and Sweden interact more frequently and closely through various Nordic collaborative efforts, such as through Norden (the Nordic Co-operation) and its various bodies[18], the pilot study showed a clear difference in culture between the two countries. And a culture difference was similarly discerned between the UK and Finland, and the UK and Sweden, when compared. At first, however, it was thought that the difference lay primarily in the output of decision-making and nanotechnologies and nanosciences discussions in each country. Decision-making related to science and technology is, for example, more openly inter-disciplinary in the UK, where the Nanotechnologies Strategy Forum, to name an example and according to its most recent minutes, includes representatives from Academia, Government, Industry, but also Civil Society organisations (in this case a Consumer Group that has been known to advocate a cautionary approach to the development of nanotechnologies and nanosciences). The same cannot be said about Finland's applied FinNano Programme[19], where the steering committee included committee members representing industry, academia, and government agencies related to the programme, but none from a civil society based organisation (Lämsä & Juvonen, 2011). That said, a think-tank was

[18] A couple of examples of Nordic platforms for interaction are there is a Nordic Council of Ministers, and NordForsk - a funding organization for pan-Nordic research.
[19] Chapter 5 describes two FinNano Programmes, one focused on applied science and was run by TEKES while another, focusing on basic science, was run by the Academy of Finland..

represented, but through someone who had previously worked with 'nano-issues' within one of these government agencies. Sweden did not have a written-down and coherent nanotechnologies strategy at all (Perez & Sandgren, 2008), and decision-making was rather taking place within groups that were more scattered than were the case in Finland and the UK.

The existence or lack of a formulated strategy did not, in itself, have an impact on the choice of methodology. What did influence it was another difference in culture, one that was more difficult to pinpoint when conducting a literature review, though it was hinted at during the pilot study: the interview situation and the difference in familiarity with, or the perception of, the identified research themes among interviewees. Some of which, according to interviewees' own accounts, were said to be due to cultural differences between the countries and between their professional identities. In some cases, the questions were simply misunderstood, partially understood, or not understood at all.

This further spurred other questions and clarifications, and, often, a more in-depth conversation that took the study to a much deeper level than originally intended. One example was the concept of public engagement, which as a concept became more complex in discussions held in Sweden or Finland and where the complexity could not be put down to one of many linguistic obstacles. The reason for this being that public engagement does not have the same meaning in Finland or Sweden as it does in the UK, and it is hardly practiced at all. Such discussions changed the nature of the interview situation significantly, to the point that the interview, at times, became an in-depth exploration of interviewees' experiences that provided more detailed and richer data than expected, which, in turn, would not have been fully captured through discourse analysis. Some of the interviews also moved beyond the pre-defined research questions entirely.

It would be possible to make an argument for not including interviews that deviated from the research questions in the study, for the sake of comparability and generalization on which to base conclusions. However, the

argument for their inclusion is compelling in that their quality offers genuinely interesting information that aids in describing and making sense of the context within which decision-making is taking place. The responses are also of interest in themselves as – when they do go into great detail in relation to a research question, they provide information about how the question was perceived and interpreted within the 'reality' as experienced by the interviewee in question, while other interviewees will have replied to the question without offering such interpretation.

## 3.3 Finding a combined methodology

Thinking 'outside the box' in qualitative research is, fortunately, not unheard of as studies do not usually conform to a standard set of rules, and the context within which studies take place will exert its influence on the study (Mishler, 1990). One could say that a majority of the interviews did 'think' inside the box as their analysis followed the original plan where the research questions grew out of themes, and the discourse was analysed in according to these themes with the addition of more themes where needed. A majority of the interviewees did not challenge this setup. However, as the interviews progressed and numbers grew, the semi-structured approach and increasing insight encouraged increased reflexivity on the behalf of the interviewer. The lesson of not expecting the expected, and 'bracketing off' expectations entirely (a method advocated by Husserl, see 3.4) – an important element of phenomenological enquiry, provided clues as to the direction of research and encouraged an open mind. Moving into the tales of experiences and the meaning of such experiences called for something more suitable than discourse analysis, and phenomenological inquiry was settled on for a smaller number of cases. Having set the stage, it is necessary to explore both approaches in greater detail to fully appreciate their differences and merit, and how and why they complement one another.

### *3.3.1 What is discourse analysis?*

Discourse analysis (DA) as a methodology is quite commonly utilised in the Social and Economic Sciences, including STS and Political Science. Broadly,

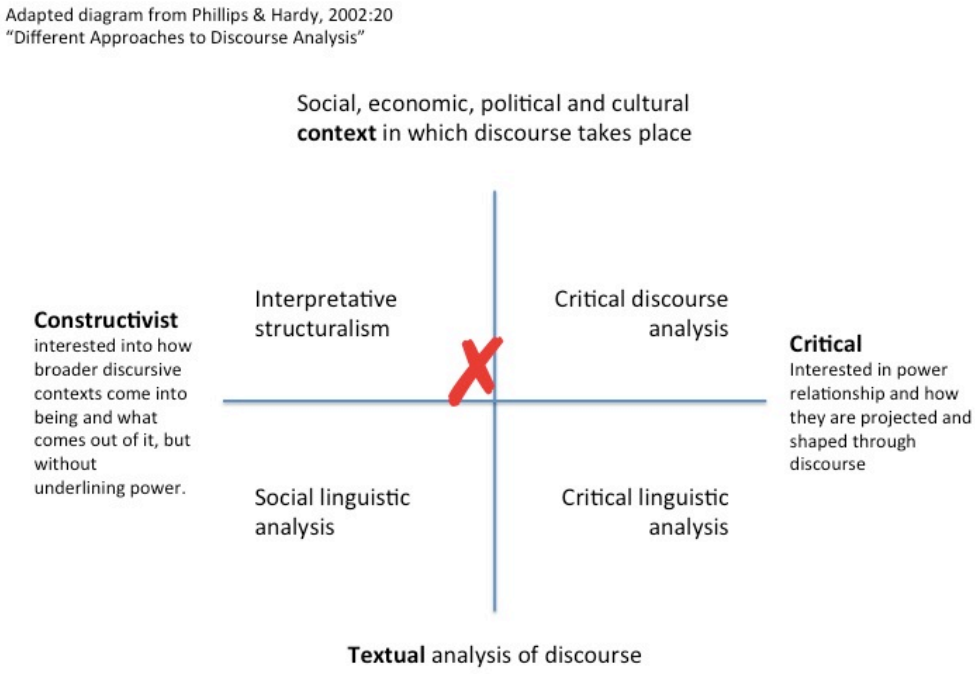
it follows a social constructionist epistemology in that language is considered something more than just a representation of the state of events that are being discussed, and the discourse itself is crucial to the construction of the ideas, values, and perceptions that shape the social reality of those part-taking in the discussion (Kvale, 1997).

For example, the French philosopher Marcel Foucault (b. 1926 – d. 1984) discussed discourse, and discursive practice in his earlier works; and meant that discourse is a rule-governed presentation of statements, concepts, and theories that, collectively, illustrate a set of articulated perceptions about 'something' (Månson, Ed. 2007:352). To Foucault, discourse existed due to discursive practices where every object or piece of knowledge is dependent on discourse and the discursive practice. The social reality, power relationships included in the discursive practice, he argued, determines and encompasses discourse (ibid.) Though an early writer about discourse, Foucault was not the first person to discuss discourse and its epistemological role. An earlier scholar than Foucault dedicating his time to discourse is, for instance, Leo Spitzer (b. 1887 – d. 1960), an Austrian philologist and literary critic whose work Stilstudien (1928/1961) was translated from German into French by Foucault. Though not coining the DA phrase – Spitzer's work explored how linguistic features worked alongside content in writing, which is one way in which discourse is analysed today. Spitzer's discourse analysis, though he did not use the term, was not –as in the case of Foucault, particularly interested in the notion of power and its role in discourse.

Indeed, the history of discourse analysis could become a thesis in itself, especially as it – through the care and scholarship of numerous scholars from a broad range of disciplines, has branched into many different connected and/or similar analytical frameworks. These include, among others, ethnography (Woolgar, 1983; Latour & Woolgar, 1986; Traweek, 1988; Schwartzman, 1993), narrative analysis (Riessman, 1993, Czarniawska 1998;), and conversation analysis (Psathas, 1995). For the sake of limitation, these branches or traditions will not be discussed further, but they are an illustration of the complexity in trying to locate a method in a jungle of options.

Describing discourse analysis as a method is also challenging, and, on closer inspection, scholars have found alternative ways of describing it. It is, for instance, an analytical way of thinking (Gill in Richardson (Ed.), 1996:144), or a methodology or theoretical perspective (Phillips and Hardy, 2002:3), and a form of scholarship (Potter, 1997, 2003 (in Hardy & Bryman)) or academic enterprise (Nikander in Holstein and Jaber (Eds), 2006). This study does not choose between these perspectives, as they are not really contradictory, but will make reference to Phillips and Hardy's description of the theoretical perspectives in discourse analysis – and place the outlook in the study into an adapted version of their diagram, below (Phillips & Hardy, 2002:19-20).

TABLE 3.3: FINDING AN APPROACH TO DISCOURSE ANALYSIS




As the diagram, by Phillips and Hardy called 'Different Approaches to Discourse Analysis', suggests, DA can be placed within two dimensions. The first asks the researcher whether they choose to focus on textual analysis, or put more emphasis on the context in which discourse take place. Secondly, the researcher will be asked to consider whether the intention is to take a critical approach, that will focus more on power, the role of power, and the

expression of power as related to the topic under investigation (Foucault outlined much of this route, as above). If power or politics is not necessarily of key interest, but the researcher is more interested in understanding how discourses influence the creation of certain phenomena and how they come to be associated with 'reality', Phillips and Hardy (through referencing to Dunford & Jones, 2000, and Hirsch 1986) argue that this can also be scrutinised at the 'Critical' side of the spectrum (Phillips & Hardy, 2002:21). If the researcher is more interested in a broader picture of how the discursive context comes into being, but not necessarily interested in power or politics, the 'Constructivist' (or Spitzer) side of the spectrum offers an opportunity to explore the features of how a social 'reality' has been constructed (Philips & Hardy, 2002:20). Philips and Hardy also place four approaches that they call major perspectives adopted in empirical studies, within the matrix: interpretive structuralism, social linguistic analysis, critical discourse analysis, and critical linguistic analysis.

The adaption of the matrix here is that the four approaches are not considered the only approaches that could be placed within the matrix, nor are they as clear-cut and compliant with their positioning as the matrix seem to suggest. Indeed, it has been a challenge to find a suitable place for the 'DA-method' chosen for this study, in particular with regard to the choice between context and text. Further, politics and power are not specifically focused on, with regards to the second dimension suggested by Phillips and Hardy, but they are not entirely written out of the 'reality' this study seeks to explore and address. All this stated, Phillips and Hardy provides the researcher with some flexibility in admitting that their own attempt to define DA is rather broad and one that includes both text and the context from within which it derives (Phillips and Hardy, 2002:19). Their following warning rings clear however, "no researcher can study everything" (Ibid.)

In an attempt to place the DA-methodology chosen here within Phillips and Hardy's matrix, a 'close enough' spot has been marked with an 'X', indicating interpretative structuralism, but also features of social linguistic analysis and critical discourse analysis.

*3.3.1.1 Theme-oriented discourse analysis*

The assumption here is that the interviewees find themselves in a professional role, though it is a new role to some of them, and that discourse becomes more than just a circumstance where language has a representational role, but also one where language has a constitutive role in that to talk and discuss becomes *work* (Roberts & Sarangi: 2005). Though very much focusing on what was said and transcribed into text, this part of the methodological framework is not lacking of the more 'ethnographic' features that come naturally through the interview situation. Immediately following each interview, notes were taken to reflect the setting within which they were held describing the features important to the identity and backgrounds of the interviewees, and the topics discussed or not discussed and the tone in which topics were discussed – this is what Roberts and Sarangi call the '*communicative ecology*' of the interview (Roberts & Sarangi, 2005:633), and the term will be used frequently with the same meaning during this study. The communicative ecology is an important piece of the puzzle in analysing interviews as it will aid in providing the ideological backdrop to the interviews, and may explain the values, beliefs and attitudes that shape statements made and opinions expressed, and is of interest in its own right.

With the large number of interviews, only the sections of each interview that were relevant to the themes as identified in Chapter two were analysed in greater depth. That said, some of the less theme-oriented parts of the discourse have contributed to the notes on communicative ecology kept for each interview. With the potential danger of losing data that at a second reading could have proved important to the themes, each interview was read through at least 3 times, and some of the interviews were re-coded following more in-depth analysis and the use of the notes.

In the last stage, connections were made between what was said, and the context in which it was said through the use of analytic themes that often could connect to the communicative ecology of the interview. Such analytic

themes were frames, contextualisation cues, face work, social identity, and rhetorical devices (as also utilised by Roberts & Sarangi, 2005).

Firstly, framing refers to the filtering process by which general values and behaviour are reworked to apply to different situations. A politician may relate differently to the exploration of new technologies than does an industrial representative, or someone identifying themselves 'an academic' may find the precautionary principle more cumbersome than does a consumer organisation executive who may be relating to the principle on a daily basis. Interestingly, sometimes people change their framework during a discussion. Interviewees may, for instance, find that they have more than one professional identity or role during the course of the interview depending on the questions that are being asked, or perhaps they way in which the question is being asked. The frameworks help to make sense of various contextualisation cues given that are specific to the interview situation. Cues can include words such as 'so', 'well', 'however', and any other means of indicating stress or intonation. Significant pausing may also be a cue, or an abrupt end to a sentence that would - if this were a cartoon, come with an exclamation mark in a speech bubble!

Social identity refers to parameters such as gender, age, social standing, religion, ethnic background, etc. Although interviewees were not asked questions specifically related to their social identity, apart from as related to their professional roles, further social identifiers and related features can be more or less pronounced during interviews, entirely unintentionally. As they may shape what is being said, however, they may also shape the setting within which it is being said in that underlining a part of the social identity of either the interviewer or the interviewee may influence their perceptions of one another, or of other individuals or situations that are being discussed. Turning up for an interview in Finland while also revealing that one of my parents is a Finnish-speaking Finn seemed to make a difference to some of the interviews held in Finland. In hindsight one can argue as to whether or not that detail should have been omitted from my introduction, and whether it actually had any influence on the data gathered. But, then again, turning up

for an interview with an affiliation to a UK University while speaking Finnish and Swedish – spoken by a mere 5 and 9.5 million people respectively, often do raise questions about my own social identity.

Another theme that may come up in interviews is that of rhetorical techniques. Interviewees may, for instance, organise their input into a certain way, or repeat what they have identified as key words, or even just mentioning such words in a certain order. Metaphors, analogies and other structural scaffolding around the way people speak or transmit a message are also rhetorical techniques that may be used with the intention to influence or persuade the listener. US President John F. Kennedy's inaugural address delivered on January 20th, 1961, is a fine example of the use of rhetorical techniques: *"And so, my fellow Americans: ask not what your country can do for you – ask what you can do for your country. [pause] My fellow citizens of the world: ask not what America can do for you, but what together we can do for the freedom of man."* In his speech, Kennedy didn't just talk to a part of the world, but to the whole world, under a very chilly part of the Cold War and in the running up to the Cuban missile crisis in 1962. The parallel structure created through the two sentences also serve as a bridge between people of different viewpoints as much as it is a poetic stroke of genius. Obviously, JFK was not interviewed for this study, but a couple of good attempts at using rhetorical techniques did occur, particularly when interviewees wanted to highlight key words or 'sound bites' for me to take away from our interaction.

Discourse analysis is useful here as it, particularly by using a themed approach and mapping gives an adequate picture of how people make sense of one another, and indeed the topic, moment by moment – and also identifies the inevitable framing and contextual cues that come through human interaction. That said, and as Roberts and Sarangi note in their evaluation of the approach in an intercultural primary care setting, it may be a difficult approach to resort to in some intercultural circumstances as contextual cues and frames may be overlooked or misunderstood (Roberts & Sarangi, 2005:637).

Summarising the mapping exercise, one can draw parallels to what Fairclough says about drawing a two-layered distinction in the construction of discourse – the 'external' elements such as culture, context, and theoretical alignment – political or otherwise, that are identified through the use of the above listed themes, influences discourse, that is also influenced by the actual textual meaning of what is said (Fairclough, 1992:253). Both layers provide an equal contribution to a given social reality; this study aims to find and understand the *meanings* that contribute to the shaping of that social reality.

The challenge here is to satisfy both Fairclough's demand in achieving a 'holistic' picture of events and meanings, and Phillips and Hardy's advice of not taking on too much. Subchapter 3.5 will discuss how this was done in more detail, at least with regards to the cases that were purely analysed using DA methodology. Some cases were more complex and provided what could be described as 'richer' and more different data, which questioned the use of DA methodology entirely, despite the potential holisticism of Fairclough's.

### *3.3.2 Phenomenology*

A methodology most commonly used in Psychology and Education, phenomenology lends itself well to qualitative study that goes into depth about people's lived experiences. Though phenomenology has expanded into various different strands depending on its application as a methodology and theoretically, all shares a core set out by German philosopher Edmund Husserl (b. 1859 – d. 1938). Husserl's phenomenological cornerstone prescribes researchers 'to go back to the things themselves' (Husserl 1927), a principle which is based on the understanding that people are intimately familiar with their own experiences of an event or phenomenon. Hence, it is, to those utilising the technique, of interest to gain insight into the means by which people 'live' experiences and how and what they identify as being the essential qualities of that experience. (Smith et al. 2009). Husserl's is an ambitious scheme, and as Smith et al. puts it – he was a philosopher rather than a psychologist, which makes the identifying of his proposed programme

a somewhat scattered read with examples spread over his writing (Smith et al. 2009:15). Further, examining the actual consciousness of interviewees would, for instance, go beyond the realms of this study. Moreover, Husserl's writing is reflecting an intention to express the consciousness and experiences of research subjects in first-person, which either would write the middle-woman researcher who intends to research the view-point of others to come to a conclusion out of the picture, or mean that the researcher would reflect on their own consciousness and experiences, which is not what this study is setting out to do (Smith et al. 2009:15). Hence, the route ahead has been chosen among a broad variety of phenomenological frameworks found, where the best 'fit' to the study is that of Interpretative Phenomenological Analysis (IPA), as described by Smith et al (Smith et al. 2009).

In outlining the theoretical foundations of the IPA framework, Smith et al. draw from Husserl's founding principles, but also discuss the contributions made by another German philosopher, Martin Heidegger (b. 1889 – d. 1976), and French philosophers Maurice Merleau-Ponty (b. 1901 – d. 1961) and Jean-Paul Sartre (b. 1905 – d. 1980). All three philosophers drew on Husserl in their approaches to phenomenology, but with criticism that IPA researchers have built on to develop IPA methodology.

Firstly, Heidegger, criticised Husserl in that he found the latter too abstract (Smith et al. 2009:16). His major work – Sein und Zeit (1927 – 2006 edition, include references below.), also criticised civilisation more generally, and radically, in that he argued that all philosophy from Plato and onwards has been erroneously thought through and by the means of the wrong 'categories' as the notions of **soul, man, and consciousness**, for instance, have been corrupted. Rather, Heidegger argues, we should focus on research into man's place in the world, which is more in line with discussing existence itself rather than Husserl's focus on individual psychological processes (Smith et al. 2009:16). *Dasein*, was a term coined by Heidegger to represent a more worldly approach towards study. The translation of Dasein is 'presence' or literally 'there-being', which, Smith and al. argues, "affords the embodied, intentional actor a range of physically-grounded (what is possible) and

intersubjectively-grounded (what is meaningful) options" (Smith et al. 2009:17). What this offers IPA, Smith et al. continues, is essentially the idea of people/research subjects as being part of a larger world than their own minds, and that their ideas, values, and experiences manifest themselves in relation to a world of objects, their environments, and other people in it (Smith et al. 2009:18). Heidegger also made a contribution to the Hermeneutics that goes into the IPA compass, which will be discussed below.

Maurice Merleau-Ponty's contribution to IPA-related theory came in the shape of a development of Heidegger's worldliness into reflections on the embodied nature of human relationships with the world, and how it has led to the perspectives humans have about the world they inhabit (Smith et al. 2009:18). His perspective is a rather constructionist one in that Merleau-Ponty underlined how all knowledge of the world is shaped by the point of view of the subject in question, and, as Smith et al. points out – the lived experience of the subject cannot be fully grasped or shared by anyone else than the person who is experiencing it, but it should not be overlooked (Smith et al. 2009:19).

Merleau-Ponty's contemporary, Jean-Paul Sartre, took one step further in his philosophising on our existence in his 1943 essay *L'Être et le Néant* (Being and Nothingness) in claiming that existence precedes essence, a claim that Heidegger similarly made in Sein und Zeit (1943/2006:42) in stating that *"Das "Wesen" des Daseins liegt in seiner Existenz"* – or, here translated: the essence of presence (or there-being) lies in its existence. That said, Sartre, though acknowledging Heidegger's contribution – but without reference (Sartre, 1943/1995:438)[20], developed the concept further and discussed the ever-developing human self, which does not exist before it is developed and shaped by the world in which the self exists. *Le Néant* also lends a clue to Sartre's thinking – not only are we shaped by our 'being', our selves are also shaped by the absence of 'being', e.g. the presence and absence of

[20] Sartre writes of freedom as being without essence "It is not subject to any logical necessity; we must say of it what Heidegger said of the *Dasein* in general: "In it existence precedes and commands essence." (Being and Nothingness, 1943/1995:438). Sartre does not include a reference for the quote.

relationships to others and experiences etc. also shape our essence (Smith et al. 2009:20).

Smith et al. offer a summary of the contributions made by Husserl, Heidegger, Merleau-Ponty and Sartre towards the backbone of IPA methodology: they move us away from of the person 'as embedded and immersed in a world of objects and relationships, language and culture, projects and concerns." (Smith et al. 2009:21). The latter three further move IPA towards the meaning of the 'I' - interpretative, which is something Husserl lacked apart from in the sense of interpretation on behalf of the 1st person and by the 1st person. A lived in world, Heidegger, Merleau-Ponty and Sartre would say, comes with relationships with objects and others, involvement with all features of the lived-in world, and – Sartre would argue, the lack of it. To understand that lived in world, one will be able to understand the experiences, or 'the things themselves', which require interpretation, and in this sense, the interpretation of experiences in order to find meaning.

Hermeneutics, the theory of interpretation, is a second vital component of IPA – much thanks to the efforts of Heidegger, a hermeneutic phenomenologist. (Smith et al. 2009:21). Though Smith et al. claim that hermeneutics originally represent an attempt to understand and interpret biblical text (Smith et al. 2009:21) – one can trace hermeneutics back further than that; from Aristotle's *On Interpretation* (Ca. 350 B.C.) which attempts to deal with language and logic in a formal and structured way, to Mimamsa (Ca. 4th century B.C.) offering rules for the interpretation of the Vedas (earliest scriptures of Hinduism). What they all have in common is the attempt to formalise or describe the process of interpretation, be it by the interpretation of text to more modern means of audio-visual data, or more specifically in this case, the transcriptions that are made following interviews.

Heidegger, in interpreting the definition of phenomenology, argued that the Greek components of the term – phenomenon ('show' or 'appear') and logos ('discourse' or 'reason'), when put together, the perceptual and analytical parts of phenomenology serve to help us examine the 'thing itself' as it

appears (Heidegger, 1927/1962/2012: 58)[21] to us – or, as laid down for this study - in second person – as it appears to others, whose experiences we are examining. Contrasting with Husserl's views on the need to scale back the role of the interpreter (or indeed not have an interpreter at all) – Heidegger underlines how something that is being interpreted cannot be a truth hanging in thin air, rather – its interpretation will always be influenced by the fore-conceptions of the interpreter (Heidegger 2006: 151-153). It is therefore the interpreter's job – not only to observe the thing itself and the lived-in world of the research object/interview subject, but also to keep track on their own preconceptions. Though it would be tempting to shield oneself from all preconceptions by deciding not to apply any at all, ahead of interviews or discussions with the said 'interviewees', Smith et al. argue – it is, sometimes, actually easier to identify exactly which or what those preconceptions are once one has engaged with the actual data. (Smith et al. 2009:25)

The issue of preconceptions with regards to interpretation could, almost, be condensed into a sub-chapter and named 'disclaimer'. One person who explored the issue in detail was one of Heidegger's students, Hans-Georg Gadamer (b. 1900 – d. 2002). One of his major contributions to hermeneutics – Trust and Method (originally published as Wahrheit und Methode, 1960) Gadamer develops Heidegger's ideas about fore-conceptions, but crucially to the interview situation, also encourages phenomenologists to exercise openness with regards to data collection. Understanding the text or data collected is one thing, writes Smith et al., while another understands the person whose experiences and meanings are being researched. The former

[21] This is a simplified translation. Heidegger's reasoning is considerably longer in that he discusses the different interpretations of phenomenon (φαινόμενον) and logos (λόγος) and the origins of each word. He eventually pins down the formal meaning of 'phenomenology' to be expressed "in Greek as λέγειν τά φαίνομενα, where λέγειν means άποφαίνεσθαι. Thus "phenomenology" means άποφαίνεσθαι τά φαινόμενα – to let that which shows intes be seen from iteslf in the very way in which it shows itself from itself.» (Heidegger, as translated by Macquarrie and Robinson 1962/2012: 58). The English translation of Sein und Zeit offers a longer footnote on the issue with more information regarding, not only the etymological connections between the Greek words used, but also between the German worlds Heidegger used. Heidegger did eventually choose to go with the simpler maxim, 'to the things themselves!' (ibid.) – and my simplified translation seeks to pin down a more operational take on the term as used in this study. For Heidegger's discussion in German, see Heidegger 1927/2006:33-35. All Greek translations taken from Heidegger's own translations.

does, according to Gadamer, have priority. (Smith et al. 2009:27). Referring to the interaction between researcher and research subject as a more mutually engaging 'dialogue' than a Platonic such, Gadamer prescribes *"[t]he first condition of the art of conversation [to be] ensuring that the other person is with us"* (Gadamer, 2003/1960: 367) Gadamer continues:

*"To conduct a conversation means to allow oneself to be conducted by the subject matter to which the partners in the dialogue are oriented. It requires that one does not try to argue the other person down but that one really considers the weight of the other's opinion. (…) A person skilled in the art of questioning is a person who can prevent questions from being suppressed by the dominant opinion. A person who possesses this "art" will himself search for everything in favour of an opinion. Dialectic consists not in trying to discover the weakness of what is said, but in bringing out its real strength. It is not the art of arguing (which can make a strong case out of a weak one) but the art f thinking (which can strengthen objections by referring to the subject matter)."* (Gadamer, 2003/1960: 367).

Another achievement credited to Gadamer is what is called 'the hermeneutic circle', which, Smith et al. writes, is of great use to IPA research as it allows researchers to move back and forth through the data in a non-linear fashion and may make it easier to discern the interpreter's own relationship to the data. (Smith et al. 2009:28).

Finally, the basis of IPA includes another component – Idiography. Smith et al. describes idiography as being concerned with 'the particular' (Smith et al. 2009:29). The sense of detail as expressed through the particular through in depth analysis is seen in a larger context that encompasses the perspectives of particular people (research subjects, interviewees etc.). Single cases matter, and phenomenological studies often only include one case study, which is considered justified if they describe 'something intrinsically interesting'. (Platt, 1988: , also quoted by Smith et al. 2009:30). Following a focus on the particular in the 'single case' allows the researcher to move on to the formulation of general principles, which later can be checked against the data gathered for other cases undergoing the same thorough analysis (though particularities are likely to come with variations between cases).

Obviously, this study does not include one single case, case study or interviewee – rather, it includes 46 cases divided over 42 interviews that could have become a very large study had all been considered with great attention to the particular. That said, as Smith et al. continues, IPA does not necessarily restrict itself to single case studies. And in this case, as IPA is applied to a handful of the cases (interviews, including both transcriptions and notes), which has been clearly motivated due to the nature of the interviews, choosing IPA as the methods for part of the study makes sense.

In summarising the theoretical underpinnings for their proposed IPA framework, Smith et al. point out that, despite Husserl's favouring of first-order experiences, IPA will take both first-order and second-order activities into account, as long as they always make up the subjective experience of 'something' (Smith et al. 2009:33) as held by a person that lives in a world and is subject to numerous relationships with the world and all things and beings in it. IPA is also concerned with experiences that are significant to the people who are experiencing them. An interviewee who does not consider his or her role in nanotechnologies or nanosciences policy-making of any interest or of note would not be of interest for an IPA-guided analysis of that experience, for instance. When their involvement with decision-making becomes an experience 'worth talking about', is of interest, and so are their attempts at making sense of the experience and its meaning. Hence, some of the interviews actually helped out in identifying which methodology to choose during the course of the interview – a turn in the hermeneutic cycle in itself.

With regard to the necessity for reflexivity, it is also necessary to draft a 'disclaimer' relaying all noted pre-conceptions on behalf of the interpreter in relation to each case study where IPA has been utilised. The disclaimer will also need to highlight when the said pre-conceptions were identified, and give an idea of how – if necessary, the interpreter managed to hinder an identified pre-conception to actually influence the discussion. Hypothetically, if I was to interview a known member of the Sweden Democrats – who I know have their roots in the nationalistic and neo-Nazi movements in Sweden – perhaps my likely pre-conception of the interviewees as a potential neo-Nazi sympathiser

would render me to avoid asking certain questions, or come to certain conclusions, as I would not want to influence the interview by the said preconceptions? Similarly, my pre-conception when interviewing an industrial representative such as Christine may be that she would not want to discuss the lack of transparency within Swedish industry. The task then is to put this conception aside and avoid leading questions.

*3.3.2.1 Mapping IPA in 5 steps*

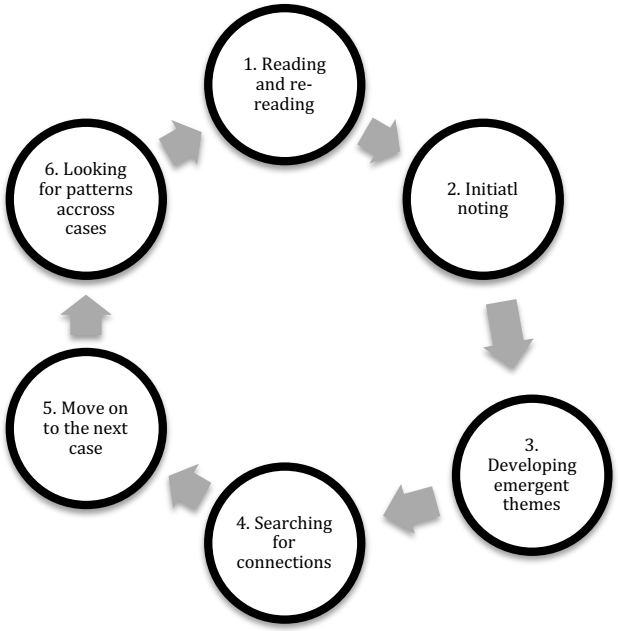
Having established the background and foundations of IPA, the study will need to pin down more concrete and practical principles for the framework. IPA does not have a rigid and clearly defined method. Rather, Smith et al. describes it to be an approach (Smith et al. 2009:47) and introduce a few 'steps' for novice IPA researchers to follow. The steps will be introduced here, though with slight alteration as the IPA 'steps' and examples presented by Smith et al. are tools that are suitable for in-depth psychological research, whereas this study – though also in-depth, is not as preoccupied with the mental state or consciousness of the research subjects, and makes no such claims.

First of all, however, a justification for the use of IPA is in order. Smith et al. underline that the prime reason for choosing to use IPA in a study is that it is the most in line with the epistemological position of the research question (Smith et al. 2009:46). Indeed, as if taking a turn in a hermeneutic circle, the research question – or rather, secondary research questions, did alter slightly depending on the interview situation. While discourse analysis is more useful when asking more specific questions, such as: How do nanoscientists relate to regulatory activities when discussing innovation? – IPA would pin down something more open-ended and explorative, such as: How do nanoscientists relate to the experiential features of being part of policy discussions? Or even – What are the experiential features of policy discussions as experienced by nanoscientists?

The intention, when this study was first embarked upon, was as claimed above, not to use IPA. It was to utilise qualitative research methods and

conduct in-depth semi-structured interviews with a rather large number of interviewees. Discourse analysis was the well tested way forward. However, the interviews took place and some original 'decisions' warranted further reflection and consideration, partially thanks to the data collected and the nature of the data collection. In a handful of cases, interviews became unexpectedly deeper than 'in-depth' in that it became obvious that the policy-making situation was of great and central interest to the interviewee, and they readily wanted to reflect on their experiences and the meaning of their part-taking in such activities. It became clear that a discourse analysis would not do these interviews justice in that a lot of data would be omitted or disregarded. Hence the use of two methodologies, which, fortunately, would steer the study away from any unwanted 'methodolatry' (Chamberlain, 2000; also referred to by Smith et al. 2009:40) – e.g. emphasising proper and correct methods before interpretation, or considering the study's actual and intended position with regards to ontology and epistemology. The six steps of IPA will be described with these circumstances in mind.

TABLE 3.4: THE 6 STEPS OF IPA
(based on Smith et al. 2009: 82-103)




In forming a circle it is possible – and indeed encouraged, to repeat the IPA process for each case.

1. *Reading and re-reading: this step involves immersing one self with the data. Re-reading will facilitate finding patterns, and the 'feel' of the interview.*
2. *Initial noting: examining semantic content and language use. This could include descriptive, linguistic and conceptual comments. (See Chapter 4, subsection)*
3. *Developing emerging themes: capturing a part of the text, but keeping it as a part of a 'whole'. Likely influence from analyst's own interpretation.*
4. *Searching for connections: there are different options for doing this. This study will seek to connect to the themes of the discourse analysis, and also to sort themes along super-ordinate themes.*
5. *Move to the next case, bracketing off what was said in the previous case as it would not do the next case justice*
6. *Look for patterns across cases: producing a Master table of super-ordinate themes and their sub-themes for all cases (See Chapter 4, subsection)*

#### *3.3.2.2 IPA as used in this study*

This study is making specific use of IPA for 3 case studies. The cases chosen include one in each country. Though DA could have been chosen as the methodology for an all-UK case study, one interview has been included for IPA here as it would facilitate a comparison between countries. There was enough data to include more cases – 2 more in Finland, and 1 in Sweden for IPA studies, but the limitation in time has had to limit the ambition. These non-included cases for the IPA study has been included in the DA part of the study, but some of the data has been explored in greater detail, using IPA methodology in unfolding the rich detail embedded in their lingual and conceptual features. Any references to this will be clearly indicated as and when made.

Turning back to the three chosen cases. IPA does not prescribe generalisations, but common themes are sought if more than one case is under scrutiny. Further, as individuals are perceived as living within a world, or being-in-the-world, that world as it can be described or lived for the three chosen cases is of interest. In fact, there are significant similarities between the three: all three are nanoscientists, of a similar age group, and the same gender. They are all also considered senior within their respective academic disciplines (their 'original'[22] academic disciplines differ), and all three have been called upon to part-take and offer their expertise in nanotechnology

[22] 'Original' used here to mark that researchers and scientists involved with 'nanoscience' or 'nanotechnology' often come from a broad range of backgrounds. In this case, they may be considered as representing Chemistry, Physics, and Engineering.

policy-making. One of their main differences, however, lies within their different takes on the primary and secondary research questions for this study, or in IPA terms – the super-ordinate themes; which makes their inclusion as IPA case studies very interesting. This will be discussed further in Chapter 4.

### 3.4 Ethical considerations

All interviewees taking part in this study were given a background or introduction to the study, and provided with its key research questions, the methodological approach, and what to expect during the interview ahead of the interview. They were provided with a list of questions that were going to be asked during the interview upon request, and they were informed of the possibility of receiving the pre-set questions in advance. All interviewees were aware of the semi-structured nature of the interviews, and knew that – if they chose to see the questions ahead of the interview, that the questions might change. All interviewees were also guaranteed anonymity, and, should they feel it necessary for their participation, they were given the choice to opt out of having the interview recorded. For the latter, two of the interviewees chose not to be recorded, of which one also chose to be interviewed over the phone rather than in person. These two interviews were carefully documented through real-time note taking, to which both interviewees had given their consent. Another interviewee asked me not to record a part of the interview, as he was going to tell me something in confidence. This has been respected in relaying his account.

In order to protect the anonymity of the interviewees, their names have been changed, and their exact place of work have not been enclosed if it has been entirely obvious who I have interviewed by enclosing it. When not referred to by their alias, interviewees are referred to by their professions as being ‘Academics’, ‘Scientists’, ‘Industry representative’, ‘Government representatives’ and ‘Other’ or similar (or by more than one role if applicable), as indicated in tables 4.1, 5.1, and 6.1. Nanotechnologies and nanosciences was a small area of research, and singling out those involved with policy-

making within a specific timeframe makes the group even easier to identify. References have also not been given to their geographic location beyond stating which country they are based in, for the same reason. If necessary to make a distinction, it has been made as generic as possible, for example: '*Esa, an Academic based at a small-to-medium sized regional University'*.

I remain the only person who knows the identity of the full list of interviewees. Nine of the interviewees were keen to know the names of others who had been interviewed, but it was not shared with reference to the promise of anonymity. All data related to their identity and the transcripts are kept safely stored according to the data protection guidelines as issued by University College London.

# Section two: Field study and data analysis

*This section is divided into four empirical chapters where chapters, 4, 5, and 6 are dedicated to one country each, and chapter 7 presents the analysis of the IPA case studies for each country. Each empirical chapter will end with a section that aims to connect to theoretical framework presented in Chapter 2.*

## Chapter 4: Nanotechnologies and nanosciences policies in the United Kingdom

> *This first of three country-specific chapters aims to present the field study results and data analysis as conducted for the United Kingdom. The first part of the chapter will provide a backdrop to the interviews through a review of all published policy papers, strategy documents, and related documentation available and found at the time of the field study. The second part of the chapter reviews the interviews held in the UK between 2008 and 2011 in relation to the research themes. A summary of the main points that came out of the UK field study and a section that aims to discuss the findings in the light of the theoretical framework presented in Chapter 2 will conclude the chapter..*

4.1 Towards a nanotechnologies and nanosciences strategy: early promotion

A lot of material such as reports, statements and reviews were found in the UK and they were easily accessible. As the UK interviews were held between 2008 and 2011, the *UK Nanotechnologies Strategy: small technologies, great opportunities*, accounted for in this chapter, was published after some of the interviews had been held.

If one was to draw a graph measuring UK government activity over time with regards to nanotechnologies and nanosciences it would result in a 'wavy' line where support and interests went from virtually no interest, to rather a lot of interest, and then back to flat sand, and for another wave to gradually build up again. The first wave started to gather mass relatively early on in 'nano'-history, through the National Initiative on Nanotechnology, a joint venture between the National Physical Laboratory and the DTI (Department for Trade and Industry). Launched in 1986 following increasing academic activity within nanotechnologies and nanosciences R&D (Research and Development), the programme sought to promote awareness about nanotechnology. The

programme was expanded two years later, in 1988, when DTI launched the LINK Nanotechnology Programme (LNP), which would support projects at universities, SMEs and large companies for the next 10 years (House of Commons, 2004:9). In an evaluation following its conclusion, the programme was described a success in that its impact had been high, sales had increased for those taking part in funded projects, and there was evidence for increased R&D output and spin-off benefits (House of Commons, 2004:9). Indeed, the UK was considered at the forefront of nanotechnologies and nanosciences internationally. That said, the wave – it would seem, started to flatten out as little was done to build on the success, and there was hardly any real industrial interest to speak of (House of Commons, 2004:9-10). The lack of industrial engagement, and the lack of funds for technological support within DTI were both given as reasons for the inaction by Patrick McDonald, then the DTI official lead on nanotechnologies, as he was being quizzed by the House of Commons Science and Technology Committee in their report pointedly entitled “Too Little, Too Late (…)” (House of Commons, 2004:9). The DTI did not spring into action again until 2000-01, when the UK had lost its position among the world leaders in nanotechnology R&D, and was trying to catch up in 2004 (House of Commons, 2004:3, 10, 64), and still trying to catch up in 2007 (Council for Science and Technology, 2007).

The first sign of a nanotechnologies and nanosciences policy or strategy was delivered though the so called ‘Taylor Report’, a report of the UK Advisory Group on Nanotechnology Applications submitted to Lord Sainsbury, then Minister for Science and Innovation, by Sir John Taylor, the Director-General of the Research Councils, in 2002 (UK Advisory Group on Nanotechnology Applications, 2002). The Taylor Report provided a number of recommendations for the future of UK nanotechnologies and nanosciences investments and encouraged the devising of a coherent national, and increased cooperation between academia and Industry (UK Advisory Group on Nanotechnology Applications, 2002:7ff). The group also underlined the necessity for microtechnology and nanotechnology to be treated as separate entities in that merging them would destroy the wanted explicit focus on nanotechnology, which the group found was ‘essential’ (UK Advisory Group

on Nanotechnology Applications, 2002:10). Separating the two was essential due to the under-appreciation and under-application of nanotechnology in the UK, Sir John Taylor later argued (House of Commons, 2004:15). Investment was particularly recommended for areas in which the UK already profiled itself, both in terms of research strength and industrial opportunities (House of Commons, 2004: 11-13), and the report writers particularly recommended further investment into six out of fourteen possible areas: electronics and communications, drug delivery systems, tissue engineering, nanomaterials, instrumentation, and sensors and actuators (UK Advisory Group on Nanotechnology Applications, 2002:7). Each area was explored through a scenario where the group sought to explain what was currently going on in the UK in the field, what the competition looked like, and what was needed to move ahead (UK Advisory Group on Nanotechnology Applications, 2002: 47-69). The group also recommended that investment be made towards setting up two national nanotechnology fabrication centres, through working with existing centres of research excellence and building on existing infrastructure (UK Advisory Group on Nanotechnology Applications, 2002:9). The Taylor Report did, according to the House of Commons Science and Technology Committee, not only provide *"a comprehensive, ambitious, affordable and achievable strategy for the development of UK nanotechnology capability: it provided a ready made blueprint which the DTI could have taken forward and implemented in full."* (House of Commons, 2004:12)

It would take the government thirteen months to respond to the Taylor Report, with an initiative at hand. Within those thirteen months, the DTI decided to commission a survey of the industrial interests in nanotechnologies in order to provide evidence to support an initiative. The House of Commons Science and Technology Committee questioned the unnecessary delay; unnecessary as the Taylor Report had already underlined that there was relatively low industrial awareness of nanotechnology, and the group had therefore proposed the devising of a strategy (House of Commons, 2004:14). Nevertheless, the Government eventually responded to the Taylor Report and some of its recommendations in 2003 by launching the Micro and Nanotechnology (MNT) Manufacturing Initiative. Rather than focusing the

funding towards the two suggested nanofabrication facilities, and on specific technological and scientific research areas identified in the Taylor Report, which could have been considered a 'Strategy' the money was spread widely to smaller entities and for supporting primarily applied research, and decided to include microtechnology in the initiative. The reasons given by the DTI for choosing to include microtechnology was that microtechnology was seen to have greater commercial potential; though this would take emphasis away from nanotechnology, this would then be developed and enabled at a later stage (House of Commons, 2004: 14-17). In investigating the Government's response to the Taylor Report in detail, the House of Commons Science and Technology Committee concluded that the delayed response that did not take account of the Taylor Report's recommendation, and the inclusion of microtechnology would have serious consequences for the commercialisation of nanotechnology in the UK (House of Commons, 2004: 17).

The MNT Manufacturing Initiative (hereafter referred to as MNT Initiative) saw the UK Government commit to investing £90m over six years from 2003 onwards. The expectation was for this sum to be met by an estimated £180m from the Research Councils, £90m from Industry, and another estimated £180m from Regional Development Agencies, making up a total of approximately £540m invested in micro and nanotechnology (House of Commons, 2004:17). This was nowhere near as much as the investments made by its main competitors, such as the US, France, Germany, Japan and South Korea who have all allocated more funds on a yearly basis to nanotechnology R&D (House of Commons, 2004:18). For instance did France, through Government funds alone, committed £500m over four years towards nanotechnologies and nanosciences; US funding increased to $1bn per year between 2003 and 2006; and Japan and South Korea both invested significantly more funds than the UK Government chose to do (House of Commons, 2004:18).

The MNT Initiative was not a strategy, however, it was a funding framework that received much criticism from the House of Commons Science and Technology Committee for being 'too little, too late' for nanotechnologies and

nanosciences. The Committee recommended that the Government should focus more resources towards nanotechnology in its ten-year investment framework for science and innovation (House of Commons, 2004: 20); the recommendations remained rather promotion-focused.

*4.1.2 How regulations and public engagement entered the agenda*

Regulation was not discussed by the Taylor Report writers, apart from remarks about a potential need for regulating the technologies discussed in their six scenarios. It was also not discussed by the House of Commons Science and Technology Committee, though a reference was made to the anticipated publication of a Government commissioned report by the Royal Society and the Royal Academy of Engineering (hereafter referred to as the RS/RAE Report), which aimed to analyse current and future developments in nanotechnologies and nanosciences and to examine their impacts and the potential need for regulations (House of Commons, 2004:48; RS/RAE Report, 2004:vii).

The RS/RAE Report was published just after the House of Commons' 'Too little, too late..' report, and sought to address and assess six issues in particular: find a definition for nanosciences and nanotechnologies; review the current state of scientific inquiry into nanotechnologies; identify current and potential applications of nanotechnologies; undertake a horizon spanning exercise into future uses of nanotechnologies and the likely timescales for the development of future applications; looking into the implications of nanotechnologies and nanosciences with regards to current and future health and safety, and social, ethical, and environmental issues; and, explore the potential need for additional regulation (RS/RAE Report, 2004:vii). Led by Dame Ann Dowling, head of the Department of Engineering at the University of Cambridge, the group of report writers, experts within a broad variety of academic disciplines, made 21 recommendations (RS/RAE Report, 2004: 85-87) whereof 19 recommendations were related to the potential impacts of nanotechnologies and nanosciences and how to approach them. Though current regulations were deemed sufficient to encompass part of

nanotechnologies and nanosciences research and manufacturing, concern was expressed with regards to engineered nanoscale materials as some, in certain circumstances, fell outside of existing regulations (e.g. environmental, health and safety, and food-related regulations). The report also pointed towards a need for more research concerning risks and the exposure to potentially toxic nanoparticles (RS/RAE Report, 2004). The UK Government, through a statement, later repeated these concerns and commented on the progress made between 2004 and 2007 with regards to their regulatory negotiations on the EU-level, and that best practice guidelines were being drawn up for industrial use and for product labelling (UK Government, 2007:17). The Government's expressed concern was particularly targeting laboratory activities and health and safety at the work place, but they also acknowledged that there was not enough money set aside towards research into nanotoxicology (UK Government, 2007:22). Nevertheless, it seems that no one, at the time, really knew who should have been doing what on the domestic level regarding regulatory concerns and that a 'let's wait and see what happens in Brussels' approach was adopted in the meantime.

The RS/RAE Report did not appear out of thin air. It was, at the time, a very comprehensive evaluation that brought forth the potential social, ethical and environmental impacts of the emerging technologies and sciences, while little had been written prior to this – at least in so far as the Government or other governmental or legislative policy papers or other publications were concerned. Rather, the 'grey goo' discussion was on the agenda (see the literature review in Chapter 2), including Prince Charles' contribution to the debate through his comparing the potential upset of nanotechnology to that of thalidomide[23] (BBC, 2004 – reporting on an article published by the Independent on Sunday). Further, the ETC Group (Action Group on Erosion, Technology and Concentration) having published two reports the year before (ETC Group 2003a, and 2003b), highlighted the potential risks of

[23] Called one of the darkest moments of pharmaceutical history, thalidomide was marketed as a safe and mild sleeping pill and given to pregnant women, many of who gave birth to babies with malformed limbs. Until this point, in the early 1960s, new drugs were viewed with optimism as being beneficial, while the thalidomide controversy challenged and changed this way of thinking about novel therapies.

nanotechnologies, and called for a global moratorium as the only credible policy response given the uncertainties of the new technologies, e.g. as laboratory guidelines were faulty and there was no regulatory barrier for the use of nanomaterials in consumer products, which would put consumers at risk (ECT Group, 2003b:2). Greenpeace made a similar call on their UK website, also in 2003, with regards to the release of nanoparticles into the environment, though their statements makes it clear that Greenpeace did not have a firm stance on nanotechnologies at the time (Greenpeace UK, 2003). Greenpeace's call for a moratorium followed the publishing of another report, commissioned by Greenpeace with the intent to explore emerging technologies, including nanotechnologies; this report did not call for a moratorium, but considered it briefly (Arnell, 2003). The RS/RAE Report claims to have considered calls for a moratorium on the development and spread of new nanomaterials, but saw no case for it should the regulatory measures and increased research into toxicology and related fields be undertaken as suggested in their report (RS/RAE Report, 2004:xii, 77, 83).

*4.1.3 The balancing of regulations and promotion*

It is not until the discussion, or at least acknowledgement, of regulations, guidelines, and ethical, social, environmental, and health and safety implications has begun that a 'balancing-act' between the regulation and promotion of nanotechnologies and nanosciences can take place. It is therefore of interest to explore how the Government and any other relevant public agencies responded to the RS/RAE Report, and also to look into the exchanges that may have taken place with regards to the RS/RAE Report's proposed independent reviews of how their recommendations would have been taken on-board, suggested at two and five years following the release of the report (RS/RAE Report, 2004:84).

The UK Government, in consultation with the devolved administrations, released a response to the RS/RAE Report in 2005, which was intended to set out the Government's agenda for nanotechnologies and nanosciences (HM Government, 2005:1). In his summary, Lord Sainsbury agrees with the

Royal Society and Royal Academy of Engineering in that progress should be reviewed after two and five years – to be carried out by the Council for Science and Technology, with evidence provided by the Nanotechnology Issues Dialogue Group (NIDG) (HM Government, 2005:4). The NIDG was meant to coordinate activities described in the Government's response, and another group – the Nanotechnology Research Coordination Group (NRCG), was made responsible for the development of a cross-government research programme into health and environmental implications of the technology and tasked with overviewing the efforts towards public dialogue and social science research. Lord Sainsbury also underlined that nanotechnologies were in their early stages, and that it was important to get their development right by *"ensuring that developments benefit society and the environment, but do not overburden Industry with regulation"* (HM Government, 2005:1). The rest of the Government's response went some way in portraying that flavour with regard to balancing the opportunities and uncertainties of nanotechnologies in that both are addressed, and all 21 of the RS/RAE Report's recommendations were addressed in turn, but not all were fully conceded with. For instance, the RS/RAE Report's first recommendation proposed life cycle assessments for nanotechnologies-enabled products and applications in order to test whether they would require fewer resources than 'non-nano' products, including resources used during manufacture and disposal – a recommendation made due to the overstated claims about risks and benefits of nanotechnologies-enabled products (RS/RAE Report, 2004: 85). The Government's point of view, on the other hand, was to advocate carefulness in constraining emerging technologies in their early stages as this could result in lost opportunities, and that new technologies should not be judged harsher than pre-existing nanotechnologies (HM Government, 2005:4). Additionally, the Government argued that life-cycle assessments were very difficult to perform, and that the methodologies by which they were done had not yet been standardised (HM Government, 2005:4). The Government also made it clear that they were much committed to a precautionary approach towards nanotechnologies and nanosciences development (HM Government, 2005:11), while also not supporting the call made for Industry's assessment of the risk of release of nanoparticles or nanotubes through the lifecycle of a

product containing them (HM Government, 2005:12). With regards to regulations, the Government commissioned reviews from the relevant bodies such as HSE (Health and Safety Executive) for health and safety legislation, and FSA (Food Safety Authority) for food standards and safety, and referred to collaboration with its partners in Europe with regards to regulatory frameworks on the EU-level (HM Government, 2005:12-15). The Government also endorsed RS/RAE's recommendation related to consumer products, by which Industry were asked to submit information about safety assessments of manufactured free nanoparticles, as well as the publishing of details of the methodologies used by manufacturers, and the labelling of consumer products containing nanoparticles. The purpose of this recommendation was to empower consumers by enabling informed consumption (HM Government, 2005:16, 17). References were also made to discussions with Industry, and with partners on the EU-level – such as the negotiations surrounding REACH, an EC-acronym for a legal framework applicable to the countries of the European Union and short for *Registration, Evaluation, Authorisation, and restriction of CHemicals*. With regard to ethical and social issues, the Government supported RS/RAE's recommendations for the training of students and staff in ethics and social issues, and for the setting up of public dialogues around the development of nanotechnologies and nanosciences (HM Government, 2005: 20). In discussing public engagement, the Government named Sciencewise – a public engagement grant scheme where nanotechnologies were identified as a priority area; the ESRC-funded project Nanotechnology, Risk and Sustainability, aiming to encourage public engagement at an early stage in order to facilitate public input into the innovation process and regulatory framework related to nanotechnologies; and Small Talk, a project that sought to feed back public views of nanotechnologies towards policy and decision-makers, and to contribute to good practice in public engagement (HM Government, 2005:20).

Two years following the Government's response to the RS/RAE Report, the Council for Science and Technology (CST) delivered their two-year review of the current situation of nanotechnologies and nanosciences development. The CST found that the Government's response to the RS/RAE Report was

fully valid, and that nanotechnologies developments since February 2005 had not thrown up new issues unaddressed in the Government's response (CST, 2007:5). The CST was happy with Government's progress with regards to dialogues with Industry related to the release of nanoparticles into water sources; reviews of current legislation made by the HSE and HSL (Health and Safety Laboratory); the initiation by Defra (Department for Food, Environment, and Rural Affairs) of a Voluntary Reporting Scheme aimed for industrial reporting of the use of and risks posed by free engineered nanoparticles[24]; and the initiation of public engagement initiatives, though they could be better fed back into policy-making (CST, 2007:5). The reason given for the lack of feedback was the insufficient communication between Government or policy makers and the actors involved with such public engagement initiatives (CST, 2007:39). However, the CST noted a lack of balance with regards to Government's investment into funding programmes – while £3m out of £13m was spent on nanotoxicology[25] and the health and environmental impacts of nanomaterials, the EPSRC (Engineering and Physical Sciences Research Council) spent £40m per year on advancing nanotechnologies, in addition to the £90m over six years committed by the DTI for commercialisation (as described above). The CST criticised the Government for relying too much on funding from the Research Councils to cover the knowledge gaps, agreed with the RS/RAE's recommended minimum amount of £5-£6m per year over ten years to fund research into toxicology and health and environmental impacts of nanotechnologies, and underlined the Government's role in supplying strategic funding as Industry did not take on the role (HM Government, 2005:6). That said, the CST commended the Government for its dealing with Industry, especially with regards to the increased dialogue with industrial partners and the setting up of NIA – Nanotechnologies Industries Association, aimed to provide Industry with a voice (CST, 2007:38).

The CST concluded their review by commending the Government for its commissioning of the RS/RAE Report, and that the UK – at the time, was

[24] By 2007, the CST noted that only three organisations had submitted information through the scheme (CST, 2007:38)
[25] £10m was spent on nanometrology, which the CST welcomed (CST, 2007:39)

considered a leader through its engagement with nanotechnologies - however, *"[i]t is now widely believed – by stakeholders from Industry, academia, learned societies and NGOs – that the UK has lost that leading position, though it has not slipped so far that swift and determined action could not regain it"* [CST, 2007:39] The call for swift and determined action was echoed by the Royal Society and the Royal Academy of Engineering in their response to CST's review and the Governments response to their own report. In its response, RS/RAE agreed with the findings of CST, and particularly underlined the imbalance in funding for development of new applications versus funding for toxicological research and other research activities related to the responsible development of nanotechnologies and nanosciences. The RS/RAE also urged Industry to work closer with Government to reduce uncertainties regarding any health and the environmental impacts of nanotechnologies and nanosciences, and to utilise the Voluntary Reporting Scheme (RS/RAE, 2007).

Another Government statement, aiming to provide an update on progress, was released in February 2008. The document does not offer a comprehensive response to CST's review or the RS/RAE response to the review, apart from a reference to how all research areas cannot be developed simultaneously, e.g. the Government has invested more into nanometrology[26] than nanotoxicology as the former is necessary to conduct the latter (UK Government, 2007:21).

Later in 2008, The Royal Commission on Environmental Pollution (RCEP) published a report that sought to investigate the potential environmental impacts of the industrial uses of novel materials and metals, and to explore the existence of nanoparticles and nanotubes in consumer products and their application in areas such as medicine and environmental remediation (RCEP, 2008:1). The report made a number of recommendations, such as offering support for the construction of a new research centre that would produce a more coordinated, larger, and focused response with regards to addressing

[26] Research concerned with measurements on the nano scale

the imbalance in funding and the critical research needs raised by the RS/RAE Report, CST, and the RCEP Report itself (RCEP, 2008:77). This was a suggestion also made in the RS/RAE Report, and one that the CST supported; the Government, however, did not agree. Particularly with regards to Environmental legislation, the RCEP report called for nanomaterials to be considered for the functionality and that their functionality rather than size would require separate risk assessments. The report writers also urged the Government to negotiate changes to REACH, where the weight threshold (one ton) was considered too high for nanomaterials that, due to their size, would often be traded or treated in significantly lighter volumes (RCEP, 2008:78). The RCEP report also requested for nanomaterials reporting to become mandatory, as Defra's Voluntary Reporting Scheme by the time the report was written had only received nine submissions (RCEP, 2008:70, 78). Finally, the report urged Government to move beyond smaller ad hoc public engagement projects towards more frequent exercises whereby public engagement, or the gathering of 'social intelligence', would become more long term and continuous in order to ensure the responsible development of nanotechnologies and nanosciences in the light of uncertainty (RCEP, 2008:79).

The Government responded to the RCEP Report largely by stating that it intended to develop a UK Strategy for nanotechnologies, which would build on an evidence gathering exercise scheduled to take place later in 2009 (UK Government, 2009:5). In addressing the points made by RCEP, the Government agreed that more needed to be done with regards to ensuring the responsible development of nanotechnologies, but also argued the point that many of the RCEP's recommendations were long-term with regards to the work and discussions needed to implement them successfully (UK Government, 2009: 5). The Government agreed with the RCEP and pledged to continue their discussion within the Nanomaterials and REACH Sub-Group on the European level, but rather than making the Voluntary Scheme mandatory immediately, the Government wanted to offer a revised version of the scheme which could be followed by a mandatory scheme should Industry not respond to the revised version (UK Government, 2009:20-22). With

regards to the public's involvement with policy-making and policy-makers, the Government pointed towards the establishment of Sciencewise's Expert Resource Centre for Public Dialogue on Science and Innovation, which – as their response was written, was looking into how to best gather and implement social intelligence (UK Government, 2009:23). Finally, the Government offered insight into its proposed engagement with Industry, much of which was run through what has been called the UK's 'innovation agency' the Technology Strategy Board (TSB) – a public agency under BIS - the Department of Business, Innovation and Skills (formerly known as DTI). In partnership with other Government departments, the Research Councils, the Regional Development Agencies, and the Devolved Administrations and others, the TSB led on a number of initiatives, such as the Nanotechnology Knowledge Transfer Network (KTN) that sought to promote responsible development and provide companies with information (UK Government, 2009:24).

The various exchanges and reports published ahead of the drafting of the UK nanotechnologies and nanosciences strategy were numerous, but also gave a flavour of imbalance with regards to promotion and regulation in terms of actual action taken by government to ensure the responsible development of nanotechnologies. However, its response to the RCEP report did offer insight into its intentions to develop a strategy, and one that would build on a broad consultation, which had also been called for concerning nano-related policy-making.

*4.1.4 Consultations and reviews*

The extensive report, review and response writing was, as the UK Government had promised in its response to the RCEP report, followed by a consultation that would provide input into its nanotechnologies and nanosciences strategy. Launched one month after its response, a specific website for the Governments stakeholder dialogue exercise – Nanotechnologies: Influence and Inform the UK Strategy became a platform that aimed to gather answers to a series of questions relating to

nanotechnologies. The intended panel included stakeholders from academia, Industry, Government and other interested organisations that had been invited by Government departments, and efforts were made to collect opinions from as many stakeholders as possible (Department of Business, Innovation and Skills, 2010: 3). When the exercise closed three months later, 41 representatives of stakeholder groups had responded to the exercise by directly answering to questions or by posting public comments on the purpose-built website (BIS, 2010:3, 4). Sorted into themes and cross-cutting themes, the report, published after the completion of the exercise, particularly highlights how the stakeholders thought nanotechnologies had potential for a positive impact in terms of manufacturing and the consumer market that was considered important to the economy, but that they were concerned about the shortage of public funding allocated toward research related to environmental impacts and health and safety, and they wanted to see a consolidated source of information for the public regarding Government activities on nanotechnologies and Industry with regards to regulations, reporting and risk assessment requirements (BIS, 2010:4).

Further evidence was gathered and consolidated by four Knowledge Transfer Networks – Nanotechnology, Materials, Chemistry Innovation, and Sensors and Instrumentation (though mainly accredited to two KTNs), and Materials UK who gathered a mini-Innovation and Growth Team consisting of Industry figures, and gained input from a few chosen academics and researchers. The Mini Innovation & Growth Team (Mini-IGT) produced a report (Mini-IGT Report) in 2010 that, based on a survey, a series of workshop discussions, and a full review of UK and international strategic approaches and a review of future opportunities, recommended for: nanotechnology innovation to remain business driven and coordinated through BIS; the implementation of TSB's Nanoscale Technologies Strategy (see below) and its suggestions for commercialisation; the setting up of a framework for risk assessments to ensure responsible development; and the establishment of a simplified Voluntary Reporting Scheme (Mini Innovation & Growth Team, 2010:3). The Mini-IGT Report also recommended increased investment into formal education and vocational training of technical staff; further commercially

focused investment channelled towards SMEs and larger companies; the investment into key capabilities for nanotechnologies innovation; funding for cross-sectorial initiatives; a leading position for the UK with regards to the international standardisation of measurements; continued investment into knowledge transfer activities between academia and Industry; and efforts to keep the public informed of product development utilising nanotechnologies developments; engagement between Industry and NGOs and trade unions; and, finally, to encourage the understanding of nanotechnologies among bankers and insurers in order to enable sound investments (Mini-ICT, 2010:3). The TBS Nanoscale Technologies Strategy, as mentioned by the Mini-ICT, was published when the stakeholder consultation had started, and offered the TSB's vision of how the TSB would *"support UK businesses to responsibly deliver market-leading nanoscale technology solutions, channelled through high-value applications that help to solve society's greatest challenges"* (TSB, 2009:7). The great challenges were identified as being environmental change, ageing and a growing population, safety and security in a connected world (TSB, 2009:7), and the TSB outlined an action plan through which it intended to invest in technologies with strong potential to meet these challenges, focus investment in line with other funders and groups, foster a climate for success within a 'responsible' context, and invest in activities that were compliant with sustainable development (TSB, 2009:7). The action plan, though primarily focusing on commercialisation, the national coordination and maintenance of the necessary infrastructure and research, and increased industrial participation and engagement, also included responsible development as an identified impact, but one that was to be achieved through international engagement through OECD and EU rather than through domestic activities (TSB, 2007:32).

*4.1.5 UK Nanotechnologies Strategy: small technologies, great opportunities*

Following its evidence collection exercise, Her Majesty's Government finally published the UK's first government-produced nanotechnologies strategy in March 2010. The strategy, which encompassed 43 action points, included the Government's strategy with regards to nanotechnologies and nanosciences

as related to ‘Business, Industry and Innovation’, ‘Environment, Health and Safety Research’, ‘Regulation’ and ‘The Wider World’.

*4.1.5.1 Business, Industry and innovation*

Apart from committing itself to the support of nanometrology investments (HM Government 2010:15), and the support for areas such as nanomedicine, regenerative medicine, renewable energy, carbon capture, and safety (HM Government 2010:17-18), many of the points made for business, Industry and innovation called for increased and enhanced networking between Industry, academia and government. The Government did, for instance, want the Research Councils to cooperate with business, KTNs and the TSB in order to single out promising research outputs for commercialisation (HM Government 2010:14). For the sake of unifying Industry, the government aimed for a Nanotechnologies Leadership Group (NLG) to be established, as proposed through the Mini-IGT Report. The purpose of the NLG would be, as the name suggests, to provide leadership and direction to the numerous entities engaged in the development and application of nanotechnologies. The group would underline industrial needs and commercial opportunities as well as enable networking and collaboration across sectors (HM Government 2010:17). The NLG was meant to include stakeholders from research institutes, RDAs (Regional Development Agencies) and academia, and it would also have strong links to the Nanotechnology Special Interest Group (NSIG), which was forming from within the Mini-IGT and KTN Programme (HM Government 2010:17).

The strategy also assigned tasks to the TSB, such as the review of the MNT Centres and to identify how to maximise their commercial potential and other benefits, and strengthening knowledge transfer in line with the wishes of the NLG. Both nanomedicine and nanosafety were previously identified as key priority areas by TBS (HM Government 2010:17&18). The Government made reference to three programmes, as outlined by the TSB in their Nanoscale Technologies Strategy – all related to nanomedicine: ‘Fighting Infection through Detection Competition’, Nano4life, and ‘Regenerative Medicine

Programme', as providing a framework for future applied research (HM Government, 2010:18).

The strategy also included a call (previously brought up in the TSB strategy) for Grand Challenges, a funding framework and process, funded jointly by the TSB and the Research Councils, that would enable nanotechnologies development and research within priority areas – here Solar Energy, Healthcare and Carbon Capture and Utilisation, to move from engineering to application (HM Government 2010:18).

The RDAs were tasked with supporting regional business innovation and by delivering regional schemes alongside TSB. They would, for instance aid business in working with universities in the regions by offering relevant vouchers or other for business relevant support and products (HM Government 2010:18). The required skills within the nanotechnologies sector was to be met by further education and apprenticeships (HM Government, 2010:19).

And finally, as for international cooperation, the UK was, through various government agencies, setting out to influence and cooperate with the OECD and the European Union (HM Government 2010: 19), and aimed to influence international negotiations and policies.

*4.1.5.2 Environmental, health and safety research*

The Government did take some of the recommendations made by the RCEP and RS/RAE into account when writing its strategy. Apart from encouraging the coordination between government departments and the Chief Scientific Advisor to the government to take the lead in such dealings, the Strategy underlined the importance of further nanotoxicological research and collaboration between institutes and researchers (HM Government 2010:20-23). Such work was, for instance, encouraged at the National Nanotoxicological Research Centre (NNRC), which was launched by the Health Protection Agency in 2009. The centre was to deliver high-quality, publicly funded toxicological research "*which will improve our understanding*

*of the risks to human health posed by nanomaterials*" (HM Government 2010:23). The first project initiated at the NNRC was due to be completed in December 2010 and concerned the bio-kinetics of inhaled nanomaterials (HM Government 2010:23). The strategy also paid attention to food toxicity and mentioned projects initiated by the FSA (Food Standards Agency) alone and partially funded through the European Commission's Framework 7 Programme. The former concerned the behaviour of nanoparticles in the gut, while the latter project was focusing on analytical methods for detecting and characterising nanoparticles in food (HM Government 2010:23). A number of nanotoxicological projects funded by the Department of Health, and future work supported by the HSE were also listed (HM Government 2010:23-24). The strategy further mentioned a joint national programme on the impacts of exposure to environmental pollutants on human health, which was to be run through the DH (Department of Health), MRC (Medical Research Council), NERC (Natural Environment Research Council), ESRC (Economic and Social Research Council), and Defra. As for international efforts related to the environment and risks, the strategy underlined the UK's role in driving, leading and supporting efforts within the OECD and the Working Party on Manufactured Nanomaterials (WPMN) into the toxicity of cerium oxide and zing oxide. The project would, according to the strategy, establish generic protocols for the sake of informing risk assessments as called for in the RCEP report and the CST Review (HM Government 2010:24). Another international project listed was ENI – Environmental Nanoscience Initiative, a joint venture between NERC, EPSRC, EA (Environment Agency) and the US Environmental Protection Agency. The aim was to produce robust models to predict the transport, fate and bioavailability of nanomaterials interacting with biological and economical systems (HM Government 2010:24).

Regarding further European cooperation, the Strategy pointed to the successful applications made for EC funding through FP7 and the UK's influence on future funding calls. The TSB was assigned a key role in making input on behalf of the UK into forthcoming ERA-NET (Networking within the European Research Area – ERA) initiatives, aiming to collate global findings with regards to the behaviour of nanoparticles (HM Government 2010:23-26).

Finally, responding to other points made in the RCEP Report, the Government sought to encourage a future workforce skilled in toxicological research by funding PhD studentships and a Career Development Fellowship at the MRC Toxicology Unit at the University of Leicester. Further, the Higher Education and Industry Forum was assigned the task to develop biological science degrees that would meet industrial requirements, and BIS' Science and Society Team was tasked with the promotion of toxicology degrees as part of their aim to encourage students to gain STEM (Science, Technology, Engineering, and Mathematics) qualifications (HM Government 2010:26, also mentioned in the Mini-IGT Report).

*4.1.5.3 Regulatory matters*

The government identified two reasons why regulation was considered important: firstly, regulation would make Industry feel more enabled to develop innovative products and lead to more efficient risk management; and secondly, the public – as consumers, would feel assured about products and that they would make informed decisions with regards to consumption (HM Government, 2010:27). Further, the strategy defined four areas in which regulation was considered important – food, cosmetics, healthcare devices and medicines, and workplace health and safety, as they were considered areas in which nanomaterials were the most likely to come in contact with humans and the environment (HM Government 2010:27). The nano foods area had been assigned three action points in the strategy. The FSA, apart from monitoring the efficiency of the regulation of food additives, would be involved in negotiations with the European Commission and Member States with regards to the regulatory framework for novel foods, and any amendments made. Similar efforts were made with regards to food contact plastics (HM Government 2010:29-30). As for cosmetics containing nanoparticles, the Government referred to a EU directive on the Safety of Cosmetic Products that was due to be implemented through the updated EU Regulation on Cosmetic Products (EC 1223/2009) in July 2013. The strategy named BIS as the competent UK authority in watching out for developments that would require further regulatory amendments (HM Government 2010:30). As with cosmetics, the strategy referred to already existing EU legislation for

medicines and medical devices, considering them sufficient. The Government did, however, prescribe further MHRA (Medicines and Healthcare Products Regulatory Agency) -led reviews of developments within the field and continuous assessments of the relevant regulatory frameworks. Finally, with regards to occupational health and safety, the Government pointed towards existing regulation through Control of Substances Hazardous to Health. Carbon nanotubes alone, due to their similarity to asbestos, when entering the lung at the right size, would be subject to specific guidelines on risk management. The HSE was tasked with monitoring the situation (HM Government 2010:31-32). More generally regarding regulation, the strategy gave the HSE and Defra the task of leading UK input into REACH, and the Government would, through discussions with other entities such as NLG, the KTNs, NGC (Nanotechnologies Collaboration Group) and consumer group 'Which?' identify what information would be useful to stakeholders (they did not define 'stakeholders' further) and collect information on nanomaterials and products containing nanomaterials. The information gathering and discussions was to be reported to a cross-Government working group that would engage with interested parties and possibly fund research jointly, for example (HM Government 2010:33-34).

#### *4.1.5.4 The Wider World*

By 'the Wider World' the Government referred to the public – i.e. consumers, those involved with nanotechnologies through work, research or business, and governments, officials, researchers, and businesses in other countries that work with nanotechnologies (HM Government 2010:35). Out of seven action points, the first point referred to the Government's intention to establish the NCG, which replaced the NSF (Nanotechnologies Stakeholder Forum) and the NIDG (Nanotechnologies Issue Dialogue Group). The group, gathering government departments, agencies, and other stakeholders, was to be tasked with facilitating collaboration and discussion between government, academia, and Industry, and communicating stakeholders' key concerns with nanotechnologies to Government Ministers (HM Government 2010:35). The Strategy also prescribed coherency and consolidation online in terms of a gathered central source on Government's dealings with nanotechnologies.

The BIS Science and Society Team was made in charge of co-ordinating a website for information on UK nanotechnologies governance that was to be hosted on Directgov or a similar site. A consumer site on nanotechnologies that ran as a pilot of a website aiming to provide balanced information about nanotechnologies and included a forum – Nano&Me, was to be reviewed and the future need for such a site decided upon (HM Government 2010:36-37). Regarding international activities, the Government pledged to continue its on-going work within OECD, FP7, and the NMP programmes. BIS was also to submit the UK strategy to the European Commission, in response to their consultation on a new Strategic Nanotechnology Action Plan. Finally, the Government aimed to continue playing an active role within the United Nations' Strategic Approach to International Chemicals Management (SAICM) and work closely with UNITAR (United Nations Institute for Training and Research) and OECD by running joint workshops with the objective to increase global understanding for the responsible management of nanotechnologies (HM Government 2010:38).

*4.1.5.5 Immediate reactions to the strategy*

As the interviews carried out in the UK were taking place in 2009-2011, the narrative that was used for the basis of the UK part of this study will draw a line here. However, some of the immediate reactions were to be read on blogs soon following the launch of the strategy. Commentators did, for instance, criticise the lack of strategic initiative and coordination of UK science policy with regards to nanotechnologies and nanosciences (Maynard 2010, Harper 2010, Jones 2010); the belief that pre-existing infrastructure and already set up projects could work for nanotechnologies the way they had been utilised for other technologies (Maynard 2010); the inadequate focus on nanotechnologies by the Research Councils who were unlikely to set up new funding calls to treat nanotechnologies exclusively (Jones 2010); the lack of reference to previous attempts at delivering UK strategies (Harper, 2010, Jones 2010); the overly precautionary approach and too much emphasis on public consultations, risks and regulation (Maynard 2010, Harper 2010); the lack of genuine upstream public engagement (Jones, 2010); the confusion of toxicology with risk science in the sense that toxicology was treated as the

'be-all and end-all' of risk identification that excluded exposure and risk assessment and risk management and the dealing with uncertainty (Maynard, 2010); the lack of emphasis on exploratory science (Maynard, 2010); the Government's push for an 'integrated Industry' for nanotechnologies which – being many technologies and industries would make their integration out of place (Jones, 2010); and the miscalculation in assessing the size of the nanotechnologies market which was claimed to grow from $2.3 billion in 2007 to $81 billion by 2015, while the actual market numbers were $2-3 trillion (Maynard 2010, Harper 2010). With regards to the market size Maynard wrote: *" if [the figures] are correct, I have to wonder why governments and Industry around the world are investing tens of billions of dollars in a technology that is only going to be worth…tens of billions of dollars!"* (Maynard 2010). He also claimed that the Government had wrongly assumed that the UK was the fourth in the world in terms of the number of nanotechnology patents applied for; while the latest figures (from 2008) showed the UK ranking eleventh with 68 nanotechnologies patents applied for in the country, while China applied for 5030 patents (Maynard 2010, Dang et al. 2010). Both Maynard and Harper criticise the lack of support for the Nano&Me initiative. (Maynard 2010, Harper 2010).

Though described as a spiralling affair of reports, government responses, further reports, reviews, papers and other documents as far as UK nanosciences and nanotechnologies policies are concerned are freely available, discussed, and fully visible. The narrative provided through this mapping exercise provided a very helpful backdrop to the interviews and potential topics and questions that might come up. It also offers insights that the interviewees, many of whose names were mentioned in the various reports and reviews, may want to reflect on in order to give their perspectives on the situations and issues related to the strategy and its development.

### 4.2 From narratives to interviews

It is important to note that some of the interviews held were held before the strategies were written. For such instances, reference will be made to that

effect when appropriate. The narratives that were collected and collated before the interviews, however, have aided the formulation of context-specific interview questions as seen in chapter 2. This is not to say that the contexts have overridden the original interview questions and themes, but the pre-interview narratives have rather helped to put the original interview questions and themes into the right context with the intent to make them more sensible, appropriate and understandable to interviewees.

TABLE 4.1: UK INTERVIEWEES

| *Interview reference* | *Alias* | *Position* | *Institution* | *Interview year* |
|---|---|---|---|---|
| George, 2008 | George | Senior Scientist (Physics and Engineering) | Academia | 2008 |
| John, 2009 | John | Researcher (Engineering) | Academia | 2009 |
| Paul, 2010 | Paul | Senior Policy-advisor | Government | 2010 |
| Harold, 2011 | Harold | Scientist (Chemistry) | Professional society & academia | 2011 |
| Tom, 2011 | Tom | Senior Policy-advisor | Government | 2011 |
| Chris, 2011 | Chris | Industrial coordinator and former scientist | Regional industrial body | 2011 |
| Anne, 2011 | Anne | Science Communication professional | Public engagement project | 2011 |
| Roger, 2011 | Roger | Industrial coordinator | Industry | 2011 |
| Scott, 2011 | Scott | Senior scientist (Physics and Engineering) | Academia | 2011 |
| Kate, 2011 | Kate | Scientist (Biochemistry) | Government /Public Health | 2011 |
| Richard, 2011 | Richard | NGO representative | NGO | 2011 |
| Brian, 2011 | Brian | Industrial scientist (Medical physics) | Industry | 2011 |
| Matthew, 2011 | Matthew | Scientist (Chemistry) | Professional society | 2011 |

As noted in Table 4.1, a total of 13 interviewees were chosen in the UK. Out of 13, 7 interviewees were chosen due to their involvement specifically with nanotechnologies policies, and the remaining six were chosen for this study as they were either recommended by other interviewees due to their involvement with specific aspects of nanotechnologies and nanosciences

policies or research, or as they were not necessarily part of policy-negotiations but because their work was directly affected by the results of policy negotiations. The group include both male and female government representatives (2), academics (5), and industrial representatives (3), alongside three 'other' interviewees representing civil society or organisations or programmes that did not fall under the other three categories. A majority of the interviewees were male and in senior positions professionally, though care was made to also include female interviewees, and to include academics at more junior levels in the academic hierarchy in so far as their participation in the study 'made sense' beyond their gender or age/seniority based representation, e.g. provided that their professional capacities were directly related to subjects that were topical to nanotechnologies and nanosciences policies being developed. With regards to geographical spread, the UK interviews were held in various locations in two countries – England and Scotland.

The data will be presented here in accordance to the order as presented in the Themes Matrix in Chapter 2, Table 2.2. As a reminder, the three indicators considered for organisational diversity in this study are 'inclusion', 'interaction' and 'openness and transparency'. These indicators will be explored in subchapters 4.2.1 – 4.2.5.1, while the indicators of social accountability are 'trust' and the potential finding of a 'trust gap', and 'public engagement' are explored in subchapter 4.2.6. Subchapter 4.2.7 is dedicated to the balancing of promotion and regulation in UK policy-making discussions, or the interviewees' perception with regards to such an attempt at balancing the discussion. Subchapter 4.3 aims to offer a brief summary of the main points as found in the UK part of the field study.

### *4.2.1 Inclusion: identities and roles*

Despite singling out interviewees in the pre-defined professional groups that academia, industry, and government are – or assorting them into 'other', the study proved that interviewees themselves often found the distinction challenging. Many, such as Richard who, working for an NGO, declared a

scientific background (Richard, 2011), while John, currently working within academia, confessed to having very close ties with industry both in the UK and in Germany and the US (John, 2009). Similar industrial ties and a scientific background were found in Tom's account. Working for and representing BIS during policy negotiations, Tom had worked with multinational R&D and high-tech industry for several years before joining BIS (Tom, 2011). Five of the UK interviewees did not claim to belong to other professional backgrounds than those within which they had been approached for this study. Paul, for instance, working for Defra and with much involvement in policy discussions, was quick at pointing out that he did not identify with another group, and was keen to underline that he was not a scientist (Paul, 2011). Professional identity and the 'belonging' to a group seemed to matter to all interviewees, but it may also have been highlighted due to the questions asked during the interview as several of them concerned how different actors collaborated.

Interviews that included an element of self-identification often had the identity question as an introductory element, used by some interviews to justify their being interviewed, which then led the interview into the direction of the first interview question (for use where applicable): *how do you describe your role in nanotechnologies and nanosciences policy-making?* For the UK-held interviews, the 'policy-making' in question referred to the negotiations from which the above mentioned *HM Government* policies and comments or responses, for which many of the chosen interviewees had given input or were about to give input. It is important to note, however, that responses were not perceived in relation to the experiences of interviewees in the context of specific policy discussion, and that a distinction taking the negotiation behind specific documents or policies has not been made in favour of exploring decision-making in general.

Ten out of thirteen of the UK interviewees claimed that they had been part of policy discussions, either as policy-makers or as policy-advisors. The academics among them were particularly prone to make a distinction between advising and making policies, but agreed to that their advice was given with

the understanding that it would be taken into account in policy-making. Scott, a senior[27] scientist whose name was listed in many of the policy documents did, for instance, describe himself as an 'Adviser' to the UK Research Councils, and working closely with the TSB in order *"(…) to make sure there are initiatives in place that some of the pure research that can be fed in to be commercialized"* (Scott, 2011). The way in which he was saying this, through face work, the emphasis on 'making sure', and the way he listed the various Research Councils, would suggest a more intimate role than just an 'Adviser'. Brian, a senior industrial scientist, likewise declared his involvement as an advisor and stakeholder, both nationally and internationally, but he was careful to underline that the organization that he represented was independent of the Government and the European Union, though he had been involved with research and funding related discussions at the European level (Brian, 2011).

Paul and Tom, representing the Government in this study and whose names appear on a number of policy-documents, both underlined their roles as primarily being the coordination of policy-discussions and to listen to expert opinion and analysis (Paul, Tom, 2011). They were quite careful in outlining their roles specifically in policy-discussions, and did not want to come across as deciding on policy.

Finally, Kate, a mid-career scientist working within a government agency, claimed not to be directly involved with policy-making at all as she was not 'senior' enough, but confessed to offering advice and opinion when requested (Kate, 2011).

It was difficult to get a clear answer as to who actually made decisions in the UK. In some respect, all (apart from Kate) seemed to think they had a part in decision-making either as coordinators or as advisors, but none of the interviewees wanted to be labelled a 'decision-maker'; the Government

[27] 'Senior scientist' here refers to a scientist or researchers on or just below professorial level, with >100 peer-reviewed published works to their name, and who also figures as a Principal Investigator or Chief Investigator of research grants on behalf of their institution or department.

representatives included. What did come across however, was that there is much collaboration and bridging between the expected parties of the triple helix in the UK.

*4.2.2 Policy-negotiations and national coordination: open or closed*

One thing that the UK interviewees largely agreed on was that the organisations, institutions, agencies or other entities that they represented were very open and that there was very little secrecy involved in their respective parts of the development of nanotechnologies or nanosciences. However, though he said that the UK was very open, George – a senior scientist, added that with regards to decision-making *"(…) there are a very small number of people who, in this country, who* [makes decisions]. *I have seen that many times"* (George, 2008). While the organisation he works for is one of openness, and perhaps more so than it used to be, but he still found that decision-making in the UK is left in the hands of a smaller group of people. This would link in with the previously made observation on the invisibility of decision-makers. Harold, a senior scientist involved with a professional society, agreed with George's point in that he remarked on always meeting the same people where ever he went (Harold, 2011). John, also a scientist, added that he found UK decision-making to be less open and transparent than US decision-making in that *"(…) a lot of it is informal decision made among a small group of people, small, like-minded group of people*" (John, 2009). John did not elaborate this point, beyond suggesting that London is *"still too segregated* [in comparison to the US]*"* (John, 2009).

Richard claimed that the policy making environment was open in that the NGO he was representing was included in policy documents and discussions, but also said it had been "hard work" to get to this stage, and that it was due to the NGO basing its involvement and claims on science and research, rather than being reactionary and asking for a moratorium (Richard, 2011). Richard made similar comments to George, Harold and John regarding the smallness of the actual decision-making environment (Richard, 2011). There was, according to Richard, one actor within policy-making that was the least

transparent - Industry. He was critical with regards to Industry's lack of transparency, engagement, and unwillingness to disclose information related to their activities (Richard 2011).

Roger, representing a group of industrial and commercial partners with a stake in nanotechnologies and nanosciences R&D, agreed to be interviewed by phone, and claimed that his organisation was very open as it received some government funding, while competitors depended on funds collected by their membership through fees or other charges. He also underlined that information about the organisation's governance or membership was readily available digitally on their website, but that he was unable and unwilling to discuss this further over the phone (Roger, 2011).

Brian, an industrial scientist, on the other hand, said that he found the policy-making environment open rather than closed. Really from 2004 to the late 2000s, Brian argued, much work had been done – starting with the RS/RAE report and onwards, and several different actors had been involved with the various reports and commentaries both home and abroad (e.g. in Europe) (Brian, 2011). Brian also pointed towards a seminar hosted by the Chemical Industries Association (CIA), which he had attended, and noted that there had been people he had not previously met present (Brian, 2011). Judging from the rest of the interview, Brian likely meant for this statement to illustrate the openness within the policy-making environment in terms of other opinions being heard, and that this was not just a smaller niche of people making decisions. However, the seminar in question was more of an informative event than one meant to influence nanotechnologies and nanosciences policies generally or an event that invited 'partners' in decision-making, he clarified.

Paul, as a Government representative, underlined the work that the UK Government had undertaken in order to respond more quickly and to engage with stakeholders and the public over 'the past few years', but he also expressed an understanding for how consultations could sometimes be considered 'lengthy'. With regards to secrecy, Paul stressed that there is not any secrecy to speak of in nanotechnologies and nanosciences policy-making

and policy-discussions, apart from some details regarding the way in which some decisions are made – a point he did not want to go into any further detail about (Paul, 2011). This was not a point further discussed by the other interviewees, though others, such as Richard as above, Matthew and Harold underlined that industry could be more transparent.

*4.2.4 Interactions, negotiations and constraints*

It seemed on Richard's reference to 'hard work', Roger's refusal to disclose much information but still making himself available for an interview, and Paul's reference to the Government having tried to respond more quickly and to engage more, that the emerging technology decision-making had hit hitherto unusual ground that was still to be defined and fully understood by all parties. It was not entirely clear how or by whom decisions were being made, and whether or not decision-making was inclusive or open was up for debate. What exactly had been 'hard work'?

*4.2.4.1 On Industry: collaboration and the Voluntary Reporting Scheme*

The discussion about openness and secrecy within policy-negotiations offered the interviewees an opportunity to reflect more specifically on the various partners they interacted with in these situations, and how they experienced such interactions. One issue that kept coming up in several of the interviews was the want and need for further engagement from and with the Industry and that they were not necessarily considered very open in their dealings within nanotechnologies and nanosciences policy-making. Yet, all academics or researchers, apart from Kate, said that they had good links within Industry or at least with companies with an interest in R&D as related to their specific research interest. Kate did, however, give a reason behind her relative lack of Industrial contacts in that she was conducting research into aerosol particles, and that companies would not find this as interesting as many other scientific lines of enquiry on the nanoscale. The laboratory within which she worked, did, given that it was within the remit of the organisation, offer its space to commercial entities for the testing of particles for health and safety, but she

did not have much interaction with them while they were on site or afterwards (Kate, 2011).

More interviewees had active links to industry, for instance Scott, who was supervising industrially and commercially funded PhD students, and was involved with a number of spin-off companies. Scott underlined the need for industrial involvement, especially in his brand of physics and engineering due to the need to test and try inventions as applications to real problems or issues. Scott did however, wish for a closer bond with regards to toxicity testing on animals, as this was information that could be of use to him but that was not always shared by industrial partners who had conducted such tests. He also said that toxicology was very much highlighted as an area in need for further funding and research in many government policy papers and commentaries (Scott, 2011).

One topic that was brought up by many interviewees was the Voluntary Reporting Scheme, and Industry's perceived lack of interest for it. While Richard, from an NGO's point of view, suggested that it could be made mandatory, Tom – working at BIS felt that it was not a very helpful scheme. Indeed, he said he found the scheme too demanding in terms of the information requested. By pointing at how the French, Dutch, German, American and Taiwanese schemes failed, Tom suggested that the lack of an international standard for categorising materials was another reason behind failure. The Taiwanese scheme, called Nanomark, for instance, found that many of the products brought forth did not actually contain any nanomaterials (Tom, 2011). He also found that the UK Voluntary Reporting Scheme *"was so technical and a lot of pages, you needed a scientist to sit next to somebody to fill it out. So that was a top-down exercise"* (Tom, 2011). Instead, Tom suggested that the exercise should be bottom-up, and that Industry and the relevant Trade Associations should be asked to provide input and that a much simpler scheme should be put in place (Tom, 2011). During the course of the interview, Tom underlined the importance of Industrial involvement, and thought that engagement with Industry should be made easier. He also pointed towards several initiatives arranged or co-coordinated by BIS and

other Government departments that aimed to facilitate engagement, such as the Mini-IGT and the NanoKTN (Tom, 2011).

Paul also commented on that the Voluntary Research Scheme had not worked out but said he would rather not speculate on what the approach needs to be, but that *"(…) industry and retailers need to take a more proactive approach, and need to recognise this is a shared agenda if they want to reap the benefits"* (Paul, 2010). Paul continued by saying that the CIA, the Nanotechnologies Industries Association (NIA), and the KTNs were moving in this direction, but that ministerial commitment would be important (Paul, 2010). Paul's statement suggests two important points – firstly, he underlined ministerial commitment, which could imply that decision-making ultimately laid with the politicians, who were quite invisible in this study. Secondly, Paul was not alone in pointing out the uncertainty that followed the general elections in 2010, which happened just before the interview. This may go some way in explaining the invisibility of government or decision-makers. Going back to his accounting for industrial relationships, Paul underlined how Defra is not a department focusing on the questions that Industry would find the most important: *"we [Defra] would like to be able to involve industry in progressing our own environmental research agenda. Industry, obviously, doesn't really think environmental research is quite as important as the research that drives innovation"* (Paul, 2010). Paul further suggested that I should try to speak to Tom[28] at BIS, who would be more involved with issues related to Innovation. The interview with Paul, and the subsequent interview with Tom made it clear that though the Government departments collaborated closely, there was a clear separation between what was considered 'Innovation', and therefore Tom's portfolio, and what was considered 'Risk' or 'Regulation' related, which was considered Paul's portfolio.

*4.2.4.2 On Government: slow and 'unintelligent' customers*

Chris, a former scientist working for a regional industrial body, agreed with Tom in that a bottom-up approach would be useful in order to make the

[28] Unbeknown to Paul, the interview with Tom was already scheduled.

scheme more appropriate and used. He also emphasised that his organisation included academics, industrial partners and trade associations, and local and regional governmental representatives on its board and that they were considered equal (Chris, 2011). However, the government, Chris continued, was the least interactive and engaging partner. Talking specifically about the NIDG (see 4.2.1) where he was taking part, Chris said that though they gathered a broad range of actors, including industry, industrial associations, consumer organisations, academics, and government agencies, there had been no ministerial presence, and *"(…)they never seemed to actually do anything"* (Chris, 2011). Since its last meeting the NIDG seemed to have come to a halt, he said. Brian also remarked on the 'slowness' in government activities, and further commented on the likelihood of the change of Government (UK parliamentary elections held in 2010) slowing down the implementation of the UK Strategy in that the new Government would have to pick up something the previous Government had done amongst all other things they had to do (Brian, 2011).

As non-industrially employed academics and scientists, George, Matthew, and Scott agreed with Chris and Brian with regards to the slowness that sometimes hampered Government action. George remarked on how he found that Government officials that he meets on boards and in committees or otherwise in policy-negotiations or other discussions are present, but that not much seems to come out of it (George, 2008). Meanwhile, Harold took a very negative turn on the Government, specifically talking about being 'precautionary', saying that Governments do not like the wrong answers, and that *"we are not dealing with intelligent customers here"* (Harold, 2011) as he reflected on how all types of asbestos are not harmful, but that he felt that he could not say that openly. What Harold meant with 'intellectual customers' was that he found the lack of scientific knowledge and understanding within Government and Government Agencies challenging, and that the lack of knowledge would easily lead to misinformed policy-making – and *"unnecessary scaremongering"* (Harold, 2011). Scott agreed and expressed concern with the lack of science and technology degrees among UK politicians and civil servants in comparison to other European countries. In

stead, he said, many have degrees in Classics or History - which was not a 'proper qualification', in Scott's view (Scott, 2011).

*4.2.4.3 On academia: need to move towards applied science*

When discussing academia and scientists, all industrial representatives and government officials underlined the importance of research and scientific input into policy-making, as this was an emerging field under development. Tom specifically mentioned the need for academic institutions and their output in terms of R&D and innovation for the UK economy (Tom, 2011). The only real criticism about academia came from the academics themselves. Kate did, for instance, remark on how scientists sometimes are too detached from the 'real' world, possibly making a reference to her own situation as she self-defined herself as primarily doing 'basic' science (Kate, 2011). She also underlined the importance of basic or fundamental science to applied science, and it is possible that she felt that she ought to be more involved with policy-making but as soon as this was brought up in the discussion she made a reference to her mid-career status and that she was not senior enough to get involved or asked to be involved with policy-making exercises (Kate, 2011). Interestingly, Scott said that he found academics very selfish as they focus more on new knowledge than worry about implications and applications, though this would be helped by initiatives like the EPSRC's policy on impact that had to be met when seeking grants (Scott, 2011). Scott's statement on basic science and selfishness is perhaps not surprising as he is working within applied research and is an advisor to the Research Councils due to his emphasis on commercialisation of nanotechnologies and nanosciences. However, taken together, Kate's and Scott's statements could suggest that there is a push for applied research in the nanotechnologies and nanosciences field, and that innovation is considered a driving force for nanotechnologies and nanosciences R&D within the academic community. Roger also reflected on this when discussing basic science, saying that Universities and research institutions have no understanding for what industry needs (Roger, 2011). George's take on the tension was that Industry considers basic science something they pay taxes for and that his institution only got industrial funding

for basic science that was targeting very specific fields, but that any 'blue skies' research was funded by other sources (George, 2008).

*4.2.4.4 On NGOs: only if not 'too extreme'*

As for working with partners outside the 'triple helix' – e.g. other than industry, government, or academia – interviewees most often said they 'ran into' NGOs in committees, during policy-discussions where NGOs were included, or during public engagement exercises or similar events, but that they otherwise would not engage much with NGOs. There were differing opinions regarding the potential challenges that NGO/Civil Society interaction entailed, and the trajectory that surfaced most commonly was one according to which it was possible to differentiate between NGOs. On one side of the spectrum were the *"too extreme"* (John's words, 2009), ones like the ECT group that were unsympathetic to the need for innovation and wanted to 'stall progress', and on the other were NGOs like Which (a consumer group) and in some cases Greenpeace, which were considered more cautious in their calls for moratoria. Scott, however, underlined how he had often been at the same meeting or panel discussion and expected to argue with NGO representatives such as Greenpeace's Doug Parr.*"The odd thing was that Doug Parr is one of the intelligent people in these, and he did not usually disagree with us"* (Scott, 2011). Again, Scott made references to the academic background of other actors, and pointed out that Doug Parr – who is a Chief Scientist and Policy Director at Greenpeace has a D.Phil. in Atmospheric Chemistry, and was *intelligent* and not in disagreement with Scott and others advocating commercialisation-oriented research (Scott, 2011). The claim of 'intelligence' on the part of Doug Parr is on par with Richard's reflections above regarding how his group has been received favourably in policy negotiation due to their emphasis on research and science as forming their views and arguments. Also Brian claimed that though Industry and Greenpeace initially felt like they were on different 'poles', he and Industry now found Greenpeace much easier to work with (Brian, 2011).

The first theme in Scott's statement, however, seems to suggest some form of 'common understanding' among the event organisers (who were not named)

with regards to the assumed feelings between Scott and Doug. Speaking to the other interviewees offered some clues to this direction. Tom did, for instance, discuss his disappointment at the GM debate in the 1990s. Though there had been public engagement through a GM nation exercise, Tom said that NGOs and other pressure groups had got involved and high-jacked the agenda. Therefore the UK does not grow GM crops (Tom, 2011). The failed debate, Tom argued, led the government to conduct a review and decide to take action to avoid a similar public rejection in the future, which led the government to establish the Science Media Centre to educate the public and provide public engagement (Tom, 2011). Tom's view on NGOs was clearly marred by the GM-experience as it came up several times during the interview. He did, however, emphasise the importance of their inclusion in Stakeholder groups and similar arenas. Tom also said that the then Science Minister, Lord Drayson, had been visited by Which, who told him that they were worried about fullerenes in cosmetics and how they may interact with the body, which, Tom said, led to the development of a UK Strategy, despite the already existing EU Cosmetics Directive (Tom, 2011). Tom expressed his positive opinion about the existence of a UK Strategy, and in acknowledging that Which played a part in bringing that into being, he expressed a cautious optimism about NGO involvement.

Tom's account offer some confirmation of the assumptions made based on Scott's account, firstly – there is an assumed trajectory that divides NGOs and an assumed NGO-like behaviour when it comes to emerging technology in the UK, and secondly, some NGOs are more appropriate 'partners' than others. Richard also confirmed the latter point and said that his group was likely to be more 'in the middle' than the rest of their NGO colleagues, and that they are one of the few that work in the area of nanotechnologies and nanosciences, rather than just have opinions about them (Richard, 2011). However, his opinion on why 'GM failed' was different to Tom's as he underlined that the failure was not due to NGO protests, but due to both the lack of real UK-need for GM crops in combination with the lack of upstream engagement with the public (Richard, 2011).

Paul, reflecting particularly on environmental NGOs claimed that they were more tied up with other, more pressing, issues, and that though the government would like to get them involved with stakeholder meetings, the NGOs themselves – in Paul's view, take the view that the government is managing Nanotechnologies effectively (Paul, 2010). Paul continued by saying that NGOs, though they wanted more money to go towards research, more public engagement, and the development of a strategic agenda, the lack of known major risks meant that they did not turn up to meetings (Paul, 2010). As none of the environmental NGOs contacted for an interview replied, it is difficult to verify Paul's statement about their being too busy to participate in stakeholder meetings. It seems from Scott's account, however, that at least Greenpeace did participate in policy-negotiations and public engagement events. The criticism that the UK Strategy and other policy documents received on blogs, commentaries, and also the criticism that the government received by other interviewees for this study does cast some doubt on whether or not others would consider the Government as having managed Nanotechnologies effectively, however.

*4.2.4.5 On the Public: to be kept informed*

The public was mainly mentioned as questions around public engagement and communication with the public came up during the interview. Again, the views on the public and their use as a 'party' differed. While Harold emphasised that there was no need to worry the public as 'nano' is already here (Harold, 2011), Tom underlined the point to increase public awareness in order to avoid *"this Frankenfood thing"* – Tom was referring to an article produced by the Daily Mail (Daily Mail, 2009) concerning GM Foods and an earlier Daily Mail article (Daily Mail, 2008) that associated Nanotechnologies to the so called 'Frankenfoods'.

Chris confessed to his not having a lot to do with the public per se, though they [his organisation] did organise public seminars and public lectures, to which they invite 'everybody' (Chris, 2011). That said, they sometimes got phone calls from members of the public with questions about new medical technologies, which he found quite difficult to respond to as they had to

explain that research and trials were still ongoing, and that it would take many years before the technologies would hit the market. Fortunately, however, they did not receive phone calls often, Chris said (Chris, 2011). From how he expressed himself, Chris did not seem at ease talking about his direct experience of the public, and he often referred to open invitations, such as inviting 'everybody' to events that were publicly announced as involving the public. The meeting invitation, however, seemed more directed to peers than to the public and the events were of technical and scientific nature and not communicated in a way that would be suitable to most members of the public. The activities that Chris had taken part in had something in common in that they were informative rather than engagement exercises, and he – like Tom, emphasised the importance of public awareness.

Richard, as representing civil society, was very much in favour of considering the general public a partner in policy-negotiations, though through the right channels that would enable the feeding back of information and opinions into policy-discussions. He also stated that Government and Industry, when suitable, were keen to be seen to engage with NGOs and with the general public, but that their opinions did not seem to really be taken into account (Richard, 2011). Paul more or less confirmed Richard's statement, but also pointed out that it was important to engage with the public on matters that mean something to them, or engagement would serve no purpose. He found it questionable whether or not nanotechnologies actually meant something to most people, and did not really see a discussion as having been called for yet (Paul, 2010). Similarly, Brian emphasised how he felt that the UK public, with a few exceptions, have not engaged with nanotechnologies, and that he therefore did not see the need to include them in his own work, though he expressed support for Nano & Me and similar efforts to inform the public of issues related to nanotechnologies (Brian, 2011).

Overall, the only cultural constraints found between the parties seemed institutional or organisational in the sense that though quite a lot of interaction was found between academia, government and industry, and some of the interviewees professed to belong to more than one of these three categories,

they were very much considered separate entities with their own separate interests. There were also instances where one of the parties did not interact enough or where their presence was lacking, and where this was being pointed out by interviewees – or instances where interviewees made it clear that the other party's lack of interaction was not surprising or at least not unexpected. When quizzed about the latter, the replies received were along the lines of 'that is just the way it is' and 'they have never really interacted with us', which would point towards an institutionalised interaction between the parties through which the culture within which they engage has a set of rules that have existed over a longer period of time and are not necessarily questioned. None of the interviewees reflected particularly on dealing with the differences between parties beyond further interaction, at least between the 'triple helix' and Civil Society organisations when necessary, but none of the interviewees mentioned including the public more than through public engagement exercises or by means of keeping the public informed and making sure they were not fed *"sensationalist stories from the Sun"* (Chris, 2011) or latched onto the Frankenfood discussion (Tom, 2011).

*4.2.5 Reflections on collaboration and trust*

In accounting for who was taking part in discussions all interviewees that were involved with them often listed the various people and institutions already listed in the policy documents found during the course of the study. Several interviewees made reference to other interviewees, which may go some way in showing that it was a relatively small group involved with the nanotechnologies and nanosciences decisions before and during the time for the interviews. Quite a few of the interviewees admitted to interacting with the same parties in other contexts as well, including with one another amongst the UK group of interviewees for this study.

With nanotechnologies and nanoscience being a broad collection of technologies and sciences, many of the academics and scientists among the interviewees had a broader network that went beyond the nanoscale. Similarly the industrial representatives found themselves interacting with other 'scales'

such as microtechnologies, or other technologies within the same region or that were directed to the same industries, such as the pharmacological industry or laser industry. Richard did not only focus on nanotechnologies in his work – which included other R&D as well, particularly related to chemicals and high-tech materials, nor did the government representatives who collaborated extensively over other issues as well.

*4.2.5.1 Leadership questioned*

With regards to all policy-making discussions upon which the UK Strategy was built, the interviewees who part-took found that leadership laid with the Government. However, they and both Paul and Tom confirmed this, acknowledged that the Government rested on expert advice, and that they had been happy to provide this when requested. Usually 'Government' was not distinguished in terms of a specific department, but interviewees considered it as encompassing both politicians and the public service, at least on Ministry level. Specifically with regards to nanotechnologies however, Brian mentioned that he thought Defra was in charge of nanotechnologies on behalf of the Government, but that this may have changed during the development of the UK Strategy, where he thought BIS had taken more of a leading role (Brian, 2011). Interviewees showed some difference in opinion as to the effect that their participation had on the outcome of the negotiation process, however. Brian, Matthew, and Roger felt that Industry was not being listened to and Matthew added that he felt that industry was quite marginalised in policy-discussions, and both Matthew and Brian agreed on that Industry and Government find it easier to listen to each other now [in 2011] than in the very beginning (Brian, 2011; Matthew, 2011). Roger was very vocal in his criticism about the UK Strategy – echoing some of the criticism offered by Maynard and Harper as he claimed it focused too much on precaution and less on the opportunities highlighted in the Mini-IGT Report, and that Industry had not been listened to enough (Roger, 2011). Chris agreed and added that the Report, which was launched in January 2010, did not seem that important to the government as there had been no ministerial presence at the launch. Chris, 2011). This, Chris said, *"sent a message to industry, to the people that were involved. And there were a lot of people that*

*came along to the launch event (…) they sent (…) somebody who is just a bureaucrat, rather than somebody who can be seen a, like, this is leading government policy"* (Chris, 2011). Chris said that the experience, to many of the involved, portrayed the lack of governmental commitment to UK industry. (Chris, 2011). Scott also brought up this experience (which is analysed further in Chapter 7), and questioned the abilitiy of the Government to learn from past experiences, which indicated that similar things had happened before (Scott, 2011). It became very clear that Industry did not feel listened to, and that the Mini-IGT experience was brought up as an example of several of the interviews was interesting as Tom, representing the Government, highlighted it as a good example of Industry getting together and providing an input into the UK Strategy (Tom, 2011); he even provided me with a copy of the report during the interview.

Richard did not discuss the Mini-IGT Report, but he was very disappointed in the Government's leadership for two reasons. Firstly, the Government could have made the Voluntary Reporting Scheme mandatory had they wanted to. Secondly, Richard claimed that there seemed to be a complete lack of momentum on behalf of the Government behind the development of the UK Strategy. When asked about whether the change of Government might have an impact on Government's reactiveness, Richard said that the document [UK Strategy] was not a good document in the first place, but that nothing had happened since the new Government got into power as officials were awaiting ministers to make decisions. *"[W]hilst this is happening from our point of view you've got the development of this technology and potentially, I would say, products being put to market without any kind of an understanding as to where they're being used"* (Richard, 2011). Richard continued by saying that most of what his group and other NGOs had asked for had not happened, and had not been taken into account in the Strategy, or been addressed by Government since the Strategy was published. However, nor had the pro-innovation and pro-industrial opinions had been taken into account (Richard, 2011). Richard did not see much use of the Stakeholder groups and other discussions in which he or his colleagues had participated.

The academics or scientists among the interviewees claimed they were listened to in a policy-context, as they were invited to provide advice based on their areas of expertise, which they were happy to do (for instance George, 2008; John, 2009; Harold, 2011). However, George questioned whether or not his advice was taken on-board as he remarked on the lack of transparency in Governmental decision-making, into which he included both politicians and public servants (George, 2008). This stated, George did not consider it 'his place' to make corrections or comment on decisions made as his 'task' was to provide objective advice and then continue doing his job (George, 2008). The academics or scientists interviewed, with the exception of Scott, did not feel that they had another role to play than offering expert advice. Though they interacted with industry and government, and sometimes with other entities as well, either regularly or on occasion, all interviewees considered academia as a separate institution that was governed by its own set of cultural, social, and legal rules.

Neither Paul nor Tom addressed any potential dissatisfaction with the Government's leadership. However, Paul admitted that a Summit organised by Which in 2008 offered the Government, or at least him, the insight that the Government *"have not necessarily been terribly good at passing the message out telling people what we're up to. Yet, people* [attending the summit] *were quite encouraged by what they heard of what government was doing"* (Paul, 2010).

Overall, the government's leadership was questioned, and its lack of leadership or the lack of taking both the points made by the industrial side, and the points made by Civil Society organisations into account in the development of the UK Strategy, caused resentment in all quarter apart from within the Government itself. Little was, according to the interviewees, done to resolve these issues. Though interviewed before the UK Strategy was written, John's perspective on leadership and the development of a strategic agenda related to nanotechnologies and nanosciences in the UK boiled down to a cultural or societal rule: *"I think British society is very slow moving on this kind of thing. The British seem to just want to debate things and analyse things for*

*so long that it just slows them down, I think. It slows them down in making progress"* (John, 2009).

A majority of the interviewees claimed to meet with other parties within the triple helix, including Civil Society organisations on occasion, in other events than those directly related to nanotechnologies and nanosciences policy making. Examples of these were open or public seminars, meetings about other topics, or engagement activities. However, there did not seem to have been any events that brought everyone together at a level playing field, following the Which Summit, which was mentioned specifically by four of the 13 interviewees. Three of the interviewees said that they interacted with other people that they had met in a policy-making context informally as friends in their spare time, but this was rather unusual.

As far as trust was concerned, there did not seem to be very much trust felt towards the government from any of the interviewees, apart from the Government representatives, and possibly Kate who also worked for a government agency. The main concerns was government 'inaction', the lack of transparency in decision-making, and perceived indecision seen through a large number of reports and meetings, but little output. Industry was more favourably viewed, though mainly and most positively so by interviewees who were closely involved with industry. None of the non-academic/scientist interviewees criticised academia. Rather, academia seemed much in want for its expertise in nanotechnologies and nanosciences. Finally, the public was largely invisible and unnoticed, but when the public was mentioned, NGOs – and particularly Which and Greenpeace, came up and they were quite favourably compared to other NGOs and civil society organisations. This was due both to increased engagement and collaboration with Which and Greenpeace, and that they were seen to base their arguments on 'science'.

### *4.2.6 Public engagement and the 'trust gap'*

That public engagement related to nanotechnologies and nanosciences had been and was taking place was common knowledge to all interviewees,

though there were differences in understanding as to what public engagement really entailed and with what purpose it was conduced. A couple of interviewees also offered feedback as to how they thought engagement exercises that they had taken part of had gone. In addition to all previously mentioned interviewees, a 13th interviewee, Anne, was interviewed particularly due to her involvement with several UK public engagement exercises.

Several references were made to the RS/RAE report, but also to the GM-experience and public reluctance to accept GMOs in the UK. Both Tom and Paul were particularly eager to display examples public engagement projects for nanotechnologies and nanosciences that the Government had been involved with or supported, such as Citizens Jury, the Nanotechnologies Engagement Group (led by Demos and Involve), and more ad hoc public engagement efforts made by the Chief Scientist. Tom acknowledged that the public had not requested these events, and that they had been rather top-down, but said that the Government was keen to engage as they had learnt their lesson from GM, and that they wanted to come across as being open and responsible (Tom, 2011). Tom also referred to an online public consultation that was arranged as a part of the development of the UK Strategy, and open to anyone wanting to provide input into the Strategy. Tom again highlighted the need for public 'awareness'.

Anne, who had worked closely with Government's effort to engage, confirmed Tom's point about the willingness to engage, and added that following the call for upstream engagement made in the RS/RAE report, another challenge emerged in that organisations that had previously been considered competitors suddenly had to find a way in which to collaborate (Anne, 2011). Anne was part of the Nanotechnologies Engagement Group, and said that the reason why that specific public engagement effort was successful was that it was not just about outputs at all, it was a good experience. She said that policy-makers tend to overly rely on reports, but they did not actually have the time to be there themselves, but as the group provided an 'easy to digest' report in addition to a short focused analysis through a presentation, Anne said they were asked to repeat the exercise. In the end, the exercise *"was*

*mentioned in a white paper whereas other, perhaps, more intellectual projects haven't had the same impact because, you know, who wants to read hundred page reports"* (Anne, 2011). On being asked how Government and Government officials had related to the event, Anne said that while civil servants were increasingly enlightened and fairly open-minded, there was less commitment on the political level and some unease with how much the civil service could do without ministerial support*"* (Anne, 2010). Paul largely agreed and said that it would be good to involve politicians in the future, but that it would need careful consideration with regards to what kind of discussions they would get involved with (Paul, 2010).

Richard particularly mentioned Citizens Jury and the following Nano Summit, both of which he thought had been good events that brought people together, but he expressed disappointment at 'the lack of Government action', and called the UK Strategy, that had followed these events, a "non-strategy" (Richard, 2011). Paul, independently, mentioned that the organisation that Richard was working for had been very critical of Government's public engagement in saying that it had been lacking, and calling for more engagement, a greater commitment to research, and the development of a strategic approach. This was something Paul said that the Government had tried to respond to over 'the past year' (e.g. in 2009/2010). Richard, being interviewed 6 months later did not seem to agree.

As for the views of the academics and scientists among interviewees, Scott differentiated between events and was very happy to take part in science festivals where he could show equipment such as their electro-microscope and speak with school children, but he did not like the Café Scientifique model where people were invited to express their opinions or discuss with him as *"[w]e had the nutters turn up [laugh], and, uh, frankly, as an expert, you're best to keep your mouth shut and sneak out the back"* (Scott, 2011). He also said that this type of engagement was not very productive and that it did not seem to serve a purpose more than being a 'tick-box exercise'. George also reflected on an event that he had taken part of where he rather than criticising the experience of communicating with the public criticised the materials that

had been prepared for the event for their lack of technical and scientific accuracy (George, 2008). There seemed to be more discontent with public engagement design than with meeting the public face-to-face.

Apart from reflecting on his involvement in public engagement at the Dana Centre as being 'not too bad', Chris' experiences were mainly related to one-way communication initiatives, such as being on the radio, or answering questions posted on the website of his organisation. However, his institution's website, he said, got 1,500,000 hits a month, and they organised public seminars, and school days for school children (Chris, 2011). Brian, Matthew and Harold did not have any experiences of public engagement, but chose to refer to professional communicators employed within their institutions. Roger and the association he represented, on the other hand, did not do science communication or public engagement. Instead, he referred to a 'US Study' that showed that *"the public isn't interested in being involved with nanotechnologies generally (…) It's interesting to involve them if they can be civil about it"* (Roger, 2011). As Roger had not been part of any public engagement exercises, it was not clear on what basis he assumed that the public could be less than 'civil', he did not want to discuss the subject any further.

Public engagement, public communication, public awareness, science communication, and engagement used on their own were all concepts used by interviewees as interchangeable terms. The exceptions to this were the interviews held with George, Paul, Anne, and Scott. Of significance for the rest of the study was that none of the UK interviewees asked what public engagement was.

Neither of the interviewees seemed to think there was a 'trust gap' there that was specific to nanotechnologies or nanosciences as far as the general public was concerned, but at the same time some thought that over-communicating could be as harmful as not communicating at all. Roger and to some extent Harold were more sceptical about involving the public than any of the other interviewees, and there may be a trust gap there. That said, neither of them

had actually done any public engagement or much nanotechnologies and nanosciences related communication to speak of, and they readily admitted this fact (though Harold had previously worked as a journalist, he had not done so during the 'nanotech era'). There did seem to be a trust gap between government and the other actors, however, which was a theme that ran through much of all interviews, apart from perhaps those had with Tom and Paul.

Another trust gap that was discerned during the course of the interviews, and with Roger, Harold, Scott, Chris, and Paul, the comments were quite heated, regarded the role of the media. Media was very often mentioned in relation to questions about risk and the perception of the public, but also with regards to 'trust'. There was also an interview question with regards to how interviewees perceived media coverage thus far, and the adjectives used to describe the media ranged from 'biased' to 'scandalous'. However, Chris and Scott both mentioned a roundtable event to be hosted by The Guardian in early 2012[29], which they both thought would offer an opportunity for 'un-biased' and 'holistic' media reporting on nanotechnologies and nanosciences.

None of the interviewees gave a clear answer to why trust gaps may occur, but both Paul and Harold blamed the media and 'scaremongering' for any lack of public trust, while Richard underlined the need for proper communication and transparency in order to keep people's trust (Richard, 2011).

### *4.2.7 Balancing promotion and regulation*

There was a clear difference of opinion among the interviewees with regards to the balance between promotion and regulation. While the industrial representatives felt that not enough was done to support industry and to fully commercialise nanotechnologies and nanosciences, a couple of academics and the NGO representative claimed that the opposite was true. The theme is

[29] The event, which was streamed live here: http://www.theguardian.com/nanotechnology-world/how-nanotechnology-is-prolonging-life-live-debate, [03/07/12] took place 31 January 2012 and was arranged by the Guardian in the UK, and was part of Nano Channels, a FP7-funded project that run similar events in other European countries.

best explored by examining how interviewees referred or discussed aspects of promotion and regulation, such as the precautionary principle, risks, health and safety, and, commercialisation, business interest, and innovation.

*4.2.7.1 On risks, health and safety, regulation, and the precautionary principle*

In terms of balancing risks and promotion, Brian expressed his disappointment with UK nanotechnologies as being weighted towards safety, and argued that the discussion should have been driven by responsible innovation instead (Brian, 2011). Reflecting on a seminar he had taken part in, he said that 90% of the content had been about risk issues despite the seminar having been marketed as being one about innovation. This sort of mentality, Brian argued, was not balanced and it did not give Industry the encouragement necessary. Industry, he continued, knew enough about taking a responsible and precautionary approach, and discussions needed to be proportionate (Brian, 2011). Roger made a similar point and said that he had worked closely with Defra (thought to be particularly risk-focused), and that the UK, being a modern democratic society, would need to keep its checks and balances, and not focus on toxicology and regulation (Roger, 2011). His statement seemed to imply that the current discussion was not democratic in that Industry was not listened to. Roger also underlined how a mandatory reporting scheme would *"kill SMEs and kill innovation"* (Roger, 2011). A mandatory scheme would be to time consuming and go beyond the resources of SMEs and he favoured a voluntary scheme (Roger, 2011).

Richard, on the other hand, emphasised the need to communicate even potential risk because if the risk had not been communicated, and something would happen, you end up looking bad and people will ask you why you didn't say anything in the first place. Secondly, not communicating potential risks could, he argued, open the floor to people who did not fully understand the science, risks, or benefits, to spread misinformation that could lead to a media and public backlash (Richard, 2011). John made a similar point, and argued that companies and business leaders have an ethical and moral obligation to be transparent about the technology they produce. If they are not, the public might get paranoid and negative outcomes could follow (John, 2009). When

other interviewees discussed the need for communication it seemed to be mainly for the sake of bringing it up, or as a reply to a direct question about the importance of communicating.

When reflecting on risks, Tom brought up an activity that he was keen to get involved with, which was the development of a 'responsible nano code'. Tom said that something like this had been developed on the EU-level, but that BIS/Government should be doing this with the NanoKTN, NIA, and CIA for their members (Tom, 2011). There were, according to Tom, previously held discussions with Responsible Futures (the company that set up the Nano&Me website), about a 'nano code', but, he said that the money the Nano&Me coordinator wanted to set up and run the website was more than they (e.g. BIS and NanoKTN) wanted to commit, and he also felt that TBS and NanoKTN should be doing the work proposed themselves (Tom, 2011). Tom also pointed towards the ERA-Net, and their current call for projects on responsible nanotechnology development (Tom, 2011)[30]. Still responding to the question about risk and how Government was working to address the 'risk discussion', Tom further mentioned the Council for Science and Technology review, saying that the Government had realised that if they were to be funding research they should be addressing the risks simultaneously. Hence, the TSB and Research Councils put out calls for proposals that made attention to potential risks a requirement for successful funding applications. (Tom, 2011) Tom specifically mentioned the need to find further funding for nanotoxicological research and life-cycle assessment, which was echoed by other interviewees too.

[30] Though possibly not of the scale that Responsible Future would have hoped for, a Responsible Nano Code was discussed and planned for in collaboration with NIA and the Royal Society in 2008/2009. It does not seem as if it was ever fully developed however, but the workshop report is available through the Nano&Me website: http://www.nanoandme.org/social-and-ethical/corporate-responsibility/responsible-nano-code/ [23.11.14] Note. This code seems to target corporate responsibility, whereas the European code (below) seems more focused towards research activities.
An European Code of Conduct for Responsible Nanosciences and Nanotechnologies Research is available for download from the consultation website held by the European Commission: http://ec.europa.eu/research/consultations/nano-code/consultation_en.htm [23.11.14]

Instead of talking specifically about risks, Chris sought to re-frame the risk discussion into one about health and safety, as he said the real danger is what goes on in labs rather than what industry does and doesn't do (Chris, 2011). Harold, Matthew, and George also expressed lab-related health and safety concerns, as being more central to their thinking than risks to wider society. At least for George and Harold, health and safety in laboratories was on their professional agendas in working in clean rooms and with research groups that conducted experiments in clean rooms (George, 2008, Harold, 2011, and Matthew 2011).

With regard to legislation and regulation, interviewees mentioned REACH as a framework they followed, and the Cosmetics Directive – but Tom was the only interviewee to discuss the 'Responsible nano code'. Rather, interviewees did not seem to know if anything was going on with regards to regulation in the UK, and many seemed to refer to the EU-level and then move on to discuss other topics. Kate added that, for her, REACH was very important as the inhalation facility she worked with was a limited resource and it brought research groups (mainly those with industrial funding) to her work place as they had to fill in the paper work to comply with REACH (Kate, 2011). This said, she emphasised that her laboratory was not available for groups or SMEs that wanted to test their products and then put them on the market, but they were available to groups whose projects fit the public health remit for the lab (Kate, 2011). She added that this was very bad particularly for SMEs who would struggle to get access to similar facilities elsewhere.

The only interviewee actively calling for regulation was Richard, whose organisation, he argued, was not asking for 'overly burdensome regulation' but rather wanted to ensure that there are enough checks in place to prevent products that are un-safe to enter the market and that there is communication about uncertainties and that consumers can make informed decisions (Richard, 2011). He further emphasised the point about wanting to meet industry halfway, but also said that consumers and the public need to be able to make informed choices, and that this was also in Industry's interest. An informed choice rested on the transparency and openness of industry and

companies with regards to the products they developed, he said (Richard, 2011).

Finally, all interviewees seemed to be familiar with the precautionary principle, though there was disagreement as to how much space it should get in UK nanotechnologies and nanosciences policies. While Richard thought it was a reasonable principle that could aid in putting a mandatory reporting scheme in place, and make sure that Industry did not go unregulated, Scott, Brian, and Harold thought it could (and sometimes had) gone too far. Though he did not want to give a clear answer about the Government's position on the precautionary principle, Tom's personal reasoning was that no using innovative designs without knowing that they were perfectly safe hampered innovation, and that – to him, seemed to be what some actors wanted (Tom, 2011). Tom went on to compare this to the use of medication and chemotherapy, saying that though there are likely side effects, people agree to take it anyway as there are associated benefits that outweigh the risks (tom, 2011). John discussed the precautionary principle within Europe as a whole, and claimed that Europeans are more inclined to ensure safety befor commercial development than their American counterparts - which he, personally, thought was a mistake in that it left Europe lagging behind its American, Chinese, and Russian competitors (John, 2009). Matthew's comment was along the same lines as he said his organisation would want the UK to be positioned between the precautionary principle and America (Matthew, 2011).

*4.2.7.2 On business interest, innovation and commercialisation*

As Brian stated, 90% of the seminar he went to was about risk issues. To some extent this was the case during the interviews themselves as well – much of what was said in the UK concerned risk, or more often, turned out to be a reaction against the focus on risk.

However, as far as research and innovation was concerned, Scott agreed with John's point in that nanotechnology in the UK had lost its special ring-fenced position due to the risk focus, and that the inability to feed the Mini-IGT

report's findings into the UK Strategy (Scott, 2011) Many of the other interviewees agreed, and Chris referred to a recent initiative by the government to set up technology and innovation centres, and that 'everyone', e.g. Industry, had hoped for schemes similar to Finland's VTT (Technical Research Centre of Finland) or IMEC in Leuven (the Netherland) which are big centres with clusters of SMEs and some academic institutes involved. However, the first centre was announced shortly before the interview, and it was seven existing centres that were to be given a little more funding for advanced manufacturing. Chris thought that rather than collaborating, the centres were likely to compete with one another for the same pot of funding (Chris, 2011). Though the initiative was not mentioned by the other interviewees, Chris' point ties in well with other comments made about the lack of funding for innovation, and the lack of Governmental commitment.

Paul underlined how innovation was considered BIS' remit rather than Defra's, but when quizzed about business needs and innovation he mentioned that commercial confidentiality was not enabling businesses to drive what companies are doing, that it was difficult to share information, and that the voluntary reporting scheme was not successful for this reason. He also said that industry and retailers would need to take a more proactive approach and recognise that nanotechnologies and nanosciences R&D must have an agenda that is shared with others [academia and government], or they would not reap the benefits (Paul, 2010). Paul clearly separated not only the remits of the two Government departments, but also the actions of academia, government and industry in this statement, as three separate entities. Paul also seemed to imply that the initiative to share information and becoming proactive had to come from industry and retailers themselves, and that the Government had done enough by arranging committees and stakeholder groups to facilitate engagement. Tom did not contradict Paul's separation of innovation to BIS, and regulation to Defra in terms of 'remits. Neither of the two seemed aware of the dissatisfaction felt by the other interviewees with regards to the Government and its actions or inaction.

*4.2.7.3 Striking a balance*

When asked whether they considered policy-discussions balanced, a majority of the Industrial representatives or commercially oriented interviewees said that the discussion was not balanced, in favour of a precautionary approach and risks. Chris summarised the collective view by saying that though living a safe environment was everyone's preferred option, the environment was never going to be safe as any technology, including electricity or water, could be used in the wrong way and lead to negative consequences. However, he argued, you can develop technologies and make sure you address the gaps, which would help to fend off competition and make sure that you are more technologically advanced than others. Should this fail, and another country achieve this level of sophistication, you and your country is likely to manufacture devices for that country, rather than the other way around (Chris, 2011).

Four interviewees – Richard, Kate, Paul, and Tom did not comment on there being an overly precautionary and risk-focused discourse. Tom, Paul, and Kate, in representing different parts of the Government, were sometimes cautious in providing their opinions, while Richard's opinion was made clear in that he found the balance too much in favour of promotion and that more could be done to increase transparency and risk communication.

4.3 Nanotechnologies and nanosciences policies and policy-making in the UK

The UK field study provided more insight into how decision-making was perceived rather than how it was conducted. The vertical power held within the Ministries that were supported by other Government agencies and boards, was constantly mentioned, and it was clear that politicians – who were not always considered 'intelligent' enough for the task, had the actual power within UK science governance. There was a visible lack of enthusiasm for their leadership among the interviewees, and a trust gap was visible, not with regards to the public and its views and trust for science or public institutions, but between academia and industry and the government. Indeed, Paul and Tom did not want to appear as if they were making the decisions, while their faces was usually the ones the other interviewees saw when the government

was represented at events. There seemed to be a wish for a more visible leadership and direct connection with the actual decision-makers in the UK.

As for collaboration and interaction, it seemed the group of actors involved with nanotechnologies and nanosciences policy-making in the UK knew one another from before and quite enjoyed interacting with one another. However, some of the platforms for interaction – as understood by Chris' account, had been discontinued, which he thought was unfortunate. There was also discontent at how Industry's views, as expressed for instance through the Mini-IGT Report, had not been taken fully into account in the UK Strategy. Dissatisfaction aside, the amount of interaction between actors had resulted in a very substantial amount of reports and consultations that offered insight into a great number of perspectives, including that of NGOs and more critical reporting that discussed risks and ethical aspects of nanotechnologies and nanosciences, which was not seen in either Sweden or Finland.

As for balancing promotion and regulation, the UK interviewees, as opposed to their Nordic counterparts, had a lot to say about both topics, and also in greater detail, including, for instance, more practical aspects of innovation and commercialisation in their accounts, or in discussing the Voluntary Reporting Scheme or responsible innovation. Such detail was not obvious in either Finland or Sweden, which could be an indication of more discussions being had in a better-coordinated fashion in the UK. However, there were differences in the perception of balance and the leaning of the scales as most industrial interviewees alongside most academics or scientists among them said that risks were given too much of a focus, and Richard would claim the opposite.

Collaborating with Richard and other NGOs was not considered unnatural in the UK, while this did not happen at all in Sweden or Finland. And a majority of interviewees had experiences of communicating with the public, though their view on public engagement differed. It seemed as if the majority of interviewees thought that the public should be kept informed and aware, and that their participation beyond this was less necessary and, as Scott put it,

'sometimes pointless'. This put the point of the event rather than the point of talking to the public in question, and interviewees felt that the desired outcomes of public engagement efforts would need to be made clearer.

## 4.4 Mode 2 and Strategy in UK nanotechnologies and nanosciences

Overall, when filled in on the basis of the data collected for this study, the Themes Matrix for the UK looks like this:

TABLE 4.2: THEME MATRIX - UK

| **The governance of nanotechnologies and nanosciences** | |
|---|---|
| **Organisational diversity** | |
| a) Inclusion | Yes |
| b) Interaction – trading zones | Yes |
| c) Openness and transparency | Often |
| **Social accountability** | |
| a) Trust (among the public) | Yes |
| b) Public engagement | Yes |

As pointed out above, the organisational diversity found in nanotechnologies and nanosciences policy-making in the UK was significant, collecting a range of actors from different professional backgrounds. There also seemed to be a push for interaction, particularly between academia and industry, even from the first National Initiative on Nanotechnology. An engaged innovation structure is also visible in the mini-IGT report, which called for increased interactions with societal actors and outlined this as being of importance to innovation.

Despite the UK Strategy not being praised for its robustness by interviewees, there is evidence of consideration for both relevance and excellence in nanotechnologies and nanosciences R&D and policy-making. Both features have been promoted from the very beginning of UK nanotechnology investment. While on the one hand, the centrality of innovation to the country and to industry, and the concern for prestige within emerging technologies

and sciences were key items on the agenda, excellence and the need to build a knowledge base, by for instance investing into STEM education, was also highlighted as a key consideration in the early initiative, later documents, and the UK Strategy. The interviews did not question this assumption at all, though some interviewees would have liked to see other contexts highlighted as more relevant than they were, in the UK Strategy for instance.

The more inclusive attitude towards policy-making, the trading zones, public scrutiny, and the inclusion of both relevance and excellence in nanotechnologies and nanosciences governance would point towards a lateral rather than a linear approach towards innovation, in line with Rip's assumptions concerning Strategic Science (as described in Chapter 2).

The notion of a 'shift' applicable to nanotechnologies and nanosciences does not gather much support within the British part of the study, as there seems to have been an inclusive climate with trading zones from the very beginning of UK nanotechnologies and nanosciences R&D and policy-making. A shift may be more visible if public scrutiny is considered in that public engagement activities and communication efforts have increased over time, especially following the RS/RAE report and onwards. However, this one feature is insufficient to fully determine whether a shift can be said to have happened. With regards to Mode2 nanosciences governance, the UK case study does not fully support this the notion as relevance and excellence seem to co-exist and all nanotechnologies and nanosciences do not happen within an applied context. That said, many other features are supported, such as organisational diversity and social accountability as outlined above.

# Chapter 5: The making of nanotechnologies and nanosciences policies in Finland

*This second of three country-specific chapters aims to present the field study results and data analysis for the Finnish part of the study. The first part of the chapter will provide a backdrop to the interviews through a review of all published documentation available and found at the time of the field study. The second part of the chapter reviews the interviews held on different locations in Finland in 2008 and 2009 in relation to the research themes, and discusses the findings in accordance to the theoretical framework described in Chapter 2.*

## 5.1 Finland

While the UK search produced a large number of reports, reviews and policy papers, the same could not be said about the search for documents related to nanotechnologies and nanosciences in Finland. It is worth noting that as the interviews were held in 2008 and 2009, and much has been written following the end of the FinNano programmes in 2010. Hence, some of the sources used here to give an adequate historical narrative were not available when the interviews were held, e.g. documents dated after 2009. The interviews themselves provided many of the details and information that have been included in the reports dated after 2009, however, and the narrative therefore partially grew out of the interview process.

### *5.1.1 Early days of Finnish investment*

Responding to increased interest for nanotechnologies internationally, the industrial potential for nanotechnologies, and the need to develop the necessary skills among researchers, the first Finnish nanotechnology programme called Nanotechnology Research Programme[31] (Nanoteknologian tutkimusohjelma) ran for three years, from 1997 to 1999. A jointly run programme between Tekes and the Academy of Finland, it was focusing on both basic and applied science and channelled FIM 43.9m[32] (£5.9m) towards 14 projects (Raivio et al. 2010:22). Not aiming to build on already existing

[31] Yu & Ziegler also uses the name "Finnish National Nanotechnology Programme" in their evaluation of the programme (Yu & Ziegler, 2000:9)

[32] FIM – Finnish Markka is now obsolete, and Finland is currently using Euro as its currency. Using http://www.xe.com the exchange rate for Finnish Markka would be 1GBP=7.41FIM

industrial interest, the programme did not expect co-funding from Industry, while the Academy of Finland's part of the investment (FIM 18.3m) was incorporated in its already existing programme for materials and structures (Yu & Ziegler, 2000:4). In their evaluation of the programme, Yu and Ziegler numbers areas where funded research reached 'state of the art level', such as quantum dot lasers and polymeric nanostructures, and concluded that one of the results of the program was that Finland had raised its profile within nanotechnology research internationally (Yu & Ziegler, 2000:5). It was also emphasised that research consortia built through the programme were very important in a country of Finland's size; and credit was paid to the 'innovative character of the Finns' and their engineering skills and coherent research infrastructure through which further investment would be likely to pay off (Yu & Ziegler, 2000:8). The report also underlined how long-term research would not yield immediate commercial success through a three-year programme, but that the programme would enable the build-up of the necessary infrastructure to achieve future commercial success (Yu & Ziegler, 200:8). None of the projects funded by the programme sought to explore toxicity of nanoparticles or materials, nor were regulations or risks, apart from a comment related to the risk of not meeting the potential of commercialisation, and further investment was encouraged to follow the end of the programme (Yu & Ziegler, 2000:11, 12).

As discussed in the review of the pilot study (in Chapter 2), Finland tried not to repeat previous mistakes, in particular with regards to having missed out of the biotechnology wave by focusing on an Industry that did not have large representation in Finland, pharmacology. As a new drug costs approximately between $800m and $1.7bn to develop from the laboratory to the market (Collier, 2003), Finland's investment of €400m spread over a number of smaller entities was inadequate. Having learnt its lesson, the Nanotechnology Research Programme was followed by two programmes, both called FinNano, whereof one, run by Tekes (Teknologian ja innovaatioiden kehittämiskeskus – transl. Finnish Funding Agency for Technology and Innovation), particularly sought to focus on Finnish strengths with regards to industrial activity, such as electrical engineering, process engineering, forestry, and civil engineering. A

*Government* Agency for Innovation ad Technologies, Tekes includes elements of UK's TSB and EPSRC.

Running between 2005 and 2010, the Tekes FinNano Programme aimed to study, utilise and commercialise nanotechnologies and nanosciences, and foster cross-disciplinarity in research and development, with the overall aim to strengthen Finnish nanotechnologies research in areas that were considered commercially viable for Finland; the areas that were identified as of particular importance were innovative nanostructures and materials, nanosensors and actuators, and new solutions of nanoelectronics (Raivio, 2010:22, 23). With funds spread over 100 research projects with international and industrial collaboration, the level required was a total amount of €70m, a sum where Tekes' input of €47m was complemented by a significant industrial contribution, which was spent on the programme over five years (Lämsä and Juvonen, 2011:11).

With regard to specific goals, the FinNano programme, which was often referred to as a 'strategy' during the pilot interviews and later interviews, aimed to achieve eight specified goals: (1) strengthen existing research and foster new expertise within multidisciplinary research groups and centres; (2) support the economic exploitation of research through commercialisation of research outcomes into technology and products; (3) support national and international networking; (4) encourage Finnish participation in EU nanotech programmes; (5) support regional expertise and link regions to international networks; (6) ensure efficient use of resources and infrastructure; (7) encourage entrepreneurial interest in nanotechnologies; (8) and ensure that the necessary prerequisites for utilising nanotechnology emerges (e.g. health and safety, safety assessment) (Lämsä and Juvonen, 2011:11-14).

Tekes' FinNano Programme and that of the Academy of Finland (AF) were closely aligned and in collaboration with one another, and there were clear overlaps in terms of Board membership for both programmes. While the Tekes' programme was an 'applied' programme, the AF programme

particularly targeted nanosciences[33] rather than applications, and emphasised an interdisciplinary approach towards research (Raivio, 2010:23). Though focusing on basic research, the programme attempted to do so as a step towards innovation. Other objectives included efforts towards achieving international visibility and advancing European and other international activities, the responsible development of nanotechnologies (including ethical challenges and health and safety issues), and to create a platform for interdisciplinarity and transdiciplinarity in nanosciences in Finland (Raivio, 2010:23, 24). Divided over 10 consortium-run projects, whereof five were Finnish-European or Finnish-Russian projects and co-funded by international parties between 2006 and 2010, AF FinNano provided Finnish research teams with a total of €9.45m (Raivio, 2010:23). This sum, particularly earmarked for nanosciences, was provided by the Academy of Finland in addition to approximately €10m yearly out of their general competitive research budget, for which nanosciences and nanotechnologies projects would have to compete with other disciplines (Suomen Akatemia, 2011:15). The consortia chosen particularly focused on research into nanoparticles and nanostructures in the life sciences and medicine, the properties of nanodevices and structures, and health and safety issues related to nanoparticles (Raivio, 2010:23).

A further €19m was made available to Finnish universities[34] by the Finnish Ministry of Education towards the running costs (e.g. infrastructure) for Finland's nanotechnologies and nanosciences efforts (Raivio, 2010:23). This is slightly less than suggested by the Committee on the development of nanosciences that was set up by the Ministry of Education in 2005, which advocated a contribution of €24m towards the running costs (Opetusministeriö, 2005:5). Apart from infrastructure costs, which neither of

[33] Indeed, Tekes often referred to 'nanotechnology' or 'nanotechnologies' and rarely included 'nanosciences' or 'nanoscience' in their reports etc., while AF tended to do the opposite – though referred to 'nanotechnologies' when discussing risks and environmental, health, and safety implications.

[34] Universities in Finland and Sweden are public institutions and therefore state funded. Finnish universities negotiate with Government with regards to their funding allocations, and the MoE programme became part of the negotiation process. Funding was not allocated to individual research groups or department, but to the universities as a whole (Raivio, 2010:24).

the two FinNano programmes provided, the MoE programme offered funding towards the improved research conditions within the identified 'spearhead areas' of particular interest to Finland – nanomaterials, nanoelectronics and nanophotonics, and nanobiotechnology; enhancing cooperation and the creation and maintenance of existing knowledge clusters and education; and better knowledge transfer between academia and Industry and supporting the commercialization of research findings (Opetusministeriö, 2005:4-5; Raivio, 2010:24). In total, the MoE and Ministry of Culture supported Finnish nano-related research infrastructure by €31m between 2005 and 2009 (Suomen Akatemia, 2011:14); their join investment reached beyond the €24m suggested by the Committee.

*5.1.2 From risk as an opportunity to risk as a miscomprehension*

The MoE Committee (also called Working Group) did flag up the need to take the environmental and health effects of nanotechnologies into account, but their reasoning was particularly framing the 'effects' as offering an opportunity for further research or applications with regards to new technologies, such as diagnostics (Opetusministeriö, 2005:10). Though also considering the need for high-profile research into health effects of nanotechnology of import, the committee also pointed towards the importance of feeding back related research conducted by researchers in other countries towards Finnish decision-makers, authorities and citizens (Opetusministeriö, 2005:10). Finally, rather than discussing public engagement or a genuine dialogue per se, the Committee noted *that "[c]itizens' awareness should also be fostered with the aid of science education and science communication"* and that investing in research into environmental and health and safety risks would be important in order to gain the trust of citizens (Opetusministeriö, 2005:10, 11). The Committee did not dwell on how public engagement was to be conducted or offer any suggestions to that effect. Dialogue was mentioned under a separate heading for societal impacts of nanotechnologies, but the emphasis was put on raising citizens' awareness rather than engaging in a two-way dialogue; the importance of 'dialogue' was reduced to the need to engage not only with the natural and engineering sciences and medicine, but with the

economic and social sciences as well when trying to introduce new products an services to the market (Opetusministeriö, 2005:11).

In describing its vision for Nanotechnologies in the future, but also considering past experiences and the completed FinNano programme, the Academy of Finland discussed risks briefly, but refers mainly to discussions at the EU-level and the need for Finland to remain active within those discussions, rather than resort to additional domestic discussions on risk governance (Suomen Akatemia, 2011:19). That said, a rather interesting observation is made in another part of the report, which could explain why regulatory and risk-related issues are not taking centre stage in Finland, in comparison to promotion and innovation: the report points out that Finnish science and research politics during the mandate periods of Matti Vanhanen's second government (2007-2010) and Mari Kiviniemi's government (2010-2011) were gathered under the 'innovation politics' label (Suomen Akatemia, 2011:15). Indeed, the report continues, the highest policy-making body for science and technology in Finland changed its name in 2008 from the Science and Technology Policy /Council (STPC) to the Research and Innovation Council, and has since provided guidelines that are more pronouncedly innovation focused than before (Suomen Akatemia, 2011:15). The Council has yet to publish guidelines that consider risks and regulation.

In evaluating the Finnish nanotechnologies and nanosciences programmes, and under the heading "Finnish nano attitudes" Raivio remarks that nanotechnologies and nanosciences have been subject to *"endless public debate"* (Raivio, 2010:35) – though examples of any such debates are not provided. The report further claims the *"most important nano-related public concern [is] – without question - the aspect of nanosafety",* but does not provide examples of nanosafety discussions, or discuss in what way it is a public concern, beyond pointing out the need for better testing methodologies (e.g. risk assessments) and the proficiency of current legislation that can be modified if deemed necessary (Raivio, 2010:35). Though the report notes that

some international organisations have been critical towards nanomaterials[35] (e.g. Friends of the Earth), such criticism has not been heard in Finland, where only 10 % of mass medial reporting *"has had a negative tone"*[36] (Raivio, 2010:35). *"Typical of and common to the negative nanosafety discussion and media attention has been the lack of a deep knowledge of the facts and risks"* (Raivio, 2010:35).

### *5.1.3 Collaboration*

The idea behind the Finnish strategy (though not explicitly called a strategy), was that the various nanotechnologies and nanosciences initiatives should strive to complement rather than compete with one another (Raivio, 2010:24). Worth noting is that the MoE programme due to its nature and emphasis on education and infrastructure rather than outright commercialisation and industrial relations, had a closer relationship with the AF FinNano programme than with the Tekes' programme (Raivio, 2010:24), how they complement one another is not made entirely clear. One strategy employed to ensure that the objectives of the programmes did not overlap was that the same people were appointed to the Boards of the various programmes (Raivio, 2010:25).

In their final reports and in Raivio et al.'s evaluation, the Finnish nanotechnologies and nanosciences programmes were described as successful, though the slight downside noted was that Tekes FinNano could have had more industrial input financially rather than solely resting on jointly funded projects, and AF FinNano suffered from fragmented, and comparatively little, funding that was to be shared between several projects. MoE funding was deemed incompatible with its intentions (Raivio, 2010:65). There was no discussion about a moratorium, or the involvement of NGOs or other civil society organisations, or the public through public engagement exercises aimed to create a dialogue between the public and decision-

[35] This is a misconception as the Friends of the Earth report (see above) was more concerned with free engineered nanoparticles and the impact of nanoparticles on the environment in general rather than nanomaterials in themselves.
[36] 90% of reporting was described as 'neutral' or 'informative'. The report makes a reference to informal news monitoring through the Tekes FinNano programme.

makers. Indeed, nanotechnologies and nanosciences decision-making was, seemingly, left in the hand of the expertise. No blogs or other commentary has been found with regards to other views on the FinNano programmes or other Finnish nanotechnologies or nanosciences efforts than those expressed in the policy documents reviewed for this narrative. It will therefore be of interest to hear the opinions and views offered by other actors in Finland during the interviews, and to get an understanding for how they may relate to Finland's 'innovation politics'.

## 5.2 From narratives to interviews

Finland was the first country in which interviews for this research project took place. The reason for this was the lack of publications and documentation of use with regards to Finnish nanotechnologies and nanosciences policies. Following a pilot study, and a review of the documents that were available and that have been accounted for above, the interviews were chosen based on their involvement with Finnish decision-making and generally within the national nanotechnologies and nanosciences R&D scene. Some, however, were chosen for interviews due to their non-involvement. This means they were not directly mentioned or involved in decision-making, while they would most probably have been involved had they worked in the UK – e.g. they held roughly the same positions as the UK interviewees who were involved in UK nanotechnologies and nanosciences policy-making. The total number of interviews held was 14, with 17 interviewees as one interview included 4 interviewees (Juha, Antti, Timo, and Heljä) working for the same organisation. However, Timo and Heljä who were invited to attend the interview by Juha just before it started did not contribute with material that was significantly different to the data already provided by Juha and Antti. This interview is therefore referred to as 'Juha & Antti, 2008'. Including Timo and Heljä (classified as "government representatives") brings the total of Government representatives to 8, as listed in table 5.1, while 6 academics or scientists were interviewed. Tuula was the only industrial representative that agreed to be interviewed, though 12 other potential industrial representatives were contacted), and Marja-Leena and Sami worked for private consultancies that

were tasked with the evaluation of nanotechnologies and nanosciences efforts. Three NGOs or civil society organisations were contacted, but none agreed to be interviewed. One of the NGOs declared that they did not have any involvement with nanotechnologies or nanosciences and that they were therefore not willing to participate in the study, and no responses were received from the other two. This does not contradict the findings in the document review on the lack of involvement of NGOs in Finnish nanotechnologies and nanosciences related policy discussions.

TABLE 5.1: FINNISH INTERVIEWEES

| Reference | Alias | Role | Institution | Year |
|---|---|---|---|---|
| Harri, 2008 | Harri | Coordinator | Government agency | 2008 |
| Tuula, 2008 | Tuula | Industrial coordinator | Regional Industrial body | 2008 |
| Juha & Antti, 2008 | Juha | Senior policy-advisor and policy-maker | Government | 2008 |
| Juha & Antti, 2008 | Antti | Policy advisor | Government | 2008 |
| *Juha & Antti, 2008* | Timo | *Policy advisor* | *Government* | *2008* |
| *Juha & Antti, 2008* | Heljä | *Policy advisor* | *Government* | *2008* |
| Kalevi, 2008 | Kalevi | Senior scientist (Materials and Physics) | Academia | 2008 |
| Jari, 2008 | Jari | Senior scientist (Medical biochemistry) | Governmental research body | 2008 |
| Marja-Leena, 2008 | Marja-Leena | Consultant researcher | Private consultancy | 2008 |
| Sami, 2008 | Sami | Consultant researcher | Private consultancy | 2008 |
| Kari, 2008 | Kari | Coordinator and policy advisor | Government Agency | 2008 |
| Aaro, 2008 | Aaro | Senior scientist (Chemical engineering) | Academia | 2008 |
| Johan, 2008 | Johan | Senior scientist (Natural and environmental sciences) | Academia | 2008 |
| Katja, 2008 | Katja | Policy advisor | Government | 2008 |
| Jaakko, 2008 | Jaakko | Junior researcher (Economics and Engineering) | Academia | 2008 |
| Paavo, 2008 | Paavo | Scientist (Electrical engineering) | Academia and Regional industrial effort | 2008 |
| Herman, 2009 | Herman | Senior scientist (Biotechnology) | Academia | 2009 |
| Esa, 2009 | Esa | Senior scientist (Physics) | Academia | 2009 |

The Finnish interviews included a slightly larger proportion of women, and all interviewees were considered in positions of seniority within their organisations, though Jaakko was considered both a junior academic and a

senior figure in policy-making as he had previously worked for Tekes. While a majority of the interviews took place in Helsinki, three of these interviewees were actually based elsewhere in the country, and two of the interviews took place in other regions.

Interviews took place in three different languages, English, Swedish and/or Finnish. In the text all extracts and quotes are translated into English while quotes originally given in Swedish or Finnish will figure in the footnotes in their original version. As for the presentation of data, the set up for this Chapter will be the same as described for the UK field study. The Themes Matrix is found in Chapter 2, Table 2.2. The indicators for organisational diversity will be explored in subchapters 5.2.1 – 5.2.5, while the indicators of social accountability are explored in subchapter 5.2.6, and part of 5.2.5.1. 5.2.7 will discuss the balancing act between promotion and regulation in Finland, or the lack of it, and subchapter 5.3 aims to offer a brief summary of the main points as found in the Finnish part of the field study.

*5.2.1 Identities, roles, and the roles of others*

The Finnish interviewees found it quite easy to identify with academia, industry, government, or 'other' (e.g. not one of the other three, which the private consultancy employees confessed to being). This said, all non-academia interviewees were eager to start conversations with underlining that they had a past or presence in academia, and, interestingly, many of them were similarly keen to hear my own justification for conducting the interviews. In fact, it turned out all apart from Antti (who had an MSc) had PhDs in Science (Chemistry, Physics, or Biology), Engineering, or Medicine. Though not currently working as a scientist, Tuula, the industrial representative, identified with scientists and said that it was necessary as *"(…) it is very difficult to go to the university to talk to professors if you haven't done your own PhD*[37]*"* (Tuula, 2008). Likewise, Harri – representing the Academy of Finland, said that though he had a past as a scientist, he was not meant to do

[37] Translated from Finnish, original: *"...on hyvin vaikeaa mennä yliopistolle puhumaan professorin kanssa jos ei ole tehnyt omaa PhD:tä"* (Tuula, 2008)

any science but still be able to understand the terminology in current research topics enough to do his job (Harri, 2008).

As for the academics, all apart from Johan and Jaakko were somehow involved or linked to spin-off companies or other industrial entities through board membership, partnership, or joint research projects. None of the interviewees was an industrial scientist and directly employed by industrial entities, but one of them – Jari, was employed within national Public Health and therefore a governmental scientist, and confessed to choose his identity depending on the context.

As for their roles, expertise and offering advice based on academic or scientific excellence was understood as being fundamental to Finnish nanotechnologies and nanosciences policy-development and decision-making. The academics and scientists took care to underline their areas of expertise and readily provided information about and under which circumstances that policy-makers had requested expertise. Marja-Leena and Sami also claimed a role as experts in that they had been commissioned to evaluate Finland's nanotechnologies and nanosciences activities by the government and sometimes by industry, based on their past as working as an industrial scientist (Marja-Leena) or as working for Tekes (Marja-Leena 2008, Sami 2008).

*5.2.2 Political and non-political decision-makers*

Despite the lack of policy documents for download and research, it became clear as the interviews progressed that Finland was very science and technology friendly in terms of R&D investment and that there was a political commitment behind it. Juha and Antti, representing the Ministry of Education were particularly underlining the work of the Science and Technology Policy Council (STPC), which, though since renamed, had been gathering under the direct leadership of the Prime Minister since 1963 with the aim to advise ministries and governments in important matters relating to science policy in Finland (Juha & Antti 2008). Juha also said that science policy had been run

through the 'strong and long arms of the government' since then, and that the Ministry of Education and the Ministry of Employment and the Economy[38] were particularly focusing on science and technology (Juha & Antti, 2008). Antti added that the strong arms of the Government included all higher education institutes, polytechnics and Universities, which – until 2010 were state institutions, and fell under the Ministry of Education. Antti added that through there was much power within the Ministries and Government Agencies in Finland, the political decision-makers made the big decisions (Antti 2008). Juha agreed, saying that the already mentioned ministries, along with Tekes and the Academy of Finland, were really the 'responsible organisations' that were left with the power to implement the FinNano programmes and any other programme related to nanotechnologies and nanosciences, and that the STPC had little to do with it once the matter had been decided and delegated. It became clear that though there were political decision-makers, the public service, to which Juha, the more senior of the two, Timo, Heljä and Antti belonged were leading the non-political decision-making (Juha & Antti, 2008)

Their account was confirmed by Katja, who worked at the newly formed Ministry for Employment and the Economy, and by other non-Governmental employees. However, Katja added that Finland was preparing to launch a broader innovation policy, which meant that the Science and Technology Policy Council's role in Innovation Policy would decrease (Katja 2008). Asked about the role of the parliament, both Johan, an academic, and Katja mentioned the permanent Parliamentary Committee for the Future (Johan 2008, Katja 2008). The Committee, which according to Johan was made up of Olympic medal winners, musicians, and other known 'personalities' in addition to other parliamentarians, gathers to *'think about Finland's future'*[39] (Johan 2008). Juha agreed and said that the committee does have the right to follow up on government activities related to the future, but that it has no budget, and it is not a very 'scientific' committee (Juha 2008). Jari also confirmed that

[38] Juha also called the ministry a Super-Ministry [transl. superministeriö] in that it had been the result of the merger of the Ministry of Labour, the Ministry of Trade and Industry, and the Regional Development Department of the Ministry of the Interior.
[39] Translated from Swedish, original: *"tänka till om Finlands framtid"* (Johan, 2008)

though they are meant to have insight into activities related to Finland's future, the committee was '*just a committee*[40]' (Jari 2008).

*5.2.3 Policy-making within a 'club'*

That strategies and policy-coordination related to Finnish nanotechnologies and nanosciences was facilitated in a top-down fashion from the Ministries and Tekes was not contested by the study participants. The 'Strategy' was referred to as being primarily the Tekes FinNano programme by several interviewees, including the AF representative. Indeed one of the interviewees included in the Pilot study had called Finland's science policy-makers a 'Club', which was something that the field study interviewees agreed with, though some extended the 'club' beyond Government. Katja, for instance, claimed that Finland had a rather narrow pool of experts that could be part of policy-discussions, to which she included Ministry officials, company representatives, and researchers, but not citizens or civil society organisations (Katja, 2008). Katja put the narrowness of the pool of experts down to there only being a few people with enough knowledge of what is going on, and that decision-making had therefore been left up to them, and she agreed with the set-up.

Jaakko went into greater detail on the decision-making process when being asked how decision-making was taking place in Finland, and said that it was difficult to say what was taking place behind the screens, and that much of Finland depended on pragmatism, which is why decision-making is not transparent. Politician did for instance, not initiate the Finnish strategy, and they had hardly discussed it. Rather, there was an understanding that investment into nanotechnologies and nanosciences was the obvious way forward, which is something industry and government agreed with (Jaakko, 2008). Particularly a small group led by Tekes had initiated and led the discussion, which had not been contested by anyone as Tekes involvement was positively perceived due to their advanced understanding and expertise

[40] Translated from Finnish, original: "*Sehän on vain komitea."* (Jari, 2008)

within technologies and science (Jaakko 2008). The importance of 'expertise' was made throughout the Finnish interviews.

From an academic's point of view, Kalevi said that it was easy to access documents such as meeting protocols from meetings of the FinNano steering committees or other strategic meetings after the events, but agreed on that the decision-making process was not necessarily very open especially within Tekes as there were companies involved (Kalevi, 2008). Aaro, another senior academic who was on the Tekes FinNano steering committee was of the same opinion (Aaro 2008). With regards to openness as expressed through the access to information, Aaro stressed that openness depended on whether it was research within corporations or research within academia you were after as it made a difference if projects were publicly funded or not. Kari, a Tekes representative, also expressed the need to keep information that concerned commercial entities and business interests secret, while all documentation and reports were made openly available. He was very reluctant to answer questions about openness and secrecy at any length, but he underlined the need to share information in order to advance research (Kari, 2008).

Not part of academia, industry or government, Marja-Leena agreed on that there was an innovation and technology policy club in Finland but rather put this down to Finland's small size. She also made the point previously made by Kari in saying that people were very likely to share information because they would realize how important that would be to progress. However, when asked what kind of information she meant, she clarified that what she meant scientific or technological knowledge rather than any background details used for decision-making processes. She did underline, however, that she found the Finnish authorities and the club an *'open club that is evolving*[41]*'* (Marja-Leena 2008). By evolving she meant that it was becoming more 'democratic' and transparent.

[41] Translation from Finnish, original: *"tässä kehittyy avoin "klubi""* (Marja-Leena, 2008)

The general collected response to whether or not the policy-making process was open or closed was that policies were decided by a smaller group of people, with limited transparency, and that nobody really seemed to question that. Two of the interviewees – Johan and Jari, however, seemed slightly less happy about the way decision-making was done, judging from the way they were talking about it, e.g. calling it a 'club' or discussing the lack of transparency.

*5.2.4 Interactions, negotiation, and constraints*

The need for collaboration between academia, industry and government was made clear by all interviewees, either by saying it directly or giving examples of their own work and its success being attributed to collaboration across professional or institutional boundaries.

When discussing collaboration, Tuula mentioned the 'triple helix' and said that the regional industrial body that she was working for was working according to the 'triple helix' model and that it was influenced equally by academia, industry and government (Tuula 2008). Tuula said that the use of the concept had been spread out in Finland, though she was not entirely sure who started using it, but assumed it came from Tekes. Marja-Leena agreed with Tuula's point about the triple helix, and said that she found the dialogue between industry, government and researchers very efficient, and added that there are academic and industrial representatives on the Science and Technology Policy Council and on the FinNano programmes (Marja-Leena 2008). She did remark on that the collaboration was particularly efficient with regards to applied nanotechnologies and nanosciences, but also said that industry was not involved with basic science (Marja-Leena, 2008).

Marja-Leena's latter point was echoed by both Aaro, who said that the universities centrally were not particularly involved with collaborative efforts as they in many ways were considered institutions for basic research (Aaro 2008). Harri agreed and said that though there was one Industrial representative on the AF FinNano Steering Committee, and there were other

individuals bridging the two FinNano Steering Committees, basic and applied sciences were treated as quite separate entities, to the point that there was not much exchange between him at the Academy of Finland and the Ministry of Employment and the Economy – or between Tekes and the Ministry of Education. Harri concluded that internal collaboration within Government was lacking. (Harri, 2008). Representing Tekes, Kari's view on this was that there was collaboration in that many boards had academics, and industrial and government representatives on them, though he also said that they were chosen for their broad understanding of the science but also the business environment (Kari 2008).

Another aspect about collaborative efforts that came up was one not related to policy-making, but rather related to the output of policies – e.g. the collaborative research that policies sought to encourage. One point that came up that was of particular interest here regarding the geographical aspects to Finnish R&D efforts. Herman, for instance, said that there was much concentration around the Helsinki area, and that he – being located outside of the Helsinki-region, felt that more could be done to support other regions. Herman also mentioned that the bodies set up for collaborative efforts regionally and also nationally – such as the FinNano initiatives, were useful as they gave a platform for researchers of different disciplines to interact (Herman 2009). When asked how he experienced collaborative efforts with partners in other parts of Finland, Esa, also based at some distance to the Helsinki Region, made the same point as Herman but added that at least in his field – Optics, there was a lot of collaboration between the various different universities across the country and that he had successful projects that also included partners in the Helsinki region (Esa 2009). Their difference in opinion with regards to Helsinki's dominance may be due to a number of reasons, such as the inter-regional research environment being more collaborative within Physics (Esa) than in Biotechnology (Herman's discipline), or it may be due to the nature of inter-regional relationships themselves as the region Herman was based in is closer to the Helsinki region and sometimes considered a 'competitor' as it is home to Finland's second largest urban area, while Esa's region is at a considerable distance to Helsinki and less financially

prosperous. Harri brought up a point with regards to regional multi-partner collaboration in saying that consortia sometimes were formed for the sake of attracting money rather than by there being good and sustainable collaborations in place (Harri, 2008).

*5.2.4.1 On Industry: and its power in Finland*

The Finnish R&D environment seemed as if it was particularly adapted for Industry and commercialisation. Innovation, and the making of a broader Innovation Policy, were very frequently mentioned during the interviews, and the difference in scale between the two FinNano programmes became clearer as interviewees often caught themselves talking about the Tekes programme, and then adding something along the lines of: 'but there is another FinNano programme as well' to the end of their sentences.

None of the interviewees had anything particularly negative to say about industry and engagement with industry. The academics and scientists among them rather underlined the need to continue to work closely with industrial partners and offered insight into the various ways in which they, personally or their groups, worked with industry. Esa, for instance, underlined the need to work with companies in order to attract investment, and said that he was liaising closely and networking within both the local Science Park, and with the regional administration (regional governance) who were very supportive of academic-industrial ties for economic reasons (Esa, 2008).

Only two issues were brought forth regarding industrial involvement that were potentially problematic, the first one related to the lack of transparency but little was said about why this was criticised. Secondly, the emphasis on applied science rather than basic science was, according to Johan – who did basic research, causing a brain drain of young people wanting to do basic science. Johan did, however, put this down as the Government's mistake rather than one made by Industry (Johan, 2008).

Only one of the Government representatives, Jari, offered any criticism with regards to Industry in that their dominance caused too much emphasis on innovation, and not enough space for health and safety related issues (Jari, 2008). Jari's experience in this respect will be analysed in Chapter 7.

*5.2.4.2 On Government and centralised science governance*

Interaction with the Government through its agencies was considered key in order to be part of Finnish R&D generally, not just on the nanoscale. However, the interviewees portrayed a rather one-way, top-down way of interaction where Government, through its non-political decision-makers, requested input as required and often offered both expertise and authority. A majority of the interviewees seemed quite content with this system, and none expressed a need for change.

Despite the top-down approach to science governance, negotiations still took place, and particularly within boards and committees specifically set up for this purpose. Kari underlined that those on the board were on them due to their expertise and knowledge, and that their contribution mattered (Kari, 2008). A majority of the interviewees agreed with this as they were on the boards themselves; some, however – Jari and Johan most pronouncedly, did not necessarily feel that their input yielded much in terms of policy outcomes and expressed their disappointment in the Government's closed ears (Jari 2008, Johan 2008).

Both Harri and Juha expressed a concern with the lack of interaction within Government itself, and Juha added that there was also a lack of interaction between Government and Parliament with regards to science and technologies. Giving an example, Juha said that the Government had, so far only ever sent one science and technology report to the Parliament, and that Parliament *"isn't interested. Those who are interested are usually, um, University Professors to begin with"* (Juha & Antti, 2008).

*5.2.4.3 On Academia*

Academia was very well considered by all interviewees, and academic achievements were held in high esteem. Indeed, Kari, Harri, Katja and Sami underlined that the Finnish economy relied heavily on technology and innovation and that the input of academics and scientists therefore was very important to the Finnish Government and its agencies and ministries (Kari, Harri, Katja, Sami 2008). Both Kari and Tuula made similar remarks with regards to the need for academics and scientists to work very closely with industry and focus on applied science or basic science of commercial use and utility (Kari, Tuula, 2008). Both Tuula and Katja underlined the need for academia to be part of the 'triple helix' as it would otherwise not function (Tuula, Katja, 2008). How this could be understood is that Kari and Tuula, and also Katja, actually seemed to say that academia is important, as long as they 'play the innovation game'.

*5.2.4.4 On NGOs: or the lack of NGOs*

None of the interviewees said that they had been contacted by NGOs or civil society organisations to discuss nanotechnologies and nanosciences, nor had they felt a need to include NGOs or civil society organisations in their work or into policy-negotiations of any kind.

When specifically asked about NGO or public involvement with regards to the STPC, Juha said there had never been such involvement and that the only 'social' involvement had been through the occasional attendance of trade unions (Juha & Antti, 2008). Harri agreed but added that though there had not been any involvement of NGOs in nanotechnologies and nanosciences policies or decision-making in Finland, it was likely to come up more in discussions as the health aspects are beginning to emerge as an issue of potential concern in Europe which could bring it to Finland (Harri, 2008). It had not, yet, gone further than internal discussions within labs, academic institutions, and within the FinNano programmes, their Steering Groups and working groups that focused on these issues, however (Harri, 2008).

Jari said Finland could not be compared to the UK in the sense that Finland did not have large-scale manufacturing, and therefore NGOs would not be as

interested or involved as they might be in the UK, Germany or France (Jari, 2008). None of the other academics had any ties to NGOs and had never been asked about nanotechnologies or nanosciences R&D at all.

*5.2.4.5 On the public: and the 'mentality' of the Finns*

The general public was not mentioned much by the Finnish interviewees – indeed the public only ever entered the interviews through direct questions regarding their involvement or whether or not they could or should be included in policy-negotiations, or when public engagement or science communication was discussed.

Herman put the non-participation of the public down to the Finnish mentality ad culture as Finns generally like new technologies (Herman, 2009). Herman continued by saying that he had never been contacted by anyone other than industrial, academic or government representatives to discuss nanotechnologies and any risks or benefits associated to nanotechnologies or nanosciences. Esa agreed with Herman, and added that the public did not respond the same way to technology as to, for instance, the medical sciences, and that he and his university would be more likely to be challenged or criticised on activities that were related to science or medicine, but that technology has not seen the same response (Esa, 2009). Esa's observation is interesting as he seemed to consider the public's involvement only to take place if they were to deliver criticism or challenge Esa and his institution. Indeed, none of the Finnish interviewees, regardless of their background, framed the public in relation to science and technology in a positive light or as being able to offer a contribution to policies or policy-discussions. It was as if to say that the public would be expected to meddle with science, or that they would misunderstand what was being said. As Harri put it *"you can't expect everyone to have PhDs"* (Harri, 2008).

*5.2.5 Reflections on collaboration and trust*

Firstly focusing on trust between academia, government and industry, and calling it horizontal cooperation, Juha said that there was a considerable level

of trust between the science, technology, and innovation players in Finland, which had been built up over time in forums such as the STPC.(Juha and Antti, 2008). Antti continued by reflecting on trust as related to the general public in presenting me with a copy of the Finnish Science Barometer, saying that in Finland the defence force and police always ended up on top while the European Union came in at the bottom among public institutions when measuring citizens' trust. Indeed Nokia Oy, the makers of Nokia mobile phones, achieved the level on trust on par with the Church of Finland, which Antti considered an example for citizens' view on technologies in general (Juha & Antti, 2008). Academic institutions also came out high on the list. Marja-Leena agreed and said that nanotechnology had not become an issue that was widely discussed in Finnish society along some form of wow-yuck trajectory. Rather, she said, Finns are very pro technology, and there is usually much trust for researchers and authorities and new technologies are seen as good things, which is good for Finnish companies. She also said that nobody wanted to stimulate discussions as there was not a demand for them (Marja-Leena, 2008). Marja-Leena also brought up the Finnish Science Barometer but added that it is sometimes a booklet that is good to pass around, but its effect on the behaviour of policy-makers is questionable (Marja-Leena, 2008).

From a scientist's point of view, Herman made a comparison with regards to the Finnish reception of stem cell research where smaller societal groups had been very concerned, but the general public had seemed to trust that all ethical considerations had been and were going to be taken into account. Nanotechnologies, he said, was going the same way, and the public trusted researchers and scientists (including himself) to do their jobs (Herman, 2009).

In discussing the trust felt for the triple helix actors, Paavo, a senior scientist, said that some professors and academics with good contacts actually managed to have some influence on the 'innovation agenda', especially with regards to brokering for their own disciplines. This was all very political, he said, and not transparent (Paavo, 2008). Paavo said that he, as a result, did not fully trust in decision-makers' claim at unbiased conduct. Though Paavo

did not sit on the boards of either FinNano programme, he was very much involved with a regional initiative to ensure a regional benefit of on-going nanotechnologies and nanosciences investments, which were sponsored by Government, Industry and the Academic institutions, based in the regions and had a lot of involvement with all three actors.

Johan, who was particularly focusing on basic science within the natural and environmental sciences (including forestry), was the only academic among the interviewees who more directly indicated that he did not feel listened to. He was part of numerous projects and working groups that also included industrial and government involvement and where he had raised the limited funding available for basic science, and sometimes questions with regards to environmental impacts of project aims, and, particularly referring to discussions with Tekes he said *"(…) Tekes makes it quite clear to me that they are not interested; they might listen to what I say, but they are more interested in what the business community says than of what academics say*[42]*"* (Johan, 2008). Johan continued by saying that he did not feel that he had an opportunity to influence policies or the agenda, but also that communications were not straightforward and that what was being said was sometimes misunderstood (Johan, 2008). Apart from Johan, Jari – a Government employee, indicated that he did not feel listened too either, which he put down as due to his research and expertise being within nano-scale health and safety (his experience will be discussed as part of the IPA study in Chapter 7).

The level of trust found for all institutions involved with nanotechnologies and nanosciences R&D seemed very high in Finland, not just judging by the Science Barometer results, but from what interviewees were saying. One could ask whether the public was trusted – but as the thought of involving the public, either directly or indirectly through civil society organisations seemed a

[42] Translated from Swedish, in original: "*(…) Tekes gör nog en sån här ganska klar point av att de är inte intresserade; de kan nog lyssna på mig men de är mer intresserade av vad företagen säger än vad akademikerna säger*" (Johan, 2008)

foreign concept to most interviewees, it was neither possible nor practical to explore this question during this study.

When asking the interviewees why they thought the level of trust among the public, but also among themselves, was so high, several of them paused to think through the question and gave a number of answers that all pointed towards cultural reasons very specifically applicable to Finland. Harri, for instance, discussed the tradition of debate and open discussion in other parts of the world, and how this was not a strong tradition in Finland as it is not part of Finnish culture (Harri, 2008). Jari agreed and said that Finland was very different to the US, where *"people are excited about everything"*[43] (Jari. 2008). Esa agreed, and said that Finns only speak when they have something to say (Esa, 2009), while Tuula argued that Finns were not easily worried, not particularly passionate, and that they usually took their time to evaluate things calmly before acting (Tuula, 2008). Along the same lines Marja-Leena said of Finns that they aimed to be 'rational', and if there were any strong criticism the person giving it would have to have a 'strong argument' and be somebody respected for it to be effective. "*But big noise will be ignored*[44]*"* (Marja-Leena 2008). She also said, having been asked about her perception on the funding gap between applied and basic funding of nanotechnologies and nanosciences R&D that *"never mind the public, even researchers thought commercialisation was a good thing, (…) we have been brainwashed*[45]*"* (Marja-Leena, 2008). Nothing in the way she said this suggested that brainwashing was a negative thing to her. A reason for this was offered by Juha who said that Finland, historically, had to turn its industrial efforts from a low-tech to a high-tech economy quickly after the fall of the Soviet Union, and it had worked out very well, which is why the general public did not see a reason to question the commercialisation and innovation effort (Juha & Antti, 2008). This, Juha and Antti argued, would create historical reasons for the public to trust in nanotechnologies and nanosciences policy-making and the emphasis on innovation in Finland.

[43] Translation from Finnish, in original: *"jossa ihmiset ovat jännittyneitä kaikesta"* (Jari, 2008)
[44] Translation from Finnish, in original: "*Mutta suuresta melusta ei piitata."* (Marja-Leena, 2008)
[45] Translation from Finnish, in original: *"älä väitä yleisöstä, jopa tutkijat luulivat kaupallisuutta hyväksi asiaksi … meidät on aivopesty"* (Marja-Leena, 2008)

*5.2.5.1 Leadership not questioned*

Overall, interviewees expressed confidence and trust in Government's leadership or at least did not question it beyond expressing a wish for further funding of basic research or more transparency. Likewise, industrial involvement or influence on decision-makers was not considered controversial, rather it was flagged by a majority of the Government representatives as a good or positive development – Harri and Jari were not as supportive of Industrial influence however. Harri's point made was that Industrial influence on leadership would steer away from basic research and leave it largely unfunded. He also expressed a concern about the lack of transparency when Industry was involved (Harri, 2008). Jari's objection was more a wish from his part for a more balanced discussion that included risks and health and safety, and to be heard when offering information or recommendations (Jari, 2008).

*5.2.6 No public engagement, no 'trust gap'*

There had been no public engagement activities at all, with regards to nanotechnologies or nanosciences in Finland at the time of the interviews, nor were there any plans for such activities to the knowledge of the interviewees. None of the interviewees really saw a need for public engagement as the Finns were not asking for it (Juha: Juha & Antti, 2008), and there had been nothing particularly negative about nanotechnologies in the mass media, according (Tuula, 2008, for instance).

Many interviewees said that they had either run, been involved with, or heard of efforts to communicate with 'the public' through seminars, conferences or websites. The actual audience of these events or efforts were invited members of the 'public' in the shape and form of scientists from other disciplines, SMEs, or organisations somehow associated with government, academia, or industry. During Marja-Leena and Sami's evaluation project, they had, for instance, consulted 'hundreds of people' with regards to

nanotechnologies and nanosciences related R&D projects in Finland, using email lists provided by Tekes (Sami, 2008).

Similarly, none of the interviewees said there was a trust gap, at least not as far as the public was concerned. In fact, the only trust gap noted during the interviewees was one that existed between the non-political decision makers within the Government and academics and scientists who conducted basic research or nanosafety related research. Interestingly, however, their objections were quite muted and none of them offered an alternative to how they saw that things could be done better. Rather, it seemed as if the interviewees found that the current order was working if not great, then all right.

### *5.2.7 Balancing promotion and regulation*

With regards to balancing promotion and regulation, all interviewees agreed on there not being any balance, or a need for balancing the two within Finland. Promotion was considered necessary and desired while regulation was not much brought up or discussed. The only interviewee who seemed to want to spend time discussing regulatory matters was Jari, who also confessed to being part of international discussions on the matter and projects with partners who brought up these issues (Jari, 2008).

#### *5.2.7.1 On risks, health and safety, regulation, and the precautionary principle*

When asked about risks and risk management, Harri said that it was unlikely that scientists would ‘do anything stupid’ as this would jeopardise their future work (Harri, 2008). He continued to say that the main ‘risk’ considered in Finland was laboratory-related health and safety. The latter was a point made by many other interviewees, and Katja and Kari added that they had discussed this previously and identified health and safety as an area that needed further discussion (Katja, Kari, 2008). Meanwhile, Jari said that there had been quite a lot of discussion about the need to prioritise the safety of nanotechnologies as an area of research, but that no Finnish organisation or institution had decided to take the overall responsibility for nanosafety (Jari,

2008). Though Jari went on to mention a number of projects that he had received funding to do safety related research, most of them were pan-European projects with EC funding. He said that the investment into safety-related R&D was left at 1% of the Finnish nanotechnologies and nanosciences R&D budget (Jari, 2008). Marja-Leena agreed with Jari's latter point, and said that the €1M that her organisation had found was Finland's gathered nano-safety research budget was much too little for proper research results to come out of it. Kari agreed and said that there was not enough money for safety research and research into the environmental impacts of nanoparticles, but he added that this should be run through the AF FinNano Programme (Kari, 2008)

Tuula said that her organisation had arranged several seminars, meetings, and a working group that was particularly working on health and safety guidelines and awareness and that it was much discussed within Industry (Tuula, 2008). But with regards to regulations, Tuula said that she, and Industry with her, would prefer if regulations would be decided on internationally rather than in Finland, as it should take place on the EU-level due to the global spread and development of nanotechnologies and nanosciences (Tuula, 2008). Jari agreed with Tuula and said that all seemed under control for the time being. He added that the process leading to legislation was quite stringent, and that legislation would have to build on good justifications and background research, which he said was lacking at the time being. Further, he added that it was particularly important to be able to justify legislation should it cause expenses to the Industry or impede on competitiveness of businesses, and that this was a very important point for Finnish decision-makers (Jari, 2008).

Specifically with regards to uncertainties related to nanotechnologies Jari pointed out one problem that did have an incremental effect of his work was the lack of standardised measurements and standardisation in general. He also said that the Finnish Technology Industry Association did not have enough resources to be physically represented during standardisation discussions and ISO meetings (Jari, 2008). Marja-Leena agreed and said that

the only company in Finland involved with any kind of standardisation-related (nanometrology) was Nokia, and that smaller companies did not participate (Marja-Leena, 2008). Jari suggested that this was due to the lack of governmental and industrial commitment to standardisation, and Marja-Leena added that she believed that companies and industry would, ideally, like to see standardisation and legislation go in different directions and that there was some concern about legislations being imposed on the back of ISO meetings and standardisation discussions (Marja-Leena, 2008).

From a scientists' perspective, Johan said that there were very few guidelines for him to follow, apart from that 'he should act with caution' (Johan, 2008). Johan also said that he had been asked to make a presentation on the potential risks of nanotechnology to the parliamentary Committee on the Future, and that they had probably heard that risks and legislation were discussed in other countries. However, he said, nothing concrete had come out of their discussion (Johan, 2008).

The precautionary principle did not evoke discussion in Finland. Indeed, some of the interviewees were not entirely familiar with the principle and what it aimed to achieve. Kari, however, said that he thought it was being followed in Finland, as there had not been any data suggesting that anything they were currently working on was harmful. He said that should such data emerge, activities would obviously cease. Kari also said, as did Juha, Marja-Leena, and Kalevi, that the precautionary principle could be seen as a stumbling block to industry and innovation (Kari, Juha & Antti, Marja-Leena, Kalevi, 2008).

*5.2.7.2 On business interest, innovation, and commercialisation*

While risks and regulations did not seem much discussed, the scale weighed in more heavily towards innovation and commercialisation. All government representatives interviewed mentioned the Finnish innovation system and the working up of a broader innovation policy. However, none of the academics mentioned the innovation policy development during their interviews, but they all reflected on the importance of innovation within nanotechnologies and

nanosciences R&D in Finland, and how it affected their work. This could suggest that academics and scientists play a smaller role in the development of Finland's innovation policy, despite the constant reference of the triple helix and need for continuous collaboration between industry, academia, and government as often referred to by the industry and government representatives.

Juha offered a definition of the Finnish innovation system, which he also called the 'R&D system', or the 'systematic approach to innovation' as being a system in three parts: the producers of knowledge and know how, all the users of said knowledge and know how, and the mechanism that facilitates the interaction between the two. These parts, Juha argued, were academia, industry and government, in that order, and the innovation/R&D system, when developed in 1990, was the broadest system in the world then and that it had been developed on the national policy-formulation level (e.g. the STPC and therefore with political backing) (Juha and Antti, 2008). As this system was pinned down and implemented relatively early on, and as a direct response to the post-Soviet financial crisis Finland experienced in the early 90s, Antti continued, there had been enough time to develop it and get it functioning well. However, he said, it was out-dated, and Finland needed to take another step towards a broader more modern innovation system that will *"re-awaken the interest of our policy-makers*", but also take a broader knowledge base into consideration and also target industrial interests that are crucial to the Finnish economy – such as forestry and ICT (Juha and Antti, 2008). Juha and Antti's points were also brought up by Kari and Katja, the former of whom added that there is little point in an innovation system that did not cater for industry (Juha & Antti, Kari, Katja 2008). Additionally, Katja and Tuula provided information about the innovation infrastructure that was growing out of Finland's development of a broader innovation policy, including the development of Aalto University (to be established in 2010), aimed to merge Helsinki University of Technology, Helsinki School of Economics, and University of Art and Design Helsinki into a new styled 'innovation university' which would be well connected to a Start-up programme, and other industrial and commercial activities (Kari, Katja, 2008). Kari also said that

nanotechnologies were considered very important within the innovation system, and that any investment into nanotechnologies and nanosciences would focus on research areas considered important by industry (Kari, 2008).

Jaakko made reflections on how government had also been re-structured through the Finnish push for innovation and that the 'super-ministry' (also known as the Ministry of Employment and the Economy, was, partially, a result of this. He also said that the emphasis on Finland's industrial strength had encouraged the growth and establishment of 'industrial clusters' that would seek to bring industry and research together and aid in finding funding for further R&D. Though there was a Nanotechnology Cluster Programme, he said it was likely that it would eventually be assorted into other clusters that were discipline specific, such as Materials or Forestry (Jaakko, 2008). Tuula also discussed the Nanotechnology Cluster Programme and said it was based in Helsinki along with 60% of the national academic and applied/commercial research resources, and that the region benefited from roughly half of all Finnish companies involved with nanotechnologies (Tuula, 2008). The cluster's location in Helsinki was an obvious choice, she said, enforcing Herman's earlier point about the dominance of the Helsinki region.

The academics and scientists among the interviewees, when discussing innovation and promotion, broke down the topic into bite-size chunks through making references to their day-to-day experiences in performing their jobs. Two issues that came to the fore were firstly, business interests versus the interests of academics, and secondly, how they experienced working with industrial partners. For the former, one of the main expectations on academia from Finnish businesses and companies, said Kalevi, was that academics would take care of basic research as it depended on heavy infrastructure, expensive equipment, and other requirements that would be too expensive for businesses to invest in. This, he continued, was the only reason for them to be involved in basic science projects (Kalevi, 2008). Johan agreed, and added that past and current involvement with businesses and companies of any kind could be very helpful when applying for funding for basic research, even from the Academy of Finland (Johan, 2008). Johan also said that it according to his

own observation seemed as if most projects that received funding, consequently and due to Industrial influence within the funding agencies, were aligned with the interests of the Finnish business environment (Johan, 2008). Esa expressed a similar view, though he also said that as he was working primarily with smaller industrial entities or companies, he experienced less pressure than many of his colleagues who worked with larger companies who would exert more pressure due to their larger financial input and infrastructure (Esa, 2009). One thing all academics and scientists among the interviewees agreed on was that Industrial and business support was necessary in Finland in order to do cutting-edge research, and none of them fully questioned this system.

*5.2.7.3 Not striking a balance*

The lack of balance between promotion and regulation was obvious in Finland, and risks were only really addressed when specific questions about risks, regulations, health and safety, or the ethical development of nanotechnologies and nanosciences were asked directly. The only exception to this rule was Jari, who made an interesting observation that exemplifies the lack of balance between promotion and regulation in Finland. When meeting with representatives for Finnish insurance companies it turned out that they were pushing for more engagement with societal stakeholders, effective communication, and research into risks. Jari said that this was interesting in the sense that he thought it was a business or industry that the innovation-oriented parts of the Finnish government did not necessarily consider in their push for commercialization and innovation (Jari, 2008). Jari continued by saying that regulation and standardization would not necessarily be the opposite of promotion and innovation, rather, standardization and regulations could – possibly, be considered helpful to innovation (Jari, 2008). Jari's point was not made by anyone else during the interviews in Finland. Rather, it would seem that the focus on innovation and commercialization was accepted and encouraged as the current state of affairs and the way ahead.

## 5.3 Nanotechnology and nanosciences policies in Finland

A number of key points can be drawn out of the Finnish field study as based on the interviews. Firstly, Finland is very much pro-innovation, and there is not much 'balancing' of promotion and regulation to speak of. Indeed, most interviewees only ever referred to nanotechnologies or nanotechnology, and did not include nanosciences when they spoke of their work, which may connect with the slight concern about the shortage of investment into basic science on the nano-scale. Indeed the difference in funding between the two FinNano programmes was almost 90% to applied science, and 10% for basic science. Another aspects of the Finnish innovation focus was found in the re-structuring of the innovation system, and consequently of state institutions, to facilitate 'innovation politics' and the broader innovation policy. This included the change of the highest science policymaking body of Finland from the Science and Technology Policy Council to the Research and Innovation Council. Secondly, Finnish decision-making seemed mainly left in the hands of non-political decision-makers, or rather, in the hands of expertise. The role of 'expertise' was very pronounced in Finland, and there was a sense of the 'expertise' label coming with 'security' and 'trust' attached to it. The authority of perceived and real 'expertise' was not questioned, nor was the idea of a small number of people (or experts) that got together forming a club contested. Thirdly, this study found no support for Raivio's claim that there had been 'endless public debate' with regards to nanotechnologies and nanosciences, nor did the study find that there had been any efforts to raise citizens' awareness as mentioned by the MoE in their 2005 report, at least not by the time of the interviews. Hence, the public and civil society did not play any part in Finnish nanotechnologies and nanosciences policy-making, and it would seem that no one thought their involvement necessary.

## 5.4 Mode 2 and Strategy in Finnish nanotechnologies and nanosciences

Filling in the Themes Matrix for Finland would, on the basis of this study, leave it looking like this:

TABLE 5.2: THEME MATRIX - FINLAND

| Themes Matrix: The governance of nanotechnologies and nanosciences | |
|---|---|
| **Organisational diversity** | |
| a) Inclusion | Maybe |
| b) Interaction – trading zones | Yes |
| c) Openness and transparency | No |
| **Social accountability** | |
| a) Trust (among the public) | Yes |
| b) Public engagement | No |

When comparing it to the matrix produced for the UK, the Finnish matrix is less straightforward. Both Finnish nanotechnologies and nanosciences decision-making and R&D is very expert-driven in comparison to that of the UK, as is the configuration of Finland's innovation system. Leadership is not questioned, and actors are not necessarily expecting invites to decision-making discussions, which is a clear difference to the UK situation. Though there is engagement between actors within academia, industry, and government (through its competent agencies), there is very little exchange with the Finnish public and no calls for social accountability have been heard thus far. At least as far as this study is concerned, interaction is left to experts and those specifically invited into decision-making processes.

There is a clear division between 'basic' and 'applied' research, an observation confirmed by both the interviewees and the division of remit of the FinNano programmes. Though Chris expressed a wish to establish Centres of Excellence in the UK along the same model used in Finland, the Finnish Centres of Excellence seem to be focused primarily on relevant excellence rather than excellence in its own right. They are certainly meant to be strategic centres, and much of Finnish nanotechnologies and nanosciences research is led and funded with relevance in mind. That said, Johan's point about the brain drain within basic nanosciences and nanotechnologies research does – alongside the gap in funding for fundamental research, indicate that there is a gap in the investment channelled towards excellence that may not be filled by the creation of Centres of Excellence. This said, Johan did find some funding for his own research, and he was not the only interviewee to conduct basic research. Johan also had relationships with

industry, and there was acknowledgement from the Tekes FinNano programme that basic science was important, though with an emphasis on the use of knowledge to solve problems related to applications.

It is clear that Finland's decision-makers are keen to fund both excellent and relevant research, however, judging from the testimonies of the interviewees and the monetary difference in investment, the latter is by far the preferred feature. There was very little support for knowledge in its own right, outside of a push towards application and economic rewards. The highlighted importance of the context of application in Finnish research would suggest a more lateral innovation system where a straight line from basic to applied science is out-dated. However, a lateral system would – if Rip's suggestions are right, include multiple actors that meet within inclusive trading zones. For this feature, this study offers a 'maybe' (see Themes Matrix) for inclusion, a 'yes' for trading zones, and a 'no' for openness. The 'maybe' could be re-named to 'it depends', in that being included depends on which group you represent and, seemingly, if you have expert-approval from expertise that is very promotion-focused. It is possible that a more thorough look at the Finnish Centres of Excellence and their operations and outputs would offer a clearer picture of the Finnish innovation system and the place for excellence within Finnish nanotechnologies and nanosciences governance. This study does not, however, offer full-fledged support for Rip's Strategic Science approach as far as nanotechnologies and nanosciences governance is concerned. While operational diversity is limited, public scrutiny is non-existent, and knowledge for its own sake seems to be lacking.

It is difficult to judge whether or not there has been a 'shift' in Finland on the basis of this study, neither the policy-documents nor the interviewees mentioned any features that would have been associated with a shift having taken place. The only potential note that could indicate a shift is related to Finland's change in focus from a low tech to a high tech economy following the fall of the Soviet Union. However, a conclusion on this basis would require further exploration of science governance prior to the shift, which goes beyond the ambitions of this study. There is some support for Mode 2

nanosciences and nanotechnologies governance however, in that science seems to be taking place within the context of application in Finland, and there is significantly less investment into basic or fundamental science. This observation, could offer support to at least one part of the model of science governance as proposed by Gibbons et al., though the lack of social accountability, openness, and interaction does not match the Mode 2 model.

## Chapter 6: The making of Swedish nanotechnologies and nanosciences policies

*The third of three country-specific chapters, this chapter is focusing on the Swedish part of the field study and its results and data analysis. Following the same set up as the other two chapters, the first part of the chapter will provide a backdrop to the interviews through a review of all published documentation available and found at the time of the field study. The second part of the chapter reviews the interviews held in different locations in Sweden 2009 in relation to research themes, while a final section will view the collected data through the lenses of the theoretical framework accouted for in Chapter 2.*

### 6.1 Sweden

The Swedish interviews took place in 2009 alongside much of the policy-related literature review, though some of the literature search also took place in 2008 during a trip specifically for this purpose, but that was not intended for a pilot study based on interviews. If the Finnish search yielded few documents and little information outside the interviews, the Swedish conditions were even poorer with regards to accessing useful materials. This was likely due to the lack of a national nanotechnologies and nanosciences strategy for Sweden. What eventually was published as a national strategy following the interviews in 2010 was therefore not discussed during the Swedish field study in 2009. However, some of the documents upon which that strategy was based were available in 2009 and therefore also discussed during interviews. The general lack of information also generated a number of questions related to the lack of a strategy, which spurred an investigation into the general R&D environment in Sweden. The pre-2010 narrative will be followed by a review of the 'Swedish Strategy' published in 2010.

#### *6.1.1 Swedish R&D*

Research and development was going strong in Sweden, and it had been going strong since the second industrial revolution much due to successes within engineering, applied research and innovations, which made Sweden wealthy – e.g. wealthier than its previous existence as an agricultural, rather poor, country where people seeking their fortunes chose to emigrate to

America or elsewhere (Gergils 2006:274). In 2006, Sweden took the lead among OECD countries as far as R&D investment was concerned, with R&D making up 3.73 % of GDP that year (OECD 2008) and 3.63 % in 2007 (OECD 2009). Though the Swedish figures were following the goal staked out in the Lisbon Strategy of increasing R&D investment to 3 % of GDP in Europe, industry remained the largest contributor to Swedish R&D, by 2.79 % in 2006, while higher education R&D spending contributed with 0.76 % (OECD 2008). The government did not contribute with much; while higher education performed around 20% of total R&D, the government institute sector lagged behind at a mere 4.5% (OECD 2008). The, by comparison, small governmental involvement with R&D spending and performance threw its shadow on Swedish innovation in that Sweden did not actually have an innovation system. As Håkan Gergils argues, Swedish politicians had not, like their Nordic colleagues, discussed the structure or goals of research (Gergils 2006:275). There was no Science and Technology Policy Council or Research and Innovation Council in Sweden. The reason for this was, according to Gergils, and the OECD report seemed to agree with him, that R&D issues have never figured high up on the Swedish political agenda, which, in turn, was due to there never having been any financial grounds for it as R&D have been left in the hands of Industry (Gergils 2006:276). This would imply, for nanotechnologies and nanosciences, that Swedish Industry would need to step up to the task of funding nanotechnologies and nanosciences research if the system, however faulty, already in place was to be relied upon.

As for how research is perceived in Sweden, and by Swedish politicians, Gergils claims that Sweden is the last, if not the only, country not to have abandoned a linear model of research – according to which development follows naturally from basic research, in a straight line, leading to useful products and services at the end of the line. Hence, he argues, research has meant ‘basic’ or ‘basic’ research in the minds of Swedish politicians, regardless of party affiliation, and innovation policy has therefore been unnecessary (Gergils 2006:280). The disinterest has, in turn, led to what Gergils calls ‘the Swedish paradox’ as there has been a lot of input, but little output. Basic research remains well developed in Sweden, in particular if the

size of the population, 9.1m in 2006, is taken into account, but safeguarding new knowledge has proved difficult (Gergils 2006:281). To give an example, Sweden has invested heavily in providing its citizens with higher education through its universities[46] on all levels, including funding allocated to post-graduate education. According to OECD calculations, Sweden had one of the highest post-graduate graduation rates among OECD countries, and came second only to Finland with 12.6 researchers per 1000 total employment in 2007 (OECD 2008). However, as the Swedish, then Social Democratic, Government admitted in their government bill 'Forskning för ett bätrre liv' ('Research for a better life') in 2005, newly graduated researchers found it difficult to continue with research at Swedish universities following their graduation (Proposition 2004/05:80:120). Though the number of post-graduate students had doubled since the beginning of the 1990s, the number of research assistant positions on offer had been more or less constant, if not even slightly decreased (Proposition 2004/05:80:120). Nothing had been done to address this problem two years after the bill had been issued (Bergström 2006:11-13). Hence, with emerging technologies and in particular nanotechnologies in mind, where did that leave Sweden?

### *6.1.2 Who is leading Sweden towards the future?*

The sub-heading for this sub-chapter is a direct translation of the title of Hans Bergström's book on the same topic (*Vem leder Sverige mot framtiden?* 2006*)*. Though Bergström uses medical and pharmaceutical R&D as his case study, his contribution to this study lies in his thorough analysis of Swedish R&D policy-making until 2006. The year is significant as the Swedish social democratic minority government was overthrown in the parliamentary elections held 2006, which saw them replaced by a centrist-liberal-conservative coalition in 2007. The new government has, since 2006, taken a different approach towards R&D, by for instance increasing funding, more or less in accordance to Bergström's wishes, which called for a thorough

[46] All universities are public institutions, and education is for free, i.e. paid for by the government itself, making education the main expenditure in governmental support for R&D

analysis of the pre-2006 government's policies and the framework within which they are settled on.

Swedish R&D policy, both past and present, is shaped by institutional factors, i.e. the environment in which policies are being formulated. Two characteristics of the Government Offices of Sweden (Regeringskansliet) become particularly apparent when comparing the Swedish Government and its organisational structure to those of other countries; firstly, Sweden, through its Ministries (Departments) has a web of relatively *autonomous agencies* that are aligned below the ministries, though they de facto carry out much of the analytical and investigative work that would be carried out within the ministries in most other countries (Finland is an exception, as Tekes, for instance, is a rather autonomous agency). The second element relates to the tradition of *collective decision-making*, which implies that the government speaks with a uniform voice (or shows an united front), and that any one Minister (Secretary of State or Cabinet Minister) cannot even reply to a question in parliament without the reply having been approved by all other ministries beforehand (Bergström 2006:24). Collective decision-making is written into the Swedish constitution, and leaves individual Ministers with less power than they are allocated through the parliamentary system as applied in the UK. There is a slight difference between Sweden and Finland in this respect as well as the Finnish Ministries, according to Section 67 of the Finnish constitution of 2000, have the power to deal with questions related to their area of policy-making by themselves, *or* through a plenary session with the rest of the Government. However, if the matter at hand is of great national importance, collective decision-making applies also in Finland (FinLex 1999/731).

The Swedish system adds a special flavour to two difficulties within governance; the '*vertical* issue' and the '*horizontal* issue'. As Bergström puts it, the vertical issue relates to how decisions are transferred vertically from the government to their independent agencies, and how information sent from the agencies is received and processed by the Government Offices. The horizontal issue relates to the coordination of governmental policies put in place through collective decision-making (Bergström 2006:25).

Regarding the vertical issue, a key problem lies with upstream communication - from the agencies to the relevant Ministries. This is due to the relative 'smallness' of the, by comparison, weak ministries that often are populated by a small number of employees that are relatively young and inexperienced. The main evaluative, analytical and investigative capacities are housed one step down in the hierarchy within agencies that employ more people who, in turn, produce a vast number of reports and papers for overworked ministry officials to process. Adding to this, Swedish ministerial staff are often moved around within the Ministry itself, which does not seem a sustainable option as far as continuation is concerned. Ministry employees, are also, despite their small number, tasked with answering public requests, preparing replies to questions in parliament and, as Bergström claims, 40 % of their time is allocated to EU-related issues (Bergström 2006:25-26). The bottom-up vertical issue extends to the workings of the Ministry itself as well: how do reports that are sent to the Ministry by its agencies come to the attention of the Minister concerned? In Bergström's view, they do not, unless it is of utmost importance, or if the Minister in question has shown interest in the subject matter at hand, or decided to follow up on specific issues through his or her own initiative (Bergström 2006:31).

As for the horizontal issue, apart from the political struggles that come naturally to a coalition government, old administrative structures seem to be the culprit that slowed down collective decision-making. The interviewees that part-took in Bergström's study emphasized that the territorial attitudes present within the Government Offices where the various ministries protect their designated areas and issues make it more cumbersome to collectively decide on issues that would concern more than one ministry (Bergström 2006:34). Bergström noted, however, that a coalition government, a relatively rare phenomenon in Sweden, may show less territorial traits as another dimension is added to the negotiations – political differences through party politics. Such differences would force the government to communicate more and in more depth, which in turn could produce more robust policies (Bergström 2006:37). The potential benefits of a coalition government is interesting when comparing

the Swedish case study to that of Finland, as Finland has been governed by coalition governments since its independence from Russia, with various constellations such as Alexander Stubb's current government (that was formed in 2014) includes his own Conservative party alongside the Social Democrats and the Green Party alongside two other right-wing parties. This, while the Swedish party structure is more divided from left to right, and any cooperation between the Social Democrats and the conservatives would be less likely, nor would the UK Labour Party and the Conservatives be likely bedfellows. Bergström, who interviewed several Swedish politicians that were or had been involved with R&D related policies while in government, claims that party affiliations matter, as the Social Democrats amongst his interviewees showed a lack of interest in strategies and focus towards the future (Bergström 2006:20). With the coalition government discussion above in mind, it would seem that the different perspectives brought forth when more political parties cooperate in policy-making would make it easier for 'the future' to be brought onto the agenda. Such a comparison would surpass the purpose of this study, but it is kept in mind in case interviewees refer to it as an explanatory factor for the lack of a clear Swedish strategy. Regardless of Bergström's theories, the future was not entirely ignored in Sweden during the minority social democratic government that preceded the coalition.

Though Bergström uses the pharmaceutical and medical disciplines as an example when listing the positive R&D related initiatives taken and initiated by the Swedish government before 2006, some of the aspects that influenced these initiatives, regardless of the change of disciplines, are relevant to this study: the re-organisation of national research administration, which brought a stronger and more united Research Council (Vetenskapsrådet - VR) that supports basic research, and the formation of VINNOVA for the support of innovation; the Lisbon Strategy within the EU, which has aided in the development of a 'trade discussion programme' for the pharmaceutical, biotechnology, and medical technology sectors in Sweden; the Swedish parliament decided that one per cent of GDP should be allocated to R&D, which effectively means that the Swedish state has set up a goal for its funding of R&D for the first time; and the Government bill of 2005 prescribed

increased pubic investment in R&D (Bergström 2006:17-18). Trade discussions (branschsamtalen), are discussions between representatives of a trade (often through their trade unions and associations) and Government representatives. Bergström provides an example of discussions between the pharmaceutical, biotechnological and medical industries, the Ministry of Enterprise, Energy and Communications (Näringsdepartementet) and the Swedish Association of Local Authorities and Regions (Kommun- och landstingsförbundet); they were later joined by the Ministry of Health and Social Affairs (Socialdepartementet) and the Ministry of Finance (Finansdepartementet), as Industry raised questions that were of concern to the Ministries. These discussions were initiated by the government, and by bringing together such a variety of actors into the discussion, and - most importantly, industrial representatives, issues such as making the system for the registrations of medication more effective, were resolved more smoothly than they otherwise would have been. As Bergström puts it, in relation to the work carried out within the Government Offices, bringing in actors from the outside changed the rules of the internal 'normal' way of doing things (Bergström 2006:42), which seemed to make decision-making more effective.

Another institutional issue that halters innovation, and by extension, economical growth in Sweden is, according to Bergström, the budgetary model in use, as it does not differentiate between expenditure under state control, and expenditure outside of state control. For example, R&D funding goes in line with what has been decided in the Swedish parliament (Riksdagen), and it is fixed and subject to cuts if other expenses that may fluctuate – such as social security (an expenditure that has increased rapidly), would be considered insufficient. The other issue relates to the fact that the budgetary model does not differ between consumption and investment. They are both considered consumption, which, Bergström argues, gives R&D an element of short sightedness as short-term benefits become more visible than long-term benefits (Bergström 2006:44-45). Hence, the budgetary model in use did not comply with a futuristic vision in Sweden. Finland chose to do otherwise, and profited immensely by investing heavily into R&D during a period of growing budgetary deficit in the 1990s, following the collapse of the

Soviet Union. This motivated Finland to re-think its strategy to grasp a share in the export of high technology with the emergence of a Soviet-less world economy, as focusing primarily on low-tech exports to the Soviet Union was no longer an option (Bergström 2006:45). The Swedish model does not allow for such flexibility.

### *6.1.3 Attempting to carve a space for nanotechnologies and nanosciences in Swedish R&D*

It took until 2006 before Sweden saw an attempt at formulating a Swedish nanotechnologies strategy. Involving and inviting input from academia, VINNOVA, Industry, the academy itself, and other interested parties, Kungliga ingenjörsventenskapsakademien (Royal Swedish Academy of Engineering Sciences) – IVA set out to propose a 'nanostrategy for Sweden' (hereafter referred to as the IVA Strategy) in 2006 (IVA, 2006). The strategy particularly built upon a report by Eugenia Perez and Patrik Sandberg for VINNOVA that aimed to shed light on the innovation system in place for nanotechnologies (Perez & Sandberg, 2007), other contributions provided by, for instance Svensk Förening för Toxikologi (The Swedish Association of Toxicology), Vetenskapsrådet, and Vetenskap & Allmänhet (Public and Science)[47] (IVA, 2006:3); no records for these additional contributions to the IVA Strategy have been found. The IVA Strategy claims, on the basis of Perez and Sandberg's report, that nanoscience and research into nanotechnologies primarily took place within larger universities and research institutes and within companies that focused on materials and biotechnologies. That said, there were very few nanotechnologies-enabled products on the market, which was said to be due to the lack of overlap and relations between scientists and companies, put down to the lack of knowledge, competence, and ability to communicate (IVA, 2006:5). Another problem was identified as being the lack of overall investment, and particularly industrial investment into nanotechnologies R&D (IVA, 2006:5). The IVA Strategy suggested an action plan through six specified action points for decision-makers and funders, namely: 1) nano-

[47] The written evidence have not been found, but IVA referres to them in their report (IVA, 2006:3)

related competence were to be nurtured and encouraged within pre-existing technological disciplines (such as material science or physical chemistry etc.); 2) basic research within bordering or cross-cutting disciplines should be funded in order to encourage transdiciplinary initiatives and knowledge; 3) Sweden would need a nanotechnological 'tool kit' and increasing support for the relevant research infrastructure, which would strengthen cross-disciplinary interaction and enable interaction between Industry and scientists and researchers; 4) a theme-based approach with funding focused towards 'themes' such as 'Energy' or 'Food Technologies', should be initiated with a great emphasis on 'applicability' with regards to outputs of investments; 5) technology transfer and the commercialisation of nanotechnologies should be enhanced through strengthening the process of innovation and engagement with and of newly established and well established corporate entities; and 6) the risks of nanotechnologies, i.e. overviewing current legislation, investment channelled towards risk research and toxicology, and research into the consequences of nanotechnologies on safety, health and the environment should be encouraged (IVA, 2006: 8-10). The IVA Strategy did not specify how these priorities should or could be operationalized within the relevant Swedish institutions, agencies, or governance structures.

Perez & Sandberg's VINNOVA report that was fed into the IVA Strategy was a bit more detailed in its discussion on Swedish nanotechnologies and nanosciences, and the need for a more vibrant innovation system. The report writers did, however, underline the lack of interaction between academia and Industry, claimed to be partially due to cultural differences between the two (Perez & Sandgren, 2007:68), to be the main reason to the lack of broad commercialisation, alongside the lack of skills and knowledge of nanotechnologies and nanosciences within the industrial workforce (Perez & Sandgren, 2007:7, 8). Further, uncertainty with regards to the toxicology of nanoparticles was also given as a reason for the lack of progress, and the report writers called for a coordinated national strategy in order for Sweden to become a leading actor within nanotechnologies and nanosciences R&D. Other bottlenecks for Swedish nanotechnologies and nanosciences development were identified, such as the lack of national political interest in

nanotechnologies and nanosciences, the lack of funding, and barriers between traditionally separate academic disciplines (Perez & Sandgren, 2007:68). Though risks and regulatory issues were flagged in the report summary, they were not further dwelled upon.

In listing the weaknesses and strengths of Swedish nanotechnologies and innovation, Perez and Sandgren identified five key points that, if addressed, would help in solving the key weaknesses: 1) a programme for applied nanotechnologies; 2) a survey of Swedish strengths and potential markets; 3) a combined national initiative for nanotechnological development; 4) the gathering of research funders and encouraging their engagement with nanotechnologies research; and 5) launching an interdisciplinary application-driven R&D programme (Perez and Sandgren, 2007:70,71).

Seemingly disagreeing with Gergils' statement about the lack of an innovation system in Sweden, Perez and Sandgren argued that the development of the Swedish innovation system for nanotechnologies had in fact taken place, but that it remained at an early stage, 15 years into funding of nanotechnologies and nanosciences-related projects (Perez & Sandgren, 2007:17). Some of Bergström's criticism was confirmed however, at least in so far as his point about political lack of interest in science and technologies was concerned.

The total financial investment into nanotechnologies and nanosciences in Sweden, not counting any industrial-corporate investment, reached SEK 230m in 2005, whereof SEK 14m were spent on designated nanotechnologies related research centres; the amount allocated for such research centres rose to SEK 80m in 2007 (Perez & Sandgren, 2007:60). Though the Swedish general R&D budget was calculated to 4% of GDP in 2007, which was a figure substantially higher than all other European countries bar Israel, the R&D budget allocated to nanosciences and nanotechnologies was considerably lower than that of other EU countries (Perez & Sandgren, 2007:60, 61).

*6.1.4 Devising half a strategy for Sweden*

The Swedish Strategy – Nationell strategi för nanoteknik: ökad innovationskraft för hållbar samhällsnytta (transl. National Strategy for Nanotechnologies: increased innovation for sustainable public utility) – hereafter called the 'Swedish strategy' was coordinated and published by VINNOVA following its commissioning by the Ministry for Enterprise, Energy and Communications (Näringsdepartementet) (Borälv et al. 2010:5). In comparison with the IVA-Strategy, the Swedish Strategy was more detailed in the sense that it offered plenty of background material about nanotechnologies and nanosciences with regards to the possibilities, current research and interests within Swedish R&D, and provided some detail with regards to the ethical, social, and environmental issues concerning nanosciences and nanotechnologies. Some of the material was, though not always made explicit, based on other reports, such as produced by the Swedish Chemicals Agency (Kemikalieinspektionen) on regulatory issues, risks and risk assessments (Kemikalieinspektionen, 2007; Kemikalieinspektionen, 2009a, and Kemikalieinspektionen 2009b) The Strategy also highlighted Sweden's involvement in international policy-discussions, some of which had been related to regulatory issues and ethical and social issues, within OECD (Borälv et al. 2010:21, 22) and the EU (Borälv et al. 2010:22). A sub-chapter also offered insight into the strategies of other countries, such as Finland – though in the case of Finland, reference is only made to Tekes' FinNano programme, and not that of AF (Borälv et al. 2010:26). The UK Strategy is not explored in the Swedish Strategy. Beyond international policy-discussions, the strategy also provided a background to REACH and the regulatory frameworks applicable to risks in Sweden, but concrete suggestions were not made with regards to domestic legislations beyond pointing towards the Medical Products Agency (Läkemedelsverket) that oversees legislation related to medical products and cosmetics, the European Medicines Agency (EMEA), and the European Food Safety Authority (EFSA) (Borälv et al. 2010:39).

The authors of the Swedish Strategy underlined that they had not been commissioned to produce a 'research strategy'; rather this was meant to be a

nanotechnology strategy closely connected to research (Borälv et al. 2010:44). The meaning of this statement is quite difficult to make out, but a few sentences down, the Strategy writers conclude that nanotechnology is a very broad concept, including many varied disciplines, and that they did not think it desirable to unite all aspects of nanotechnology under an "nanopolitics" umbrella (Borälv et al. 2010:44). Hence, one could argue that calling the strategy a 'National Strategy for Nanotechnologies' may be considered confusing at best, as a national strategy would imply some form of national coordination on the basis that there is a perceived need for a national strategy about the topic area, and relating it to 'nanotechnologies' should imply that it would include an element of research in so far as nanotechnologies were emerging technologies.

Ambiguity notwithstanding, the Swedish Strategy made seven core suggestions, whereof the central suggestion called for the establishment of a committee for nanotechnologies related issues. The purpose of the committee was be to spread knowledge and facilitate communication between government agencies, overview issues related to the development and use of nanotechnologies, and to provide background materials for governmental decision-making (Borälv et al. 2010:44, 45). The Committee would also monitor international development within nanotechnologies. The second suggestion was related to international involvement with the purpose of influencing regulatory discussions, which was also to be a task suggested for the Committee. The third suggestion called for the integration of risk analysis, risk management, and the innovation process, and for risks to be considered early on, during, and in the end of the innovation process, rather than just at the end of research or development. The purpose of such an exercise would be to enhance the possibilities of technologies rather than to hamper their development (Borälv et al. 2010:48). The fourth suggestion was to identify areas for thematic investments, particularly areas where nanotechnologies would address societal and global challenges, and to encourage collaboration between academia, industry, and public institutions (Borälv et al. 2010:49). The fifth suggestion concerned the need to encourage innovation through connecting nanotechnologies to already existing investments such as 'the

environment' or 'health', and to encourage the development of knowledge with regards to the production of nanotechnology-enhanced products to corporate entities (Borälv et al. 2010:50). The sixth suggestion referred to technology transfer and the need to connect Academia and Industry, and to keep the nanotechnologies-related infrastructure up to date (Borälv et al. 2010:51). Finally, the seventh suggestion aimed to foster communication with the public in order to secure the sustainable development of nanotechnologies. The Swedish Strategy writers particularly underlined the need for the public to understand the benefits and risks of technologies, as the public's trust for nanotechnologies is as important as technological progress in itself (Borälv et al. 2010:52) It was also stated that Sweden should draw lessons from public engagement initiatives carried out in other countries, but no suggestions were made with regards to how such activities would be carried out and by whom, and examples of engagement were not brought up.

### *6.1.5 The non-exclusive research strategy for nanotechnologies and nanosciences*

Rather than devising a national research strategy, nanotechnologies and nanosciences were identified as one of 20 strategic areas of research by the main research funders Vetenskapsrådet (VR), Forte (formerly Fas), and Formas, in their recommendations to the Swedish Government in 2009 (Vetenskapsrådet 2009). The Funders, in their recommendation, also made recommendations with regards to the division of funds, as well as the projects or initiatives to fund. The funds would then be allocated directly to the host institutions for each initiative (e.g. universities). The recommended initiatives for nanosciences and nanotechnologies for 2010-2014 were 'Chalmers Nano-initiative' and 'The nanometer Structure Consortium at Lund University', which were recommended awards totalling SEK 315m, over 5 years (Vetenskapsrådet, 2009). The total amount included funding for infrastructure costs. For the sake of comparison, SEK 315m would amount to approximately £27,5m[48]; divided over 5 years the total sum spread over two initiatives would be £5.5m per year in research funding (incl. infrastructure costs). This

[48] Using xe.com for the conversion, the rate is 1GBP=SEK11.46 [22.08.14]

amounted to significantly less than did UK and Finnish investment. However, further funding was likely to come from other non-governmental Trusts, general funding programmes that have not been specifically earmarked for nanosciences and nanotechnologies, and other agencies or public or private bodies not accounted for by VR, as was the case in 2008 where figures presented by Dahlöf and Wihed suggest that a total of SEK 600m, e.g. £52.2m, of public funds were spent on nanotechnologies (Borälv et al, 2010:70).

### *6.1.6 Finding a balance in Sweden*

The many agencies and dispersed governance in Sweden has made it difficult to patch together, literally, a narrative of national Swedish nanotechnologies and nanosciences governance – to the point that the Swedish Strategy, national by name, does not in fact look like a coherent and national strategy as it does not want to be considered a step towards 'nanopolitics' or a research strategy. It is also difficult to balance the approach to promotion versus regulations as the strategies and other documents reviewed do not necessarily offer clear guidance with regards to the desired approach, and they do not give a clear picture of who is to do what, and why. The role of the public, civil society, and public engagement are also not discussed at greater length. There is no evidence for there having been any public engagement exercises or involvement of either the public, or civil society organisations and NGOs in the formulation of either of the two strategies, beyond a brief mention of Public and Science having been represented. No blog posts or other expressions of opinion authored by actors outside of the realm of 'expertise' were found to discuss any of the reviews or Strategies; there was also no discussion of a moratorium in Sweden.

The picture becomes slightly clearer with regards to the interactions between actors, in so far as it is clear that there is not enough interaction. Therefore hearing the first hand account of actors within Swedish nanotechnologies and nanosciences R&D with regards to their views on interactions, interdisciplinarity, funding and promotion, regulations and risks, public

engagement, to mention a few topics - and also, if possible, their take on Bergström's horizontal and vertical issues, becomes interesting.

## 6.2 From narrative to interviews

The Swedish interviews took place in 2009 and ahead of the publication of a number of the policy documents included in the document review. Indeed, several of the interviews discussed the development of the Swedish strategy as a currently on-going project.

A total of 15 academics and scientists, government representatives and industrial representatives were interviewed in Sweden, whereof three interviewees could be considered as 'other' – one of which (Sven) belonged to a non-governmental professional society, and the other – Fredrik - being a representative for a Trust that handed out funding to strategically important research projects. A third person – Olof – could be considered 'other' as he was, though a senior academic, not directly involved with nanotechnologies but had researched the Swedish science policy landscape for decades. As seen in Table 6.1, a majority of the interviewees, seven in total, were scientists or in academia, whereof two had dual positions – Britta was an academic but also a government representative, and Gustav was primarily representing an Academia-Industry partnership but was employed by an Academic institution. One person, Christine, was a former scientist turned industrial and trade representative, and identified herself as such rather than as a scientist. Of the government representatives, one interviewee – Emma, represented a Ministry, while all other government representatives – Ulf, Britta, Eva, and Maja were interviewed as representatives for government agencies. One of the interviews included two people – Christine and Suzanne, who had realized that I was about to interview them both separately, and suggested that they would be interviewed together as they were close collaborators and they wanted me to learn about their joint efforts in bringing industry and academia together into an entirely new initiative. This interview is referred to as 'Christine & Suzanne, 2009'.

TABLE 6.1: SWEDISH INTERVIEWEES

| *Interview reference* | *Alias* | *Position* | *Institution* | *Interview year* |
|---|---|---|---|---|
| Sven, 2009 | Sven | Coordinator | Professional Society | 2009 |
| Anders, 2009 | Anders | Scientist and researcher | Academia | 2009 |
| Christer, 2009 | Christer | Senior scientist | Academia | 2009 |
| Fredrik, 2009 | Fredrik | Coordinator | Funder | 2009 |
| Ulf, 2009 | Ulf | Policy-advisor | Government | 2009 |
| Britta, 2009 | Britta | Senior scientist | Academia | 2009 |
| Jan, 2009 | Jan | Senior scientist | Academia | 2009 |
| Eva, 2009 | Eva | Senior policy-advisor | Government | 2009 |
| Christine & Suzanne 2009 | Christine | Senior policy-advisor | Industrial association | 2009 |
| Christine & Suzanne, 2009 | Suzanne | Scientist | Academia | 2009 |
| Maja, 2009 | Maja | Advisor | Government | 2009 |
| Erik, 2009 | Erik | Scientist | Academia | 2009 |
| Emma, 2009 | Emma | Policy-advisor | Government | 2009 |
| Gustav, 2009 | Gustav | Coordinator | Academia and Industry partnership | 2009 |
| Olof, 2009 | Olof | Senior academic | Academia | 2009 |

Four NGOs or civil society organisations were contacted for interviews, but none wanted to take part – three did not reply to the request. Six large companies and SMEs based in Sweden were also contacted, but none decided to take part. Two companies (one large multi-national corporation and one smaller Spin-off company) replied to the request and said they did not want to be interviewed, while four companies did not respond to the request.

The interviews took place in five different locations across Sweden, and all interviews were conducted in Swedish with some English words and concepts included that were specifically related to nanotechnologies and nanosciences as much of the related vocabulary is in English. All original quotes appear in footnotes when and where translated into English in the text.

As in the two previous field study chapters, the Themes Matrix is found in Chapter 2, Table 2.2. These indicators for organisational diversity will be explored in subchapters 6.2.1 – 6.2.5, while the indicators of social accountability are explored in subchapter 6.2.6, and part of 6.2.5.1. 6.2.7 will

discuss the balancing act between promotion and regulation in Finland, or the lack of it, and subchapter 6.3 aims to offer a brief summary of the main points as found in the Finnish part of the field study.

### *6.2.1 Identities and roles*

With the lack of a strategy and other policy-documents at the time of the interviews, it was necessary to particularly focus on finding interviewees who would be involved with developing a policy. Finding the right interviewees proved a challenge, but using the backgrounds and professional profiles of those involved with UK policy-negotiations and Finland's FinNano Programmes as an example provided a selection of interviewees who could, between them, answer the standard set of interview questions.

As was the case in Finland, a majority of the interviewees had PhDs in Science, Engineering or Medicine, regardless of whether they currently worked as scientists or otherwise in academia or not. Fredrik, for instance, had previously worked for VR and said that a PhD had been a requirement for landing the job as a policy advisor (Fredrik, 2009). Eva, working for VINNOVA said that it was really important to have a PhD in order to be considered credible among scientists and researchers. She added that she had a past as a Product Manager within an SME, which was also important, especially when working at VINNOVA due to the emphasis on applied science and collaborations with industry (Eva, 2009). Both industrial representatives underlined their academic pasts, and said it was of great importance in order to do their jobs properly in light of working with academic groups and with science (Christine & Suzanne, 2009; Gustav, 2009). All of the academics or scientists among the interviewees specifically saw themselves as academics or scientists, unless they, like Gustav and Britta, had dual positions. And Sven, working for IVA, a professional body for engineers, confessed to being an engineer but also to having worked within companies and industry in the past. This, he said, was very important as IVA was a very entrepreneurial organisation (Sven, 2009).

Getting a feel for their roles in a policy-making context was less straightforward. The academics and scientists among the interviewees underlined how their jobs were to do research, but that some of them had been approached for their expertise in certain areas – such as Erik, whose area of expertise was nanotoxicology (Erik, 2009), and Suzanne, who had been approached by both industrial entities and government officials about the potential opportunities offered by nanomedicine (Christine & Suzanne, 2009).

As for the government representatives, they underlined the importance of *Appropriation Directions* (Regleringsbrev) through which Sweden's political decision-makers delegated power to non-political decision-makers populating the government agencies where policy-making and implementation was to take place. The appropriation directions, received yearly and with a set budget, defined the role of each agency, said Eva and Maja (Eva, 2009; Maja, 2009). Working for different agencies, their tasks and roles did not overlap – though agencies could request advice from other agencies in order to deliver a task delegated from above.

Gustav, though also representing his academic institution pointed out that his main task was to encourage industrial and academic collaboration and ensure the availability of shared research infrastructure (e.g. the clean room and equipment) hosted within his institution. He said that his role, though not likely to play a part in national policymaking, would be to share information regarding the practical aspects of academic-industrial collaborations within nanotechnologies and nanosciences, and also to keep track on infrastructure needs (Gustav, 2009). Christine, on the other hand, was more directly involved with policymaking on behalf of Svenskt Näringsliv (The Confederation of Swedish Enterprise) – SN – and was informed about the development of a Swedish Strategy. Christine worked closely with government and academia, representing commercial and industrial interests, and one of her roles was to build up collaborations with academia – which is what she had done with Suzanne (Christine & Suzanne, 2009).

*6.2.2 Decision-making by appropriation directions*

Similarly to Finland, Sweden has very strong Government Agencies; however, the Finnish agencies came across as being slightly more autonomous than the Swedish agencies that relied on what was specified in appropriation directions on a yearly basis. Eva said that the tasks for each agency were quite clear, and it was VINNOVA, for instance, that had been given the task of writing a Nanotechnologies Strategy for Sweden. They would, she said, do so in collaboration with other agencies, such as VR and Kemikalieinspektionen (KEMI), and they were planning to arrange a hearing that would include academia, industry, and society. When quizzed, she said that 'society' meant the state as in other agencies, ministries, and – if appropriate, civil society organisations. The general public was not included in the concept of 'society' (Eva, 2009). The lack of public engagement will be discussed below, but as for the involvement of several agencies, it became clear when interviewing government representatives at multiple agencies that the appropriation directions were considered immensely important by all interviewees, and that there was a reluctance to discuss topics that would fall under the delegated powers of another agency (Eva, 2009; Ulf, 2009; Britta, 2009; and Maja, 2009). This seemed to suggest a rather fragmented system of governance that was actually quite difficult to overview. Emma, working at the Ministry of the Environment, confirmed that though she was working at a 'higher level' in the hierarchy, she did not have much to do with the formulation of the strategies and similar tasks. Rather, she said, her work entailed feeding back information from the relevant agencies to the Ministers attached to the Ministry and support the Ministers in their work (Emma, 2009). About the 'hierarchy' Anders, a senior scientist, said *"Sweden has flat hierarchies (…) where elitism isn't okay (…) [and] it is quite close between the Prime Minister and the homeless*[49]*"* (Anders, 2009).

A flat hierarchy is the idea behind horizontal management, which is what the Swedish decision-making landscape looks like. However, horizontal

[49]Translation from Swedish, original: *"Sverige har ju platta hierarkier (…) och elitism är ju liksom inte okej (…) [och] det är ganska nära mellan statsministern och uteliggaren" (Anders, 2009)*

management also brings fragmentation within the organization in its wake, unless there is clear coordination and communication between its parts, which did not seem to be the case in Sweden.

*6.2.3 Policymaking: open, closed, or sometimes open?*

While the Swedish interviewees made their roles of decision-making or not decision-making clear, and the Swedish system of decision-making was not questioned by a majority of them, they rejected the idea of there being a 'club' or small gathering of people making decisions in Sweden without much transparency. Rather, the fragmentation led to, as Anders put it, a 'network of networks' which does not become visible until you are inside it (Anders, 2009). Rather than one club, Anders described the Swedish science governance system to be one of many clubs.

Of the government representatives, Ulf agreed that Swedish decision-making could a little bit club-like, but that it was more spread out and open than in Finland much due to the emphasis of the Right-of-Access Principle (Offentlighetsprincipen) that dictates that all governmental decisions and discussions are to be publicly available (Ulf, 2009). Eva and Emma also mentioned the importance of this principle in Sweden and said that transparency was very important (Eva, 2009; Emma, 2009).

Olof, having researched Swedish science policy for many years, argued that there was a significant difference between Swedish and Finnish decision-making as related to science and technology in that Finland utilized a more centralized governance structure, while Sweden did not – though, he said, VINNOVA has pointed at Finland as an example of what Sweden needs, which has not gone down well with politicians of any colour (Olof, 2009). Olof continued by saying that Swedish science had been more centrally governed with regards to the decision as to which research areas to focus on, but that this had changed into some kind of "politicized science" where Sweden's political decision-makers based on advice from various government agencies

and their own priorities decided on which ‘strategic research areas’ to fund for the next four years while the Government remained in power (Olof, 2009).

In terms of openness and transparency, all interviewees claimed to have easy access to information and that the decision-making environment was open in Sweden rather than secretive. However, Britta and Eva said that there was limited openness with regards to companies and Industry, and sometimes within academia (Britta, 2009; Eva, 2009). Fredrik agreed with regards to the former, but said that some level of secrecy was necessary for Industry in order to make strategic investments (Fredrik, 2009), and Jan made a point regarding the latter saying that it was difficult to get insight into academia nationally as academics and scientific groups in different regions or even institutions were competitors (Jan, 2009). Eva further said that she sometimes felt that there was a lack of willingness among academics to engage in nanotechnologies and nanosciences decision-making as they did not agree with the terms ‘nanotechnologies and nanosciences’ and considered the ‘nano’-level as a natural continuation of their own academic disciplines (Eva, 2009). The overall opinion among interviewees was that the decision-making environment was open and not particularly secretive, though fragmented into many different networks and groups that were not always easy to get an overview over.

### *6.2.4 Interactions, negotiations and constraints*

The triple helix was mentioned by a number of interviewees, but in more detail by Eva, who confessed herself being an impersonation of the triple helix having previously worked within both academia and industry (Eva, 2009). Several interviewees addressed the need to connect more, particularly between academia and industry. Less was said about connecting with governmental institutions, at least by the academics and industrial representatives themselves.

#### *6.2.4.1 On Industry: a wanted match*

The most commonly occurring comments about industry were related to the need to connect with them for the advancement of nanotechnologies and to facilitate strategic science. The Trust Fredrik worked for, for instance, required industrial and academic collaboration in order to release funds for what was meant to be 'strategically important research of great public value', and so did the programmes that Eva and Ulf ran at VINNOVA (Fredrik, Eva, Ulf, 2009). Suzanne and Christine had, for instance, secured funding though Fredrik's Trust, and said that they had employed a 'high gain, high risk' attitude, and that it have been crucial to getting their project off the ground (Christine & Suzanne, 2009). Other funders did not, according to Christine, offer similar flexibility. VR did not insist on industrial funding, Britta said, and would not, in fact, pay out funds to industrial entities at all as it was focusing on basic science conducted at academic institutions (Britta, 2009). Ulf underlined how he found that industrial entities and companies welcomed the open exchanges with academia and that he thought that they realized the importance of openness for innovation (Ulf, 2009), and Christine gave the example of her and Suzanne's collaboration that resulted in an un-presented project run in Suzanne's institution (Christine, 2009). Suzanne agreed and said that the collaboration with SN and industry in general, within her area - nanomedicine, actually had an impact on the way in which decision-making as related to the project was taking place. She said that for older and more senior male colleagues who usually always sat on boards and decision-making bodies within her institution had had to give way for people who 'got things done' and whose involvement with the project was more prominent, and that Christine's and SN's involvement had been important to achieve this (Christine & Suzanne, 2009). Suzanne added, however, that in terms of openness, discussions involving industrial or commercial entities were not open, nor were sometimes academic discussions before proper agreements had been signed. Christine agreed with her assessment of the situation (Christine & Suzanne, 2009).

Overall, interviewees did not have anything 'bad' or negative to say about industry, and they rather expressed a wish for further interaction.

*6.2.4.2 On Government: spread out and difficult to overview*

With regards to the government and its institutions the Swedish non-governmental interviewees proved more critical than their Finnish colleagues. The two main points made were related to the structure of government, which was considered fragmented, and the slow response shown towards the formulation of a nanotechnologies and nanosciences policy. With regards to the former, Jan, Christer, and Anders argued that the government due to its fragmented nature did not fully appreciate the demands or opportunities within different and equally fragmented academic communities and networks (Jan, Christer, Anders, 2009). Jan was particularly vocal about the building of and 'excessive' investment into the European Spallation Source (ESS) facility to be built in Lund, the area where Jan was based. Its building, Jan argued, was a good example of how far lobbying 'can get you'. Nobody involved with the project, he said, had been able to explain why it was a good investment (Jan, 2009). Having just returned from a breakfast meeting about the ESS facility that had been organized by the ESS Consortium, Jan said that the head of the Consortium had explained what ESS is without having any idea of what she was talking about as she is not a physicist, though she was backed up by Industry. Jan argued that the facility was just slightly more advanced than already existing infrastructure in the US and Japan, and that committing European research funds towards it for the next 50 years was not a sustainable solution. (Jan, 2009). Jan argued that the fragmented nature of government and also academia made it difficult to resist lobbying like this. He also argued that the government agencies should understand that this was not a useful use of resources (Jan, 2009).

With regards to the second claim, the slowness in developing a strategy, the point was made by Christer, Olof, Jan and Anders (Christer, Olof, Jan, Anders, 2009). Particularly Christer, who was a very senior 'nanophysicist' and had been part of the Swedish nanotechnologies and nanosciences field for many years, had a lot to say on this topic. Some of his comments will be discussed during the IPA study, but one of his main claims was that he, alongside other leading nanoscientists had tried to initiate a strategy as early as 2001, but that government had not been interested (Christer, 2009).

Christer particularly discussed his experience of approaching a director for one of the funders whose approval would have been very important should their 'lobbying' attempt be successful. He said the director was quite reluctant in her meeting them, and following their presentation she had said *"But my goodness, none of you is even a vice provost![50]"* (Christer, 2009). Christer thought the reluctance for 'nano' to be picked up by the funders and government agencies alike was down to the bottom-up way in which they had approached the issue. A few years later they tried to re-initiate the process through IVA, but this also didn't lead anywhere, he said. The strategy that was being developed in 2006 was a top-down initiative, with the government on top*,* which Christer said, was quite typical for Sweden (Christer, 2009). Anders also expressed his frustration with the lack of activity thus far, particularly following the IVA strategy (Anders was not part of Christer's early bottom-up effort) that had not achieved much. He added that what was needed was really the relevant Government Agency to action a strategy, which he said was now happening at VINNOVA (Anders, 2009).

Speaking on behalf of IVA, Sven also showed some frustration over the lack of interest for the IVA-strategy (he did not mention Christer's previous attempt). He said that the IVA-attempt had originated from academic and industrial partners meeting over several seminars and meetings and then deciding to put together a 'suggestion' rather than a 'policy', that eventually was not supported by funders and government (Sven, 2009). Interestingly, Sven's interview was very much a long monologue, and it seemed as if he had been keen to discuss this experience for some time. Sven also expressed some frustration in the slowness to develop a Swedish strategy, and remarked on the fragmented policy-making and decision-making going on in Sweden (Sven, 2009). Both Emma and Fredrik confirmed that they knew about the IVA-initiative, but also that it did not get much support (Emma, 2009; Fredrik, 2009). Emma continued by referring to the 'authorities' and how government agencies were now moving ahead with a strategy. By her emphasis on 'authorities' and 'government' it was clear that she thought a

[50] Translation from Swedish, original: *"Men herregud, ingen av er är ju ens vice-rektor!"* (Christer, 2009)

policy would have to come from a top-bottom mechanism rather than being initiated by the academic or industrial communities, or by professional societies that exist independent of the state (Emma, 2009).

The general point of view regarding the government and government institutions seemed to be that there was not much other actors could do in terms of driving initiatives and that there was a lack of oversight rather than transparency in government actions. There was also an understanding among some of the interviews of that there was some interest for research and science among Swedish politicians, but that they would need to articulate and invest specifically into nanotechnologies and nanosciences research and development and acknowledge the uniqueness of science and technology on the nanoscale (Britta, 2009; Christer, 2009; Christine & Suzanne, 2009).

*6.2.4.3 On Academia: competitors and old fashioned*

While government was accused of being fragmented, the same was said about academia, particularly by the academics themselves. Jan, for instance, had made this point when discussing the ESS facility, and Gustav agreed in saying that the facilities he ran was used by regional groups and companies but it was not a national resource (Gustav, 2009). Christer, however, referred to the early bottom-up initiative for a strategy as a national effort in that his 'friends' and 'colleagues' were from all parts of the country, they did know one another from before (Christer, 2009). Suzanne made a similar point in saying that there was not much coordination among academic groups nationally, as they were also competing for the same funding, but that she knew everyone involved with her area of nanomedicine, and that she would want to collaborate with other groups if there was interest (Christine & Suzanne, 2009). However, she continued, the main problem she found was really the coordination between academia and industry, which is why she was so happy to have connected with Christine over their joint project (Christine & Suzanne, 2009).

Christine agreed with Suzanne in saying that she found that companies and industrial entities often took the first step towards approaching academics and

research groups, while she wanted to change this and turn it around. This she said would give academia more power in terms of sitting behind the steering wheel with decision-making power within projects rather than following the rules or guidelines set up by industrial or corporate funding. In order to do this academics would have to more actively interact with industry (Christine & Suzanne, 2009). As and industrial representative this could be considered a curious answer from Christine, but, based on her interaction with Suzanne and hand gestures, she seemed to underline how industry could accommodate academia if academia was reaching out to industry.

Ulf said that researchers very often wanted 'academic rewards', by which he meant the development of their own research areas, and publications, whereas VINNOVA would want to see financial rewards attached to investments. He said that this was one way in which it could be difficult to work with the academic community, and he called for further engagement between groups and disciplines (Ulf, 2009). Likewise, Ulf had found that academics and scientists did not necessarily understand politicians and vice versa, and that communication between the two therefore was lacking (Ulf, 2009). Ulf's latter point was particularly targeting politicians and governmental institutions on the regional level, where, he argued, it would be particularly important that the two camps interacted considering the fragmented nature of academia (Ulf, 2009).

Academia faced similar criticism as the government itself as being fragmented and not particularly approachable by industrial entities, which is a significant contrast to the case of Finland, where there were very tight links between academia and industry. Interestingly, criticism was delivered from within academia itself as well, but none of the interviewees regardless of 'camp' made any suggestions for how to change the situation.

*6.2.4.4 On NGOs: nowhere to be seen*

NGOs or other civil society organisations were not discussed and none of the interviewees had ever been contacted by a Civil Society organization. However, Maja said that her colleagues had been contacted by the NF –

Naturskyddsföreningen (Swedish Society for Nature Conservation), but they did not discuss nanotechnologies to her knowledge (Maja, 2009). None of the interviewees expressed strongly held opinions about NGOs, which may have been due to their lack of engagement with said NGOs.

*6.2.4.5 On the Public: not involved and not asking for it*

None of the interviewees had much to say about the public and the public was neither framed in very positive or negative terms. Suzanne and Britta had experience of interacting with the public through public engagement events, as described below. However, Suzanne particularly raised the need to include communications as a part of MSc and doctoral programmes at the Universities in order to educate young and aspiring scientists to communicate their research and avoid controversies or otherwise avoid public scepticism towards science (Christine & Suzanne, 2009). Christine agreed with this need, and both of them underlined that though there had not been many negative news stories in the Swedish media thus far, that might change should there be a lack of communication or miscommunication on the behalf of scientists involved with nanotechnologies and nanosciences (Christine & Suzanne, 2009). This said, Olof and Anders said that the public was very invisible and inaudible in Sweden as far as nanotechnologies and nanosciences policies were concerned, and Olof further said that they did not ask to be involved either (Olof, 2009; Anders, 2009).

*6.2.5 Reflections on collaboration and trust*

The various opinions and perspectives of the other actors involved or not involved with policy-making in Sweden paints a picture of a fragmented science policy and R&D environment. As there was a lack of industrial representatives being interviewed it was difficult to say concretely how industry perceived academia and government. However, from the input from the interviewees chosen for this study, it seems, particularly judging from Christine and Gustav's input, as if industry was slightly less fragmented and that commercial entities were quite distant to the policy-making environment. Eva said that they, when developing the strategy, would arrange a hearing

that would include industrial entities, and she underlined that VINNOVA usually did seek advice from Industry and commercial entities with regards to their interests in nanotechnologies and nanosciences R&D (Eva, 2009). Britta said that she, herself, was not involved with the strategy and also said that VR did not have close ties with commercial entities but that they worked closely with VINNOVA, who did (Britta, 2009).

When asked about collaboration, Fredrik said that the Trust had representatives for both industry and academia on their board, and government too at times (one of its previous directors was a former MP), and that he had seen that this provided a platform for the two to meet. This he said was very important as it seemed as if industry knew what academia was doing, but that academia was not as well informed and that there was some prejudice in that academia often thought that they were ahead of industry with regards to new ideas, while industry often, actually, were ahead of academia (Fredrik, 2009). A platform for interaction had also been underlined as a necessity to facilitate collaboration and to work for innovation in Sweden by other interviewees, and particularly Christine and Suzanne who emphasized Fredrik's point and how happy they were with their own collaborative project (Christine & Suzanne, 2009).

With regards to trust for policymakers, Christer made his sentiments clear through his upsetting experience of trying to encourage a strategy formulation process, but said he, instead of mistrusting the decision-makers themselves, felt less trust in the system of governance as he felt locked into the Swedish system, which did not encourage bottom-up engagement (Christer, 2009). Singling out politicians rather than non-political decision-makers, Jan, however, said that he found that politicians' thought of the future as a 4-year event, and that politicians were very short-sighted and preferred to concern themselves with visions that lasted for the durations of their time in office and no further (Jan, 2009). Jan also added that there were many politicians that did not have a doctoral education, and that he felt that they [politicians] did not know what they were talking about when discussing science or research (Jan, 2009). Anders, on the other hand, said that he found that politicians were

quite interested in the longer-term future, but that a system of 'technological neutrality' was in place as people [understood to mean non-political decision-makers] were scared of politicians picking the wrong winners. Rather the market should make decisions about areas for investment and run this through a competent government agency, VINNOVA (Anders, 2009). Apart from Jan, and possibly Christer, the other interviewees were quite positive about politicians and non-political decision-making, though they thought it was very fragmented and that it was difficult sometimes to get a clear answer to a query as the various agencies themselves did not always know where to turn.

Ulf argued that there was quite a lot of trust for others in Sweden, and especially in research as everyone knows everyone else (Ulf, 2009). However, Erik, Christer, and Jan said that it was important to make the right connections in order to achieve your aims and that there was often politics involved with large research projects and much competition between different academic groups in different parts of the country (Erik, 2009; Christer, 2009; and Jan, 2009). Beyond competition, they all agreed that within certain disciplines and networks they often knew one another well and met outside of the competition for funding or research results. As for non-academic interviewees, the overall impression was that there was plenty of trust in academia and their work, provided that they communicate and followed rules and regulations (Christine & Suzanne, 2009; Britta, 2009; and Ulf, 2009). Christine, Ulf, Sven, Fredrik, and Eva also underlined how they thought that academia would have to do more to connect with industry however, as they saw that as crucial to Sweden's future and innovation system, and there was some concern – expressly from Fredrik and Sven in particular, at academia's willingness to connect this way and abandon the more 'old fashioned' way of doing things (Christine & Suzanne, Ulf, Sven, Fredrik, Eva, 2009). Particularly with regards to building relationships between government, academics, and industry, Eva added that she found the other areas of interaction than through boards or arranged meetings very important, such as chatting during coffee breaks. This, she argued, would saw the seeds for further collaboration and good relationships between parties that were necessary to build trust (Eva, 2009). Again, what seemed called for was a platform where actors could

engage freely and openly outside of actual policy-discussions or seminars, after which they returned to their respective domains.

*6.2.5.1 Leadership questioned and not questioned*

None of the interviewees really questioned the leadership of government agencies in Swedish science policy. However, Christer made a comment on the manner in which science policies were initiated and would have liked for there to be a mechanism for bottom-up policy-making, or at least of influencing policy decisions (Christer, 2009). Though Jan delivered some criticism towards both politicians and non-political decision-makers, he made no suggestions for how else to govern science, and none of the other interviewees really questioned the Swedish system or leadership. However, there seemed to be some confusion about leadership, which could be due to the rather fragmented system of networks of networks that seemed difficult to overview. Indeed, discussing 'leadership' many interviewees seemed a bit confused at what the topic was. Did the question concern the development of a strategy, or leadership within the risk discussion, or was it about research prioritization?

With regards to research prioritization, as an example, a similar basic-applied divide to Finland in terms of investment into innovation, dissatisfaction among researchers was not found. Rather there was a push for academics to take more responsibility for commercialization and innovation by connecting more to industrial entities, and Eva and Ulf said that as their VINNOVA programmes required 50% industrial and 50% academic input, they were left with a smaller number of proposals (Eva, 2009; Ulf, 2009). Indeed there seemed to be a reasonable amount of funding available for basic science – and none of the academics and scientists conducting basic science research contradicted this. It did, however, seem as if both government representatives and industrial representatives were expecting academia to 'make a move' in the direction of applied research. Suzanne, who was conducting applied research within nanomedicine, confirmed this with Christine's backing during their interview. They both held up their particular project as an example that they would like to see more of in Sweden, and that academia should take a step towards more

innovation and application-oriented research and join forces with industrial partners (Christine & Suzanne, 2009). Overall, the interviewees did not point towards government leadership with regards to research prioritization, but rather on each and every institution's own initiative, which could suggest that 'leadership' – the leadership of different tasks and in relation to different institutions or jointly was as fragmented as the institutions themselves had been claimed to be. This was not in line with Christer's assessment of the situation as it was between 2001 and 2006, which could suggest some 'new thinking' with regards to leadership with in science governance in Sweden.

*6.2.6 Some public engagement, not much of a trust gap*

A small number of interviewees had participated in public engagement events arranged by VA, and particularly Forskarfredag (Researcher's Night) were mentioned (Christine & Suzanne 2009; Britta, 2009). Part of a European Commission supported series of events that took place all over Europe, Forskarfredag aimed to show the public how interesting science and research could be. Both Suzanne and Britta thought that these events were important and Britta was particularly underlining how open communications about how risks and ethical issues were dealt with was necessary especially in order for nanomedicine to avoid the same kind of backlash that genetics had seen (referring to GMOs). She did not, however, see a role for the public in terms of directing scientific pursuits or offering insight into how research funding was to be spent. Rather, she said, this could be done by competent representatives for the public as decided through general elections, who then appoint competent expertise to advise them (Britta, 2009). With regards to GMOs and genetics, this was not brought up by any of the other interviewees, and did not become as big an issue in Sweden as it was in France or the UK. Britta also mentioned that during the annual Book Fair in Gothenburg usually there was an event called Forskartorget (Researchers' Square), which she said was a popular event where researchers met the public (Britta, 2009). Britta said she had also been on TV to discuss biomedicine, and that her organization had exhibitions on various topics that she had participated in (Britta, 2009). Suzanne had done some public engagement through her institution by

preparing and designing posters that were written in an 'easy–to-understand' fashion, and that were hanging in all public spaces of the institution (which includes a large hospital). However, the posters were also meant for researchers of other disciplines who she thought ought to be interested in what her group was doing, but who were not really 'interested in technology' (Christine & Suzanne, 2009).

Other interviewees were not entirely sure what public engagement entailed. Fredrik, for instance, referred to the Trust's communications department (Fredrik, 2009). He also said that the communication of their research was a part of the 'third task' of the Universities as set out in the Higher Education Act[51], but also said that he knew of Forskarfredag and that the Trust made a financial contribution (Fredrik, 2009). Ulf recalled that VA arranged engagement activities, but said that very little was being arranged for 'normal people'. The professional societies organized events, but they were mainly targeting politicians and researchers. As for academics, Ulf said that it was important for them to communicate their research and to publish in popular science magazines in order to increase their visibility (Ulf, 2009). Overall, all Swedish 'public engagement' activities seemed to be of the informative and public awareness-oriented kind.

As for media coverage, all interviewees said that they had seen nanotechnologies and nanosciences related news articles in the media, but the coverage had not been sensationalist. This said, the main paper mentioned was Ny Teknik (New Technology) whose audience is likely to be already interested in technologies and science. Christine and Suzanne had been delighted to see an article in Ny Teknik describing their own research, but said that there was a big step between public interest and being contacted by a member of the public (Christine & Suzanne, 2009). However, Suzanne later expressed her disappointment with Swedish science journalists and said that they rarely had a proper background in the natural sciences, and that when they did report on science stories they did not offer much interpretation

[51] Higher Education Act - Högskolelagen 1992:1434, 1st chapter, 2nd paragraph. All Sweden's laws are available online: https://lagen.nu/1992:1434 (in Swedish only)

or depth. Instead, she said, they settled for a capturing headline, and statistics (Christine & Suzanne, 2009). Gustav and Erik also noted that there had been writings in various magazines and papers that were more directed towards the interested public, but Gustav connected with Fredrik's point about the third task above and said that his department did outreach as decided that the higher learning institutions should (Gustav, 2009).

As for why there was not much public engagement going on in Sweden with regards to nanotechnologies and nanosciences, Anders argued that Sweden had not had any particularly controversies related to emerging technologies, though the nuclear power discussion was mentioned, which in the 1970s resulted in much protests and discussion, which in turn caused a general referendum about whether or not to dismantle Sweden's nuclear power stations in 1980 (Anders, 2009)[52]. Anders said that little seemed to have happened since then and that the people's movement that arose out of the nuclear power issue may very well have been a movement that rose out of the 1970s generally. He also said that there had been very little interaction in general about nanotechnologies and nanosciences, but that the Swedish people tended to act around an issue, and that the environment and pollution was an issue that they felt very strongly about rather than technology in itself (Anders, 2009). Christine made a similar point when she recalled how she had been part of public consultation about diagnostics in the 80s following the publication of a paper that argued that a gene for homosexuality had been found. There were interest in their event, much thanks to this bit of research that actually had nothing to do with Christine's research group, but, she said, as long a you are prepared for I, remain fully factual, and avoid ending up in a discussion the event is exactly what is needed. People need to be able to come and ask questions (Christine & Suzanne, 2009). Christine and Suzanne did not harbour a guess at why the public engagement initiatives had stopped suddenly in the 1980s.

[52] The Swedish populace voted to out-phase nuclear power and close its plants over time. Only one of the nuclear power plants actually closed, and following a parliamentary vote in 2010 that resulted in an initiative to modernize the reactors of the remaining plants, rather than shutting them down, it seems unlikely that Sweden will be shutting its plants in the foreseeable future.

Emma, who originated from [country withheld] where more public engagement exercises such as consensus conferences were taking place, said that she had no idea why such events was not arranged in Sweden, but she found it surprising that those working with questions related to democracy in Sweden had not picked up on this (Emma, 2009). Olof's reply to the question was very upfront in that he said that all of Sweden's political parties harboured a tradition for 'vetenskapstro' – belief in science, and 'vetenskapsvänlighet' – friendliness towards science, according to which there were no discussions or engagement with science as it was not considered necessary. And, he said, VA rather gave a pathetic impression as nobody cared about them (Olof, 2009). If you go to universities to ask what VA is, Olof continued, possibly 1 in 100 might know who they are, but 1 in 1000 might know what they do (Olof, 2009). Rather, Olof argued, supporting science is uncontroversial as it is part of Sweden's economic success (Olof, 2009). VA was, according to Olof, set up more in order to have set something like it up rather than to meet a need in a very technologically friendly and science friendly country. The public was not asking for this, he said, and setting it up had in itself been done for 'precautionary' reasons – just in case there would ever be an issue (Olof, 2009).

Olof, Christer, Christine, Ulf, and Emma all made references to surveys into trust run by the SOM Institute at the University of Gothenburg. The survey regularly found that there was much trust for societal institutions, and researchers and academia constantly figured high up in the charts. There was, according to all interviewees, no trust-gap to be discussed in Sweden.

### *6.2.7 Balancing promotion and regulation*

It became apparent as the Swedish field study progressed that none of the interviewees brought up regulation or risks by their own accord, rather the opportunities of nanotechnologies, the importance of cutting-edge science, Sweden's nanosciences and nanotechnologies related research capacity, and the need to move towards more commercialization and innovation were

brought up frequently and by all interviewees. The academics and scientists among them were also keen to explain and discuss their on-going projects and their importance to the advancement of nanotechnologies and nanosciences.

*6.2.7.1 On risks, health and safety, regulation, and the precautionary principle*
Regulation, risks, and health and safety were brought up through direct questions about whether or not risks ever came up during discussions in Sweden, whether or not health and safety was considered, and what – if there was any, the regulatory discussions should look like.

As for the government representatives, Eva, Britta, Ulf, and Emma, said that risks were very important, and said that they were 'managed' or 'dealt with' by KEMI (Eva, 2009; Britta, 2009; Ulf, 2009; and Emma, 2009) or on the EU-level (Emma, 2009). Eva, Britta, and Ulf added that risks and health of safety had to be accounted for in any awards handed out through their funding programmes. However Eva added that discussions regarding whether or not it is ethical to take risks or whether some risks were worth taking were not much discussed. Ethical discussions, she said, came mainly from ethicists themselves, while scientists had shown reluctance in such discussions (Eva, 2009). When asked about whether there had been much discussion about risks in Sweden Christine said *"we only agree on that we aren't any good at taking risks, but we don't discuss how we'll improve on our risk-taking*[53]*"* (Christine & Suzanne, 2009).

Gustav and Erik pointed out that, like in Finland, the only health and safety discussion taking place concerned work in clean rooms (Gustav, 2009; Erik, 2009). This discussion was the same within both academia and Industry (Gustav, 2009), and Anders added that there was a feeling among at least larger companies that not acknowledging that they had thought about risks or health and safety would be 'bad for business' (Anders, 2009).

[53] Translation from Swedish, original: *"Vi är bara överens om att vi är dåliga på att ta risker, men vi diskuterar inte sen hur vi liksom skall bli bättre på att ta risker"* (Christine & Suzanne, 2009)

The only government representative to offer any insight into the regulatory discussion in Sweden, Maja, gave a brief summary of the three nanotechnologies and nanosciences related appropriation directions that KEMI had received thus far. The first concerned an inventory of research and knowledge, while the second aimed to provide a continuation of the inventory. The third and then current appropriation direction requested a study into what kind of regulatory measures would be needed (Maja, 2009). Maja only wanted to discuss her own work and was reluctant to discuss anything conducted by any other group at KEMI. She did comment on REACH however, saying that REACH was quite a challenging legal framework due to its use of weight as a measurement but that it was being revised on the EU-level (Maja, 2009). With regards to the cosmetics directive, Maja said that it was for the Medical Products Agency (Läkemedelsverket) to look into, but that KEMI was being kept informed and had offered support in their discussions (Maja, 2009). With regards to health and safety, she referred me to the Swedish Work Environment Authority (Arbetsmiljöverket), but said that she had not heard much about any progress made on their part (Maja, 2009). She was reluctant to answer questions about how she felt the collaboration between different departments were going, but said that she worked closely with the Ministry of the Environment. Finally, Maja also refrained from commenting on whether or not she found the discussion in Sweden balanced with regards to innovation and regulation, but said that she 'felt' that there was more emphasis on innovation (Maja, 2009).

Erik, the only scientist interviewed with a research interest in nanotoxicology, recalled the first KEMI appropriation direction and the large survey of nanotechnologies and risks that it had initiated. He said that the result of the study was that Sweden should consider writing a strategy and that KEMI would continue to carry the responsibility for questions regarding risks and regulations. However, he said that Sweden – being quite progressive with regards to the regulation of Chemicals, had not yet engaged much with these issues and seemed to wait for the outcomes of regulatory discussions in the EU. Erik also agreed with Christine and Suzanne in saying that the many

unknowns with regards to nanotechnologies and nanosciences made it difficult to regulate, and that this might be a reason for delays (Erik, 2009). Emma agreed with his point but continuously pointed towards either KEMI or regulatory discussions on the EU-level, and said that it is unlikely that all uncertainties would be transformed into certainties before there were regulations applicable to the nano-scale (Emma, 2009)

*6.2.7.2 On business interest, innovation, and commercialization*

The main points made concerning innovation related to how Sweden was trying to develop a strategy, or should develop a strategy, for instance by starting to list strategic research areas – which Sven argued was partially a result of the IVA-strategy (Sven, 2009). Other interviewees such as Christer, Fredrik, and Britta also highlighted the IVA-report and said that it had been useful in marking the importance of the 'nano-research area' (Christer, 2009; Fredrik, 2009; and Britta, 2009). Eva agreed, and called it a stepping stone towards the Swedish strategy that was being developed. That the strategy it was being developed by VINNOVA was also significant in that there would be an emphasis on innovation, strategic thinking, and industrial interests (Eva, 2009). Further, the strategy was going to include materials developed through engagement with industrial entities and also academic institutions, which would make it more robust and useful as a tool for innovation (Eva, 2009).

Suzanne and Christine were quite eager to see a strategy that included a strong innovation element, and had tried to connect with the relevant government agencies to make this point. They wanted to ensure that decision-makers would know how to best support innovation and called for an innovation system that would be less top-down and allow for a bottom-up approach and researcher-led initiatives. *"For instance, what we are currently doing with* [smart materials] *nobody would be able to say that there should be a new strategy here and that we are going to use these* [smart materials] *to communicate with cells, that is something only* [name of colleague] *and I*

*would have been able to come up with*[54]*"* (Christine & Suzanne, 2009). Christine and Suzanne's point echoed Christer's point about the need for bottom-up initiatives.

Concerning business interests and commercialisation, both Gustav and Christine said that though companies were interested, there were few products on the market yet due to nano-enabled products still being on a developmental stage (Christine & Suzanne, 2009; Gustav, 2009). All academics, including Britta who did primarily basic research, had industrial ties. In conducting research for the Swedish Health Care Service, Britta was not financially dependent on the Health Care Service, but appreciated their input into her research (Britta, 2009). Erik had a similar relationship to industrial entities in his region, but it was one that was mainly about exchanging information. He said companies, particularly larger companies, were interested in information about life-cycle assessments and toxicology as related to nanoparticles in products such as food packaging, but that they did not have common projects (Erik, 2009). It seemed as if further engagement could be a desirable prospect for industry and commercial entities as well given the right 'business friendly' circumstances.

*6.2.7.3 Not striking a balance*

This study found no evidence of a balanced discussion that included both regulatory issues and innovation in Sweden, though the very fragmented governance system made it difficult to fully grasp the extent of the inbalance, and it is possible that a different set of interviewees could have drawn a different picture. However, the interviewees chosen for this study had very little to say about regulation, risks, or health and safety, and that they were critical about the slowness and way in which the push for innovation was taking place. It also seemed, and Christine said it directly, that Swedish nanotechnologies and nanosciences R&D was still in an early phase, and that

[54] Translation from Swedish, original: "*Och det här som vi nu gör med de [smarta materialen], ingen människa hade kunnat stått och sagt att ja vi ska ta en ny strategi här nu ska vi använda [smarta material] för att börja kommunicera med celler, det kunde ingen annan än [kollegans namn] och jag komma på* " (Christine & Suzanne, 2009)

it, therefore, was not possible to discuss risks much, and that things would look quite differently in a few years' time.

## 6.3 Nanotechnologies and nanosciences policies in Sweden

The main points drawn from the Swedish field study was that Swedish decision-making was very fragmented, and that Bergström's notion of horizontal issue remained a reality in Sweden. There also seemed to be support for his description of the 'vertical issue', especially in so far as the communication between the agencies and the ministries is considered on the basis of the interview held with Emma, who did not seem aware of much of what was going on at the relevant agencies. Though there seemed to be a willingness to bring more actors into the policy-making landscape, at least based on the repeated calls for further engagement between academia and industry as noted during the interviews, the Swedish strategy was written by representatives from a number of government agencies alone. That there had been hearings that included academic institutions and industrial representatives, was made clear, but where their actual input informed the policy was not obvious, nor had the 'inclusiveness' stretched to include NGOs or civil society. In fact, society seemed quite absent in Swedish science governance over all.

Borrowing Gergils concept of linear models and applying it to decision-making, the Swedish top-down rather than bottom-up way of policy initiation seem to follow the model rather accurately which would be in line with Bergström's critique regarding 'old administrative structures' that interfered with collective decision-making. It is likely that the same structures appear in government agencies as within the Government Offices themselves. It seemed in Sweden as if every actor had his and her own purpose and worked independently but with little coordination among them. The importance of having a PhD or the right education in order to he perceived to have the 'authority' to comment or work on certain issues also seemed rather old fashioned.

With regards to the balancing act between promotion and regulation, no such balance could be found during this study, and the Swedish strategy does not appear balanced either. However, with the institutional fragmentation within the government machinery and among academic institutions, and the weak NGOs and lack of public input, it is not entirely possible to draw conclusions as to whether the balance is due to risks and regulation not being considered important in Sweden, or whether the lack of balance is due to difficulties in communicating between actors in a R&D and science governance system that is very difficult to overview and navigate. Either conclusion could have an element of truth in them, and it is possible that the lack of input from the public or NGOs may not in itself be a sign of a troubled or undemocratic system. After all the lack of a trust gap may be a sign of health in terms of good governance that has managed to achieve its 'goodness' on other grounds than pushing for public engagement and events that 'the public has not asked for'.

Tellingly about the lack of overview in Sweden; during our interview in Finland and as he had filled me in on Tekes' Nordic collaborations, I asked Kari, the Tekes representative, whether he knew what was going on in Sweden with regards to nanotechnologies and nanosciences investment. *"I hoped you would tell me that",* Kari said (Kari, 2009).

## 6.4 Mode 2 and Strategy in Swedish nanotechnologies and nanosciences

With the fragmentation and lack of coordination, filling in Sweden's Themes Matrix leaves it looking like this:

TABLE 6.2: THEME MATRIX - SWEDEN

| Themes Matrix: The governance of nanotechnologies and nanosciences | |
|---|---|
| **Organisational diversity** | |
| a) Inclusion | Not sure |
| b) Interaction – trading zones | No |
| c) Openness and transparency | Sometimes |
| **Social accountability** | |

| | |
|---|---|
| a) Trust (among the public) | Yes |
| b) Public engagement | No |

A fragmented innovation system and nanotechnologies and nanosciences investment seems badly coordinated and is governed by fragmented decision-making. Though numerous actors are interested in nanotechnologies and nanosciences within academia, government, and industry, little was done (at the time of the interviews at least) to coordinate their efforts or interests. Likewise, little evidence was found to support any claim for public scrutiny playing a part in Swedish technologies and sciences generally, which was also true for nanotechnologies and nanosciences.

As for relevance and excellence, it seemed as if Sweden was focusing more on excellence than relevance, in a completely opposite move to their Finnish neighbours; and it may very well be that Sweden is locked into old science governance structures that has a sense of Mode-1-ness about them. Academic rewards being priced higher than strategic rewards among academics, or the accusation thereof, could point in this direction – and the notion gains support in the lack of industrial-academic interaction, which was mentioned repeatedly in interviews. Not formulating a strategy and not acting on proposed strategies could also be an indicator of the lack of 'relevance'-oriented thinking within Swedish science governance at the time. Overall, nanotechnologies and nanosciences do not seem to have been flagged up as 'something special' in Sweden that would have warranted a concentrated effort and increased investment.

The lack of operational diversity and interaction, public scrutiny, and strategy alongside a linear innovation system add up to something that seem more Mode 1 than Mode 2 as far as Gibbons et al.'s models of science governance are concerned. It is therefore not necessary to consider whether or not there has been a shift at al. Sweden similarly does not fit in with Rip's idea of Strategic Science, at least if nanotechnologies and nanosciences are considered an example of the Strategic Science model. The complete lack of strategic thinking or efforts, the fragmented and badly coordinated

governance system, and the linear innovation system would point in this direction. A majority of the interviewees do, however, seem eager to move towards a more strategic governance of science, which, should the fragmented system one day become more coordinated and flexible, could result in a move from what seems like a very linear innovation system to a more lateral such system.

## Chapter 7: IPA Case study

*This rather short chapter aims to provide an interlude in the shape of the IPA Case study. It has been given its own chapter in order to differentiate between the case study and the field study.*

### 7.1 IPA Case study

The themes chosen for this study have been explored through a large number of interviews, for which a number of central points have been summarized in the end of each chapter in Section 2. There are clear differences in nanotechnologies and nanosciences decision-making in the UK, Finland and Sweden, and there are also differing opinions and perspectives evident among the interviewees within the same country. While some of the interviewees found the semi structured style of interviewing more challenging and would have preferred a more structured interview with clear questions that left less room for discussion and reflection, other interviewees offered a more thorough glimpse into their own experiences of the decision-making environment. With the rich material available for a number of the interviews, and as it would provide not only a more interesting and substantial cross country comparison, this study will include a short IPA case study that includes one interviewee for each country.

The case study is based on the original interviews held with Scott, Jari, and Christer, for which a shorter part of the interviews have been chosen for IPA treatment. As richer accounts were given primarily when interviewees were unhappy about an event related to policy-negotiation, three ‘unhappy’ experiences have been chosen. The focus here is not on that their experiences were unhappy, but rather what made the interviewees unhappy or frustrated enough to single the events out as an ‘adverse event’, and how they moved on from that specific event. How they dealt with their own role – or saw their Self in the events differently is interesting to this study for the sake of comparison, as all three are still involved with nanotechnologies and nanosciences policy-making, or at least policy-advice on a national level in each of the three countries.

*7.1.1 IPA Case Study: Policy-negotiation as an adverse event*

With regards to their characteristics, there were quite a few similarities to be found between Scott, Jari, and Christer. Firstly, all three are senior scientists that have served in an advisory capacity to their respective governments or government agencies. Scott received some form of financial compensation for his work as related to Research Councils, Jari was employed directly by the government, and the government through the university that employed him paid Christer's salary. Though they belonged to three different academic disciplines, all three were closely associated with nanotechnologies and nanosciences, and all three had been part of policy-discussions and negotiations. Secondly, concerning the chosen interview extracts, all three interviewees were unhappy, and their unhappiness was due to their advice not being listened to, and all three wanted to talk about their unhappiness and explore that particular experience. Indeed, in Christer's case, much of his interview concerned this one experience, while for both Jari and Scott, it was a shorter period of reflection but still long enough for an in-depth reflection to take place, and one that would capture their experience and sense of self in these particular policy-making contexts. Finally, all three interviewees responded to variations of the same question – *Do you feel that your contribution is listened to?* The question could be considered too closed for an IPA study – where a better question would have been *Tell me about what it is like to be an advisor*, but it worked in an open-ended enough fashion in all three interviews and the interviewees took the opportunity to go into depth on the experience through providing an example of a time when they had not been listened to.

In analysing the data for each transcript, the methodology used is described in Chapter 3. A number of super-ordinate themes and themes were grouped together into a Master table of themes for the group, which is included in Appendix II.

*7.1.1.1 Scott and the UK Strategy*

As described in Chapter 4, Scott had been much involved with many of the policy-discussions in the UK that led up to or were fed into the UK Strategy. Scott also had a past and present in industry and particularly in Spin-off projects. Scott's experience related to how the Mini-IGT Report, which he had been much involved with in developing, had not been taken any notice of when the UK Strategy was written. Answering the question about whether he felt that his advice was being listened to, Scott said:

*"Seriously, when BIS brought out a strategy document on nanotechnology* [UK Strategy]*, um, about 18 months ago. It was one of the worst written documents I've ever seen, so it didn't say very much for their standard of report writing. But worse than that, the person who wrote it didn't understand what the word strategy meant, which is pretty serious and, um, all it recommended at the end of the day, was setting up of more committees. Not abolishing some, but setting up even more [laugh], as though that solved a problem. And hardly any notice was taken of, uh, our, advice from, uh, a report which came out at about the same time, in fact, I know they saw it, because I saw the drafts on my email. There was a thing produced by the Technology Strategy Board, Knowledge Transfer Networks, called the Mini Innovation and Growth Team Report on Nanotechnology. It was ignored, and the strategy document was watered down to something [laugh] and really vague."*

Though Scott 'laughed' during the interview, they were not particularly happy laughs, rather they were laughs of disbelief, which was a theme running through much of Scott's account. He was clearly finding it very difficult to understand why 'hardly any notice' had been paid to 'our advice' despite clearly having seen that their advice had been read. Scott brought up a number of themes in this extract that are also visible in other parts of his interview. One of the more central points to his account was his place in the situation, and he continuously brought up the differentiation between 'him' and 'them', or 'us' and 'them' event though he had been much involved with the advice that was to be fed into the report, this extract clearly marked that being advisor was not the same as being a decision-maker, and that the 'report writer' had not done a good job at all. This also tied into a longer extract with regards to the lack of 'proper degrees' (as included in the field study) among the advisor employed in the civil service, and the lack of scientific backgrounds in the CVs of UK politicians. The clear pointer towards the lack

of expertise among those making decisions was, it seems, Scott's way of trying to understand why his advice had been ignored. He made several references to the slowness in government action, and his point about 'setting up more committees' was one marker of this sentiment.

That Scott realized that 'they' had seen the Mini-IGT report by seeing drafts in his inbox connected to another theme in his account, which was the lack of transparency and feeling left out. This made him reflect on the access to information in Government:

*"Um, it's easy to find out what's going on if you approach through the Research Councils and the TSB because they have been very effective in communicating. Their websites are full of stuff, um, and they have regular meetings, so its very easy. But they're hamstrung by what, uh, Treasury releases to them and those decisions are made at a higher level, and its very hard to penetrate what thoughts are going on at that high level"*

Hierarchy was another theme that ran through Scott's account, and he clearly set the lower levels of decision-making apart from the higher levels in the hierarchy with regards to transparency, and he was concerned about cuts at short notice – which he later said would not have happened in the US without being discussed with other instances first. The vague result of the policy-making process that preceded the launch of the UK Strategy had left Scott disappointed and with a hurt sense of achievement. However his mood changed during the interview:

*"And, um, I've been trying to make the current government aware of the mistake they're making with this, and I do see a possibility of a turnaround now, in this. And the other thing that I think is happening is a realisation that it is not the nano technology that you push; what you do is, you push all the sector areas, and use nano technology to provide the solution. So I think this …it's taking a long time for the message to get across."*

From his account it seems that Scott expected to be listened to in his capacity as an advisor and that his input should have some authority. With the previous government having made the mistake, it seemed as if Scott had dusted himself off, rolled up his sleeves, and made a fresh attempt at getting listened to by rehearsing a sound bite that he wanted politicians to understand

'what you do is..'. He also underlined that he saw a change in government – e.g. a change in 'them' as a potential way of moving ahead, despite also having complained about the same government's budget cuts. This, he also stressed, was only in so far as the government would take more interest in the topic and not leave this in the hand of the civil service.

Scott's account marked how he did not trust decision-makers or the decision-making process much, following an incidence (and possibly other incidences) where he had offered advice or input that it later turned had not been listened to. When considering why the adverse event had taken place, Scott was quite determined to focus on what he thought was wrong with the 'other party', at the same time as he justified why his input was required in this policy-making context, e.g. he had the education, expertise, links with business, understood what was going on etc.

*7.1.1.2 Jari and Nanosafety*

Jari was a senior scientist working specifically on nanosafety and health and safety issues for a governmental research institute linked to a government agency. He had represented Finland internationally, and the institute and agency nationally with regards to nanosafety issues, and he had been appointed as an advisor on nanosafety and health and safety during policy-discussions in Finland.

Jari's account was one of confusion as he assumed two Selves - which in itself was a theme - during the first half of the interview, the government official that was paid by the government and representing government interests, and Finland overall – and the government employed scientist who happened to do research into an area that was not really of interest to the government. Eventually, Jari mainly assumed the latter role, especially when his domestic work was being discussed and the question about whether or not he was listened to was asked:

*"Well, they ask for my opinion but they don't take it into consideration, like when we had a meeting [at his institution] last spring. It was attended by*

*Tekes, and a Centre of Expertise, the Nano-cluster program, and the Academy of Finland and some other organisations. After our discussion all these organisations, er, identified nanosafety as a very important issue, but none of them was ready to take an overall responsibility for safety in nanotechnology. So for the time being there is really no organisation in Finland who is willing to take overall responsibility for the safety of nanotechnologies.[55]"*

Jari had attended the meeting as an advisor, and he carefully expressed some frustration and disbelief at the lack of responsibility for this within government, by for instance mentioning it twice. He also said that there would be no funding available for nanosafety research following the end of the AF FinNano programme, and that nanosafety should be considered 'applied science' anyway, but that it could not fall into Tekes FinNano as the programme was going to change into one supporting only commercialisation in 2008. This particular statement was followed by a sigh, and he continued by saying that:

*"And Tekes policy is that what's interesting to companies is interesting to Tekes. And that what's not interesting to companies is not interesting to Tekes, it 's always been like that… it has always been extremely difficult to get any money from Tekes to do research on safety on nanotechnologies and actually frustrating. But it's the way it is. And our Institute have got some €60,000 so it's… well, it's money of course, but it's not enough, I think.[56]"*

After a short pause he continued:

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[55] Translated from Finnish, in original: *"No niin, he kysvät mielipidettäni, mutta eivät ota sitä huomioon, kuten kokouksessa viime keväänä. Mukana oli Tekes ja Nano-cluster…, Nano-ryhmäohjelma, Suomen Akatemia ja muutama muu organisaatio. Keskustelun jälkeen kaikki nämä tahot, hm, totesivat nanoturvallisuuden hyvin tärkeäksi aiheeksi, mutta kukaan heistä ei ollut valmist ottamaan vastuuta nanoteknologian turvallisuudesta. Siten tällä hetkellä Suomessa ei ole organisaatiota, joka on halukas ottamaan kaiken kattava vastuun nanoteknologioiden turvallisuudesta."* (Jari, 2008)

[56] Translated from Finnish, in original: *"Tekeksen menettelytapa on saada yritkset kiinnostumaan Tekeksestä, ja se mikä ei kiinnosta yrityksiä, ei kiinnosta Tekestäkään. Niin on aina ollut. On aina ollut erittäin vaikeaa ja todellakin turhauttavaa saada rahoitusta Tekekseltä nanoteknologioiden turvallisuustutkimukseen. Niin se vain on. Laitoksemme on saanut noin 60 000 €, mikä on… no onhan se tietysti tyhjää parempi, mutta mielestäni ei tarpeeks"* (Jari, 2008)

*"You think that with all the… all investments for these past years in nanotechnologies, and still, in Finland, it [nanosafety] gets about 1% of the whole investment. It doesn't look very good.[57]"*

One theme found in the extract of Jari's interview that was particularly related to his dual identity as both an advisor and scientist. He also sat on a governmental board, which, due to the nature of its purpose, to some extent also made Jari a decision-maker. This gave him another role, but it was not enough to contribute to his sense of 'self' in his professional life. Other themes that came out of Jari's account were related to the misunderstanding of the purpose of nanosafety research. He particularly mentioned Tekes focus on commercialisation and innovation and how that did not include nanosafety, though Jari thought it should. He did, for instance point out that while Tekes did not want to invest in nanosafety, while they wanted to appease industry, large companies invested in nanosafety, but did not share information with him or his colleagues. In Jari's opinion this should be a reason for Tekes to take financial responsibility for nanosafety too. 'Responsibility' was a word that was mentioned very frequently, and it was clear that Jari felt that the government agencies through their power in directing Finnish research and innovation also should be taking responsibility for the research areas less obviously linked to innovation. Jari made it clear that he felt that his discipline had been left out, and that he had not been listened to, but he understood why that was. He did not passionately criticise the way government agencies made decision or complain about any lack of transparency in Finnish science governance. Rather, he gave the impression of acknowledging that 'it had always been like this', and he made no suggestions of how to change it, or that he intended to bring this up with anyone. Indeed, one theme that appeared in Jari's account, but not in Scott's was one of 'Acceptance' for the situation as it was.

Jari did not express any opinion or view that could be interpreted as one of 'distrust' for decision-makers. He just indicated that he wished they had

[57] Translated from Finnish, in original: *"Ajattele kaikkia viime vuosien investointeja nanoteknologioihin. Silti Suomessa se (nanoturvallisuus) saa noin 1% kaikista investoinneista. Ei näytä kovin hyvältä."* (Jari, 2008)

prioritised their funding decision differently, and that the organisations present at the meeting should have made a different decision with regards to taking responsibility for nanosafety and nanosafety research.

*7.1.1.3 Christer and a failed bottom-up attempt*

Christer was also a senior scientist, and had similarly to Scott and Jari been an advisor on a range of committees and boards, including the board of NFS (Swedish Research Council – which later became a part of VR). Christer was particularly unhappy about an experience from 2001 in which he, with a group of colleagues from other parts of Sweden, had tried to influence policy by initiating it bottom-up. This was meant to be the first step towards a national nanotechnologies and nanosciences strategy, and the group feared that as they found the change from NFS to VR disorganized, and unless they gathered forces and did something about it, Sweden might miss out of a nanotechnologies and nanosciences boom. Having written a plan of action for nanotechnologies and nanosciences, at a summer cabin, the group gathered to approach decision-makers and funders, but got what Christer called a 'chilled' response. Accounting for an attempt at gaining support for the action plan, which was going to be their last, the group met with the Director of an important funding body:

*"(…) and there we were discussing with her, and she sits and goes like – But my goodness, none of you is even a vice provost!* [pause] *That kind of tells you (…) well at least that was the worst cold shower I've had with regards to, and I've had more cold showers, but I actually, but, I thought it would be an advantage for us to turn up as researchers, and not as administrators, but apparently that didn't work in her worldview then eh, but we felt everything fall to pieces, and I guess our activities decreased after that. And we had even organized a conference and appeared in popular media (…)*[58]*"*

[58] Translation from Swedish, in original: *"(…) där sitter vi och pratar med henne och så sitter ho så här – Men Herregud ingen av er är ju ens vice rektor!* [paus] *Det talar om liksom det (…) men i alla fall det var den värsta kalldusch jag har fått när det gäller, ja jag har ju fått fler kallduschar i livet, men jag riktigt, men, jag trodde ju liksom att det faktiskt var en liten merit att vi var där som forskare och inte som några administratörer men, men så fungerade det inte i hennes världsbild då va, fast att då kände vi liksom hur hela alltihopa rasade ned och, och då minskade väll våra aktiviteter efter också. Och vi hade ju ordat konferens och varit med i populära skriverier (…)"* (Christer, 2009)

The experience had very clearly left its mark on Christer and his colleagues, and smarting from this one experience became a theme he returned to as it affected his view on the work on the IVA strategy (2006), and the Swedish strategy (2010), of which he took part or was consulted. Getting a cold shower, in Swedish, means that you are experiencing a shock in a negative way, and it goes some way in describing how Christer felt about the experience. In fact, feelings such as 'disbelief', 'disappointment' and 'rejection' is a theme that goes through his account of this event but also the rejection associated with the IVA-Strategy where he had first expressed hopefulness at everyone getting together to talk about a strategy again, and that the chair of the group was an IVA representative who was also rooted in industry – and therefore, the group was 'not just academics'. Multi-partner collaboration is identified as another theme in Christer's account and he related to such collaboration as being unique in Sweden. However, the IVA-strategy failed, according to Christer, as everyone - e.g. Research Council representatives, other government agency representatives, academics, IVA, and industry, pulled in their own directions and guarded their own territories too fiercely. This pointed to another theme in Christer's account, which was connected to the uniqueness in multi-partner collaboration – Old fashioned thinking. Old fashioned thinking and territorial thinking is something Christer returns to frequently as a reason for the lack of collaboration between actors in policy-negotiation. Tied to the theme is also the view of mid-career or senior researchers who were not yet made vice-provosts that seemed obvious at least with the Director of the Funding body that they visited. The sense of not being listened to, especially when it really mattered – for Sweden, was a painful memory for Christer.

Christer also found that bad communications between academia and decision-makers could be to blame, and he said that it is possible that the group also did a poor job out of communications. Jari and Scott had not shown similar doubt in their own actions, but it is likely that Christer had thought about these events for some time due to it being quite a traumatic memory.

In searching for reasons to explain the failure in formulating a Swedish Strategy, he was clear to point out that he did not think that the decision-makers have been 'difficult' on purpose, and said that he really did not have any issue with any one of them. He had, for instance, met the Director again during the IVA-Strategy discussions, and was happy to see her there. Christer did not make any statements that would imply that he held any mistrust for the various actors involved, but he did underline how he would like a bottom-up approach to be possible in Sweden, and that getting an overview of policy-making was quite difficult. However, he said, and offered insight to this study from a country-comparison point of view:

*"As researchers, I think we are quite similar in all three countries* [Sweden, Finland, and the UK] *as individuals that is, but then we're obviously locked into our systems* [of science governance*], and it's impossible to get away from all of that.*[59]*"*

*7.1.2 Bringing their views together*

Each experience described in the case study needs to be evaluated in its own right and within its own context. However, their experiences offer a glimpse of the differences in the decision-making climates in the UK, Sweden and Finland, which confirm observations made during the field study. A very limited and personal account that the recollections of one isolated experience is may not say much about other potential explanatory factors than those mentioned or 'felt' by participants, however, which is a limitation. The limitation does not invalidate their accounts however, but while it is impossible to say much about the push for commercialization or centralized science governance in Finland based solely on Jari's account of this one experience, when put together with what the interviewees in the field study (including Jari) had said about the innovation push and centralized governance, this provides a more nuanced picture.

[59] Translation from Swedish, in original: *"Som forskare så vågar jag tro att vi är rätt lika i alla tre länderna, alltså som individer, men vi är naturligtvis låsta i vårt system och allting sånt där så det kommer man inte ifrån alls."* (Christer, 2009)

The case study particularly highlighted the difference in settings within which decision-making is taking place and how each interviewee, all members of that setting through their advisory capacity and 'expert label' related to a conflict or adverse event in that given setting. Particularly with regards to the UK decision-making setting, Scott seemed to expect that his advice would be heard and acted upon due to his being an expert and appointed as such. Scott did not criticise the system, but focused on the failings of people or groups of people employed within Ministries. However, put together with the actual decision-making system in place in the UK, the Ministries make the decisions, through their elected politicians, and neither the politicians themselves or the Ministry employees, in Scott's view, are experts. That Scott therefore expected that expert views would carry more weight may therefore not be surprising. That said, Scott was probably not the only expert consulted for the writing of the UK Strategy.

Jari on the other hand did not seem to expect his opinion to be guiding decision-makers, but he did expect it to be taken into account as he expressed disappointment at nobody taking responsibility for nanosafety. However, he framed his disappointment more as directed to the area of nanosafety than as disapproval of his own contribution, and did not necessarily take the lack of response as personally as Scott did. Rather, he accepted the situation by shrugging and saying 'It's just the way it is', after which he moved on to another topic. It seemed as if the Finnish science governance system did not really invite disagreement, but then Finland was very much centrally governed by a 'club' whose members were considered 'experts'.

Christer, on the other hand, was very frustrated, but more at the Swedish system of decision-making that did not take account of the importance of enthusiasm as expressed through is attempt at a bottom-up approach. He also delivered a critique to Sweden's lack of collaboration, which was due to fragmentation and old fashioned thinking. Yet, he had made new attempts, despite having been rejected, and it did not seem as if Jari's acceptance would have been an appropriate way forth in Christer's view. Sweden did not,

after all, have a centrally governed system, and it seems as if Christer and his colleagues thought that there might be room for manoeuvring provided that the many partners in the fragmented science governance system in place were on-board and understood the value of collaboration. Nor did he question the professional conduct of anyone that was involved with the rejections.

### 7.2 Mode 2 and Strategic Science in the IPA case study

The case study confirmed the findings presented in the three empirical chapters with regards to the state of science governance in Sweden, Finland, and Britain, though some of the themes were explored in greater detail, and could offer explanation to previously presented features. One example of this came through in Christer's experience of trying to initiate a Swedish nanotechnology strategy. It illustrates the lack of lateral thinking and fragmentation noted for Swedish science governance and innovation rather clearly, and the experience and repeated experiences over time, does suggest that there may be structural, cultural, and historical reasons to the way nanotechnologies and nanosciences were, and possibly still are, governed. A similar observation can be drawn from Jari's account of Finnish science governance in that though there seemingly are efforts to engage with multiple stakeholders and views, in the end Tekes' interests and expertise seem to prevail above that of the experts they consult. Scott also made a similar comment in feeling that he had not been listened to as the Mini-IGT report – in his opinion – had been little but ignored in the development of the UK Strategy. Further, both Christer and Scott clearly expected to be listened to as they were portrayed or portraying themselves as experts, which says something about how science governance is expected to be expert-driven. Jari also expected that his advice and opinions on nanosafety would be considered, though unlike Christer and Scott, he did not seem as certain about actually being listened to. As illustrated through these examples, it seems as if engagement and interaction – where it exists, may be conducted for the sake of doing it, which puts the role that increased inclusion of actors play in modern science governance into a different perspective.

Further, as far as relevance and excellence were concerned, Christer's case did not illustrate an environment that was particularly interested in nanotechnologies and nanosciences, whether relevant or excellent, while Jari's experience portrayed a governance system where relevance may be in the eyes of the beholder. Tekes' idea of what was relevant was clearly different to Jari's idea of relevance in nanotechnologies and nanosciences R&D, though there was some overlap. Investment into excellence that is relevant could be considered a step in the direction of Strategic Science however, had there also been more genuine interaction between actors and public scrutiny.

As for the UK, Scott came across as a spokesperson for relevance more than excellence in its own right. But again, the idea of what was to be considered relevant differed between his own interpretation and that of decision-makers. This said, of the three interviewees, Scott seemed to operate within a system that was functioning more in line with what outlined in the Strategic Science model and Mode-2 notion, as he – despite his disappointment, remained positive about being able to have an impact. He also described a more lateral innovation system where interaction, operational diversity, and public scrutiny and accountability was to be expected. Scott's account indicates that the British system may be more flexible than those of the two Nordic countries.

# Section three: Comparisons and Conclusions

*This section gathers three chapters that aim to offer a comparison between countries that is supported by both the field study as presented in Chapters 4-6 and a case study conducted through IPA – Interpretative Phenomenological Analysis, as included in Chapter 7. Secondly, Chapter 9 will connect the empirical findings to the main theoretical contribution that this study has sought to make to STS-research. Finally, Chapter 10, will offer the overall conclusions for this study and discuss potential future research directions.*

## Chapter 8: Cross-country comparison

> *This chapter aims to capture a comparison between the three chosen countries for this study. The comparison will rest on the field study, but also on a case study that includes extracts of three interviews – one for each country. The chapter will look back at the research question and the theme matrix as presented in Chapter 2 before offering a comparison in relation to the themes for the study.*

### 8.1 Comparisons and contrasts

A cross-country comparison does not look as systematic when done through qualitative studies as they do in quantitative studies. The reason is that the accounts provided by the interviewees for the field study and for the IPA case study are not quantifiable, black or white, or easily attributed to ‘yes’ or ‘no’, or 1s or 0s. Indeed, the theme matrix as presented in Chapter 2 was created to serve as a mind-map rather than a matrix where each country could be crossed against whether or not their nanotechnologies and nanosciences governance system was adhering to the attributes marked for Mode2 knowledge production and Strategic Science, here Organisational diversity through for instance ‘interaction’ and Social Accountability by ‘public engagement’. Rather, the qualitative approach offered a more nuanced picture, with grey scales, that are not done justice by the matrix. However, it will be used as a springboard to discuss and present the outcomes of this study, and to guide the conclusions in Chapter 9.

*8.1.1 Revisiting the research question and themes*

Deriving from the pre-2008 literature review, the research question figures within the assumed context of a science governance setting that is increasingly heterogeneous, transdisciplinary, accountable, and quality control oriented:

*How do decision-makers perceive their own roles and the roles of others in the nanotechnologies and nanosciences policy discussions, particularly in relation to the balancing of promotion and regulation*?

The question, with its assumption in the background obviously assumes that the science governance world was more heterogeneous, transdisciplinary, accountable and quality controlled. In that Gibbons et al. and Nowotny et al.'s Mode1/Mode2 thesis did not build on empirical data, such an assumption would be premature. And as was shown during the pilot study, there was little evidence of similarities between Finland and the UK with regards to organisational diversity and social accountability, which therefore rendered the two interesting for further study. The attempt here was therefore to ask the research question based on the assumption of organisational diversity and social accountability, which also suited a number of other themes that came out of both the literature review and the pilot study. The themes that came out of the literature review were particularly related to the trading zones for nanotechnologies and nanosciences policy-making, and whether the inclusion of a broader variety of actors had resulted in more robust policies. The first theme would be included within the enquiry into organisational diversity. The other theme regarded a 'trust gap' and whether or not such a thing was visible in Finland and Sweden, and if so, what role science communication and public engagement efforts might have to bridge the gap. This would fall under 'social accountability'. The pilot study reaffirmed that the themes already listed were of interest to pursue due to the differences between Finland and the UK.

Finally, in an attempt to operationalize the matrix, a set of questions used to measure social capital were modified to suit the study and to serve as a template for the formulation of interview questions. The reason for the use of

the questions – which were developed for community based research, was that the context for research was not dissimilar, and the themes followed by Dudwick et al. (2006) to measure social capital and under which their questions were formulated were not very different from the themes included in the matrix below, namely: networking, trust, collaboration and cooperation, communication, social cohesion and inclusion, and empowerment. The questions and their re-working into questions suitable for this study are listed in Chapter 2.

Worth noting is that the aim of this study was not to outright verify or over-throw NPK or any other theory or idiom, but to use them as reference points for the exploration of the research question and to explore whether any of the empirical work conducted could support the claims made in the Mode 2 and/or Strategic Science models. Nor is the study aiming to be exhaustive in the features listed under 'Organisational diversity' or 'Social accountability', but the features of each of these assumed characteristics in modern science governance are determined by the themes that emerged and were accounted for in Chapter 2.

Table 8.1 shows what the Matrix looks like when filled in on the basis of the empirical findings of this study. Each entry will be discussed separately below.

TABLE 8.1: THEME MATRIX FILLED IN

| Themes Matrix: The governance of nanotechnologies and nanosciences | | | |
|---|---|---|---|
| *Country* | *UK* | *Finland* | *Sweden* |
| **Organisational diversity** | | | |
| a) Inclusion | Yes | Maybe | Not sure |
| b) Interaction – trading zones | Yes | Yes | No |
| c) Openness and transparency | Often | No | Sometimes |
| **Social accountability** | | | |
| a) Trust (among the public) | Yes | Yes | Yes |
| b) Public Engagement | Yes | No | No |

*8.1.2 Inclusion*

As the first part of the research question concerns the roles of the actors involved with policy-discussions, their views on their roles became the subject of one of the first questions asked during interviews. It was essential to understand their perceived roles before organisational diversity could be discussed, and the discourse soon fed into accounts about inclusion in policy-discussions.

All interviewees, regardless of country, identified themselves as being either scientists, government representatives, industrial representatives, representatives for civil society, consultants, or representatives for professional societies; the latter three roles have been considered 'other' in this study. Their identification as belonging to these roles were also the basis for which their inclusion into the study. That said, when asked to elaborate on their involvement with policy-making or discuss their input, many of them had a footing in some of the other roles, most commonly academia through previously obtained degrees or research conducted within academic institutions. Having an academic past, and preferably a PhD, was particularly important in Finland, and to some extent in Sweden, in order to be part of policy-negotiations or to have anything to do with nanotechnologies and nanosciences policy-making. Some, particularly interviewees in the UK and Finland, also had close bonds with industrial entities, such as Spin-off companies. The country that had interviewees with the most varied professional backgrounds was the UK, where interviewees also had the greatest variation with regards to opinions and comments. Despite being fewer in numbers, the UK interviewees rarely provided identical answers to interview questions. A greater number of interviewees in the UK confessed to being part of policy-negotiations, consultations, and hearings, while there seemed to be considerably less such platforms for interaction available in Sweden and Finland, and interviewees claimed to have more specified roles. Interviewees that had been approached to advise policy-makers in Finland and Sweden often offered a careful account of why they had been asked, whereas this was not really the case in the UK.

As for their inclusion into policy-negotiations, the policy-making environment in the UK seemed very broad in the sense that a variety of actors were consulted or included in the decision-making process – either directly from around a table, or through hearings or reports that were fed into policies that were decided on by the UK decision-makers. The decision-makers in this sense were the UK Government through its ministries. The broad inclusion criteria catered not only for government representatives, industrial entities, and academia, but also for civil society, which is something that did not happen in either Sweden or Finland. However, as became clear in Scott's account presented in the case study, advice was not necessarily listened to and decision-making was very much left in the hands of politically elected non-experts who could choose how or if to include expert advice in their decisions.

The decision-making power in Sweden and Finland was more expertise-driven, where influential government agencies had the mandate to make decisions on behalf of the less powerful – e.g. politicians who lacked the necessary expertise. However, while Finnish science governance seemed to be very centralised and where all interviewees pointed at Tekes as the government agency with the most 'power' in decision-making, the Swedish system of governance was less centralised and a fragmented infrastructure that proved difficult to research. Christer's account of how the fragmentation made it very difficult for Sweden to produce a national nanotechnologies and nanosciences strategy, illustrated this feature well.

*8.1.3 Interaction*

In terms of the setting up of 'trading zones' for actors to interact, whether the interaction was happening within a policy-making context or otherwise in relation to nanotechnologies and nanosciences, it seemed the UK and Finland had moved ahead faster than Sweden. Sweden was the only country where a platform for engagement between academia and industry was requested, for instance, while Finland had several such platforms within efforts such as the nano-cluster programme, VTT, or in other spaces. In fact, much of Finland's

innovation strategy aimed to encourage such interaction. Finland also offered other areas to meet, such as within working groups and seminar series and similar – some of which were feeding into policy-making, e.g. the working groups or events arranged in relation to the FinNano programmes. In terms of including actors into policy-negotiations and other interactions related to nanotechnologies and nanosciences, the UK outdid Finland by including NGOs and members of the public, or at least getting academia, industry, government, and representatives for civil society together within platforms such as stakeholder advisory groups, or public engagement exercises.

In discussing interaction with interviewees, a second part of the research question appeared through asking them to reflect on the role of other actors, or the interaction that they had with other actors. Again, rather different accounts were recorded for all three countries.

*On industry*

All academics in all three countries, apart from Kate, said that they had good relationships with industry, though some had more active links than others. It turned out that those working more closely with applied science and research had more connections, such as Scott, Aaro, and Suzanne, than those focusing on more basic research, such as Kate and Britta. Though Johan's research was oriented towards basic science, he was very well connected through his position at VTT. Academics in all three countries, who had connections with industry, also often gave examples of research projects where they worked together rather successfully.

While the Finnish government representatives were quite eager to give insight into their own good relationships with industrial entities, the UK government representatives indicated that there was a separation in that Tom had the better industry connections, instead of Paul as this was the remit of BIS rather than Defra. A similar tendency was seen in Sweden, even if in a more fragmented fashion, where different agencies had relationships with different industrial associations and types of trade. That said, VINNOVA was possibly

the best-connected government agency as far as industrial connections were concerned.

Overall, the general opinion within all three countries was that industry was essential for the development of nanotechnologies and nanosciences, and also that good industrial links were necessary in order to take advantage of the opportunities offered through technologies and sciences on the nanoscale and their applications. However, further engagement with industry was asked for in both Sweden and the UK, though perhaps more acutely so in Sweden where the engagement was not considered adequate. The only criticism laid at industry's door was that there was a lack of transparency with regards to industrial research into toxicity and nanosafety, and Richard raised concerns about the lack of information offered by companies towards the Voluntary Reporting Scheme.

*On Government*

Opinions were particularly varied regarding interactions with the Government and its agencies in all three countries. While the Finnish interviewees were generally quite content with the centralised and top-down Finnish science governance system and did not discuss it at great detail, the Swedish non-governmental interviewees were quite concerned with the fragmented Swedish system and the slow decision-making process that such a system entailed. As was seen in Christer's account during the IPA Study, this system, which he also called old fashioned, had made the formulation of a nanotechnologies and nanosciences strategy into the drawn out and slow process it was.

The most vocal in their criticism of the Government and government agencies among the interviewees were the UK interviewees, and particularly those either within industry or who had close ties with industry. Though they differentiated between civil servants and politicians, as the politicians were the real decision-makers in the UK, both groups were criticised for being too slow and for not possessing enough knowledge of science and technology to make

the right decisions with regards to UK nanotechnologies and nanosciences investments and goals.

*On Academia*

All interviewees in all countries agreed on that academic input and interacting with academics was essential for nanotechnologies and nanosciences R&D. The Swedish criticism delivered for academia was similar to that of government in that there was a lack of national coordination and collaboration that resulted in a fragmented network of networks of academic institutions that became competitors rather than collaborators. Another point was that there was not enough collaboration with industry and that academics and scientists should consider focusing more on applied research as developed within partnerships with industry. A similar point was heard in the UK, where Scott wanted to encourage his academic colleagues to embrace applied sciences and industrial links, as did Kari and Tuula want the Finnish academics to work more closely with industry.

*On NGOs*

NGOs or other civil society organisations were not interacted with in Sweden or Finland, at least not as far as nanotechnologies and nanosciences were concerned. Indeed, the lack of collaboration and engagement with and by them could explain why none of the Swedish or Finnish NGOs or civil society organisations contacted chose to be part of the study.

The same could not be said about NGOs in the UK, where several of the interviewees had met and discussed with NGOs, and particularly Greenpeace and Which. There were mixed feelings about NGOs among the interviewees, and they were divided into two groups – the group that Richard belonged to, which based their arguments on research, and the group that were considered too extreme to work with. It seemed as if nanotechnologies and nanosciences, following past science-related controversies, saw an increase of interaction that included societal organisations. This was also called for in the RS/RAE report (2004), which many interviewees referred to. Sweden and

Finland did not have a similar push, nor did they have controversies in the same sense as the UK.

*On the Public*

Though not necessarily considered a 'party' during interactions, the UK interviewees underlined that it was very important to interact with the public, if only to increase awareness and keeping the public informed. Similar sentiments were expressed by the Swedish interviewees, though a very small minority of them had actually had anything to do with the public, while the Finnish interviewees did not fully understand what was meant by interaction. The lack of engagement or communication with the public in Finland was generally put down to Finns being very pro-technologies, and that they trusted the decision-makers to make the right decisions, and the academics to conduct research in a responsible manner. Finnish culture was put forth as a reason for the lack of public interest or discussion by more than one interviewee.

### *8.1.4 Openness and transparency in decision-making*

Overall, the interaction among actors painted a rather different picture of the decision-making context in each country. While there was interaction, including with actors external to the 'triple helix' - e.g. NGOs and civil society organisation and the public in the UK, the two Nordic countries could not show similar efforts. The fragmentation of the Swedish system also became clearer when interviewees reflected on the roles of others and their interaction with them, and the same can be said of Finland where there seemed to be a general 'acceptance' of Finland's centralised expert-driven science governance model.

Further reflecting on collaboration with regards to openness and transparency, or the antonym – secrecy, there were, similarly, differences between the countries in question. While the Finland's science and technology agenda and investment was governed by a club or a smaller group of people and with limited transparency, according to a majority of the

interviewees, the interviewees did not really question this system. Rather, there was an element of ‘acceptance’ for the way things were managed and done by all actors involved. The levels of trust expressed between the parties seemed rather high, and Jari’s experience in discussing nanosafety, and Paavo’s comment with regards to how some well-connected individuals could claim advantages for themselves and their research, did not make either of them put forth a claim that would tarnish the trust felt for the governance of Finnish sciences and technologies. It was also claimed that Finland was a small country where everyone knew everyone else, which helped in building trust.

A similar point was made in Sweden, by Ulf, though more than one interviewee claimed that it was important to know the right people in order to achieve aims especially within larger research projects with many partners. Overall there was a sense of there being much trust towards other partners in Sweden, though it was not necessarily as united a statement as that of Finland. Christer, for instance, did not necessarily feel that he trusted the decision-making process – the process rather than the decision-makers themselves, following his experience with trying to initiate a bottom-up process. And Jan was less than complementary about politicians in general and the way that lobbying had brought forth the ESS facility to southern Sweden. What was said, however, was that, again, the fragmented nature of Swedish institutions made it difficult to get a full overview with how decisions were made and by which process, and that there was a lack of transparency despite the adherence to the right-to-access principle. Another flaw found in the Swedish system was that it was rather old fashioned, in line with Bergström’s findings about Swedish administration.

The picture of the UK was a clear contrast to that of Sweden and Finland; though rather than all different actors distrusting one another, it was clear that a majority of them distrusted the decision-making process in terms of how politicians and the civil service exercised science governance in relation to nanotechnologies and nanosciences. In some cases, such as that of Scott and Harold, they rather mistrusted the decision-makers themselves. Richard

expressed some concern with industry and that industrial entities were not transparent enough, but that was the only comment that did not specifically target decision-makers. Other institutions and actors that were not particularly trusted by several of the UK interviewees were the media and some more extreme NGOs.

*8.1.5 Public engagement*

The UK interviewees were aware of a number of public engagement exercises, and several of them had been involved in such events where they had met the public but also interacted with NGO or civil society representatives, other academics, government representatives, and academics. Several of the interviewees made references to the RS/RAE Report and the lack of public support for GM as reasons for them to engage with the public and many of them could name at least one such event if they had not taken part themselves. However, one issue raised among those who had participated was that the purpose of events was not always clear, and that some events did not seem thought through. Both Paul and Tom expressed their support for public engagement, though Paul also said that such events would need to have a clear focus. The opinions of the academics, scientists, and industrial representatives among the UK interviewees ranged from optimism and happiness at having taken part of events that were not 'too bad', to less excited statements such as Roger's interest in involving the public "if they can be civil about it" (Roger 2011).

Public engagement was a rather unknown concept in Sweden, though two of the interviewees – Suzanne and Britta, were found to have been involved with Forskarfredag. However, the engagement and communication that had taken place with regards to nanotechnologies and nanosciences in Sweden seems to have been on an entirely informative level, rather than a genuine dialogue with citizens about on-going research and the risks and opportunities associated with nanotechnologies and nanosciences.

While some of the Swedish interviewees had heard of public engagement, none of the Finnish interviewees had witnessed or participated in any such event in Finland, at least not related to nanotechnologies and nanosciences. Some of the interviewees did not know what public engagement was, and most of them did not understand why public engagement should be considered necessary. Again, the explanation offered was that Finns trusted technologies and scientists.

*8.1.6 Trust and 'trust gap'*

With regards to trust and a trust gap, some of the Finnish interviewees had provided me with hard copies of the Finnish Science Barometer and pointed out that there was a lot of trust in Finland, and no trust gap to be discussed. Indeed, the lack of media reports or any form of report that would suggest distrust or a trust gap among the Finnish populace with regards to nanotechnologies and nanosciences would suggest that their assessment would be fully valid.

The Swedish interviewees made the same point and pointed towards a Swedish survey that aimed to capture trust for societal institutions. In similarity to Finland, there had not been any media reporting or civic activity that would suggest the presence of a trust gap in Sweden.

Finally, the UK interviewees had in similarity with both the Swedish and Finnish interviewees, not noticed a trust gap in the UK, and the point was made about how over-communicating with a public that did not show much interest in engaging could be as harmful as not communicating or engaging at all. Rather, the UK interviewees moved the trust conversation away from the public, and towards the media or decision-makers instead, where the lack of trust and transparency was a greater concern.

*8.1.7 Balancing promotion and regulation*

Having explored the first two parts of the research question – what roles the actors assumed, and how they perceived the other parties around the table,

the study moved towards the more specific strophe within the research question – to explore the balancing act between promotion and regulation in relation to nanotechnologies and nanosciences. Rather than just figuring as a background, the assumed roles and the perception of others offered explanatory power with regards to the balancing act explored here.

With regards to the balancing act, most interviewees – regardless of country of residence and work – agreed on that there was no balance to be seen, but for different reasons. While the Swedish and Finnish interviewees drew a picture of there not being much of a risk or regulatory discussion at all and that the scales were weighing down in favour of innovation and promotion, the UK interviewees were divided in their comments. While Richard claimed that innovation and commercialisation outweighed a risk discussion and regulation, all industry representatives and a majority of all other interviewees claimed the opposite.

*8.1.7.1 Risks, health and safety, and regulations*

The country with the most to say about risks, health and safety, and regulation with regards to nanotechnologies and nanosciences was the UK, at least as far as the selection of interviewees for this study was concerned. There had been, by comparison, a lot of reports and comments already published such as the RS/RAE report and the RCEP report that either included risks or concerned risks as their main focus, which had generated discussion in the UK. With an attempt at more open dialogue and inclusiveness in policy-making and policy-discussions, the risks-related arguments, and NGOs that brought up risks were included in discussions at an early stage. A majority of the UK interviewees had met with NGO and civil society representatives and some had even met with the public and discussed risks and health and safety concerns, and all of those experiences were not reflected with negative terms or scorn. However, as Scott's part of the IPA case study shows, as did the opinions of other academics and all industry representatives, there was much disappointment with the large part that risks played in the UK Strategy, and there was resentment with regards to the lack of attention that the Mini IGT-report received. However, the resentment and disappointment seemed, on

closer inspection, to be more due to the way in which the opinions, advice, and expertise offered by the interviewees to the policy-discussion had been ignored or watered down by decision-makers – e.g. with the process of decision-making, rather than with the discussion about risks, health and safety and regulation per se. In fact, most interviewees, Scott included, were quite happy to discuss risks and health and safety, and the importance of conducting responsible research.

Paul, who was interviewed before the UK strategy was launched, did not have too much to say about regulation, apart from it being discussed in Europe, despite having said that it fell within the remit of his department. And Tom, who was interviewed after the strategy had been launched, seemed unaware of the upset it had caused.

The risk, health and safety, and regulatory discussions in Finland were quite non-existent, which seemed to be reflected in the total of €1M that was spent on nanosafety research in Finland. This was a small amount in comparison to Finland's total investment into nanotechnologies and nanosciences R&D. Jari's IPA account of the meeting where no one wanted to take responsibility for nanosafety suggests that it may have been a box-checking exercise. That the Finnish Technology Industry Association did not have the funds to send a representative to meetings on standardisation is also a telling point of the lack of encouragement available for this kind of discussion in Finland. Yet, trust remained high, and there was general 'acceptance' of the way risks, health and safety, and regulations where not discussed among all interviewees, including Jari.

The situation in Sweden was very similar to that of Finland, though there seemed to be more funding available for nanotoxicological research within general funding programmes. However, the fragmented Swedish governmental and academic system made it difficult to get an understanding for in what way and where risks and regulations were being discussed in Sweden. The only government representative interviewed who had anything to do with regulation and risks kept referring to other agencies or to regulatory

work on the European level, and the only scientist among the interviewees to focus on toxicological research said that very little was going on to his knowledge and that it may be too early to discuss regulations in the light of all the 'unknowns'. None of the interviewees expressed any concerns with regards to the lack of a regulatory or risk discussion in Sweden. Health and safety was in Sweden, as in Finland, much left in the hands of the research institutes themselves, and the competent authority.

*8.1.7.2 Innovation, commercialisation, and promotion*

If Finland was not having a regulatory discussion or seem very concerned about risks, that could not be said about innovation, which was very much on the agenda of the Government, its ministries, and agencies much under the lead of Tekes. Historical reasons were given for Finland's innovation focus and friendliness, and moving ahead was not questioned by a majority of the interviewees – though Jari raised some concerns with regards to the lack of spending on nanosafety, and Johan was concerned with the potential brain drain that could result from the focus on applied science. Despite their concerns, and that they both said that they were not always listened to, they said that they accepted the situation as it was. Overall, the Finnish interviewees showed a lot of support for the way in which decision-making had been left in the hands of 'experts' and the idea that this would be challenged seemed foreign and out of tune with Finnish culture.

The Swedish nanotechnologies and nanosciences scene was very different to that of Finland in that there seemed to be a lack of national coordination, or possibly coordination in general. There had been attempts at initiating a strategy before, once by Christer and his colleagues, and another time by the same group in collaboration with IVA and many other actors, but it had come to nothing due to the fragmented Swedish science governance system, and among all the actors involved. In 2009 there was, however, another attempt under way, and all of the interviewees were very supportive of the effort; even Christer, expressed support for it, if muted. One thing that was very obvious in the accounts presented by the Swedish interviewees, however, was how the lack of coordination had resulted in a lack of 'trading zone', and several of

them wanted to see a platform for exchanges and discussions between academia and industry in particular.

Finally, much of the UK interviews that concerned the balance between promotion and regulation were very much focused on how risks and regulations got too much space in the UK Strategy. Much of the innovation and commercialisation discussion got lost in the critique. The main points that were drawn out of all other comments were related to the need to take the Mini IGT report seriously and that more interaction was needed between academia and industry. Chris also made a point about how an infrastructure investment had gone wrong and made centres benefiting from the investment into competitors rather than collaborators, which was another critical point delivered at UK decision-makers.

## Chapter 9: Analyis and discussion

*This chapter aims to view the empirical findings of the study through the lenses of the theoretical framework, and to illustrate the main theoretical contributions offered by this study to STS-literature.*

### 9.1 One model does not fit all in science governance

The key argument that has come out of this thesis is that though there are elements of currently rolling emerging features of Mode-2 and Strategic Science on show in all three countries, it is impossible to generalise either model on all three. It is impossible despite their geographical proximity, similar socioeconomic circumstances, and interaction within Europe, the European Union and other international organisations or platforms for collaboration. When explored more closely, each country has approached nanotechnologies and nanosciences differently for slightly different reasons.

#### *9.1.1 Learning from past experiences*

Approaching new technological and scientific fields on the basis of past experiences came up as explanatory variables to the British and Finnish approaches to the development of nanotechnologies and nanosciences policies. The lessons learnt and acted on were very different between the two countries, however.

In the case of the UK, both documents and interviewees made references to past controversies, such as the lack of enthusiasm for GMOs. Instead, for nanotechnologies and nanosciences, it was argued – public engagement and overall engagement with multiple stakeholders was necessary to move science governance into modernity. Reports were commissioned, public engagement exercises were held, and the general discourse with regards to the nano-scale included both considerations for the potential risks and the potential rewards of R&D and investments. The increased engagement between actors, which could be considered more horizontal than vertical, does tune in rather well with the assumptions made by Gibbons et al. and Rip

regarding a Mode 2 and Strategic Science model of science governance, in terms of lateral engagement between different stakeholders. However, as became more obvious in Scott's account presented in the IPA case study, it is important to go into greater detail when exploring such engagement – as the stakeholders who have been 'engaged' are not necessarily always listened to, which questions the purpose behind engagement. A similar observation was made with regards to public engagement as a number of interviewees seemed to struggle to understand the use for all public engagement exercises – though recognizing that communication with the public was important. Similarly, the UK interviewees underlined the importance of a discourse that included both the benefits and risks of the emerging technology and science, while some personally thought that there was either too much emphasis of one over the other.

Finland's lesson was not related to a past controversy, as there did not seem to have ever been one. Instead, the lesson related to Finland's loosing out of the biotechnology wave. Therefore, the policies related to nanotechnologies and nanosciences were more focused on already existing Finnish strengths – both in terms of academic excellence and industrial capacity and interest. What Finnish decision-makers wanted was a more strategic effort that would make a genuine difference to the Finnish economy. Engagement between academia and industry, new platforms for engagement between nano-stakeholders, and a push for applied science, became key to moving Finnish nanotechnologies and nanosciences in the desired direction. The result was a very innovation-focused decision-making environment where expertise played a leading role. However, engagement was very selective as was the discourse. Where UK decision-makers invited a broad spectrum of stakeholders to express their opinions, views, and concerns, their Finnish colleagues restricted engagement and discourse to feed their interests. Further, there was a clear lack of consideration for public scrutiny and social accountability that, in addition to conditional engagement, does not chime well with the ideas behind a Mode-2 or Strategic Science governed world.

None of the Swedish interviewees or documents reviewed offered a similar pointer towards past experiences.

### *9.1.2 Institutional structure*

Sweden's complete lack of a strategy and the difficulty in producing such a policy document was explained by the fragmentation of the Swedish science governance system. It was very difficult to get an overview of decision-making processes and the relevant actors involved, even for senior 'experts' or the decision-makers themselves. This study does to a large extent support Bergström's findings with regards to the lacking institutional structure and complicated decision-making process, as discussed in Chapter 6. The fragmentation and resulting lack of strategy does not fit at all with Gibbons et al.'s or Rip's thinking around Mode 2, a shift, or Strategic Science. There is also a split between excellence and relevance in Sweden, which is very likely due to the fragmentation, but it is also likely due to the old-fashioned – potentially "Mode 1" way in which science is governed, and the institutional memory that has become difficult to change. Despite being highly expertise-driven, the institutional structure did not necessarily pay that much attention to its experts – at least as far as the study-results presented here are concerned. And where experts had been consulted, their areas of expertise were clearly defined, and they could not comment on broader issues as that went past their comfort zones, such as the case of Maja who kept referring to other agencies when questions went past her own tightly held area of expertise (see Chapter 6). That said, change was called for in this regard, by for instance Christine and Suzanne in their push for more engagement between academia and industry.

The Swedish institutional structure does not offer a place for engagement, nor does it call for public scrutiny in scientific and technological development. In fact, as Gergils argues, it does not cater for an innovation system either. However, the development of an innovation system seemed to be on the agenda in the various policy-papers that were being prepared in the wake of developing a nanotechnologies and nanosciences strategy, which could mean

that the Swedish institutional structure and science governance structure might be changing to accommodate a move towards what could be called Strategic Science.

Where Swedish science governance seemed old-fashioned, fragmented, and less modern, Finland's system came across as much more dynamic with regards to its innovation focus and structured approach to nanotechnologies and nanosciences investment. Indeed, though it goes beyond the scope of this thesis, it is worth considering whether a push for innovation or the innovation system itself helped to shape Finland's institutional structure and science governance system.

As for the UK, little was said about the infrastructure within which science is governed, apart from remarks about the competence (or incompetence), education, or intelligence of decision-makers. This could be interpreted as a wish for a more expert-oriented system on par with that of Finland. Though most interviewees did not specifically expand on this topic, nor did they identify any alternative ways in which science could be governed.

### *9.1.3 Culture*

Finnish culture was offered as a reason for the lack of public scrutiny and social accountability in Finland. Exploring the depth of Finnish culture goes beyond the scope of this thesis, but it could potentially be worth researching as part of a socio-anthropological study as it was repeated as a cause for Finland's lack of public scrutiny by more than one interviewee. Apart from it being pointed at as an indicator of why Finnish science governance works the way it works, a couple of observations were made that could be indicators of culture being a potential explanatory factor. Firstly, leadership was not contested, and instead of questioning leadership interviewees often shrugged their shoulders and said that this is just the way things are done in Finland. As Marja-Leena put it, you do not listen to people who just make a lot of noise.

Secondly, the high levels of trust for academia and other societal institutions seem to affirm this point – those filling in the questionnaire upon which the Finnish Science Barometer was written clearly did not consider the lack of public scrutiny or social accountability to be an issue that would affect their levels of trust. Trust for expertise and institutions also seem to have become a part of organisational or institutional culture in Finland, especially as those running the science governance apparatus seemed comfortable with their role as experts and leaders. There was also little questioning of other parts of the machinery, though some of the interviewees expressed concern for the lack of interest in basic science and nanosafety issues and research.

Neither Gibbons et al. nor Rip foresee culture (e.g. here broadly referred to as applied to a nation or people) as a potential threshold to a Mode2 shift or Strategic Science, though Rip has later pointed at political and institutional culture as possibly having an influence on the research produced within different countries (Rip, 2011:2). If culture was proven to be an issue that would limit the public scrutiny and social accountability seen in a given country, it is also uncertain whether this would mean that Finland would be unsuitable for an 'upgrade' into full-fledged Mode 2 or Strategic Science in terms of science governance model. As modern science governance is considered more 'flexible' and inclusive, then perhaps the models or theories exploring it needs to be equally flexible and allow for national variations. In many other respects Finland seems to fit reasonably well into the blueprint for Strategic Science and Mode 2, as discussed in Chapter 4. Culture was not flagged up for consideration during the Swedish and UK interviews, or in any of the related policy-documents.

### 9.2 Mode-2 Shift, Strategic Science, or both

The analysis presented in this chapter and the concluding sections of each of the empirical chapters have shown some variation between the three countries that make it difficult to provide a generalisable conclusion as to whether Gibbons et al.'s and/or Rip's model of science governance more adequately describes the state of nanotechnologies and nanosciences

governance. The UK is the closest in terms of suiting both models, though this study neither supports nor opposes the notion of a 'shift' having occurred as argued by Gibbons et al. It is possible, considering that the UK had a 'past' to learn from, that the lessons learnt had already been learnt and nanotechnologies and nanosciences were developed post-shift. However, investments were made into excellence for it's own sake, and both excellence and relevance seemed to co-exist which would suite Rip's model more than Gibbons et al.'s model.

Like for the UK, Mode 1/Mode 2 shift was invisible in Finnish decision-making. Though trying to learn from the past by approaching nanotechnologies and nanosciences differently to previous investments into biotechnology R&D, both science and policy-making was still taking place within a structure that had seen little change. This study could not find enough evidence of there having been a Mode 1/Mode 2 shift in Finland. Further, though the lack engagement and public scrutiny could be a fit with Mode 1, Finnish nanotechnologies and nanosciences governance was very focused towards relevance, which in turn is a good fit with Mode 2. In other words, the Finnish part of the study threw up elements of both Modes, which does not support Gibbons et al.'s model. Finland also does not fully fit in with Rip's thoughts around Strategic Science. Though this study offers some support for a 'watered-out' version Strategic Science in that excellence – though only if judged relevant, was pursued alongside relevance through the FinNano Programmes and in various other trading zones and parts of the Finnish innovation apparatus. However, the infrastructure through which all nanotechnologies and nanosciences efforts were governed was not openly governed with the input of multiple actors – but very much expert driven. This is a clear challenge for Strategic Science, if operational diversity and public scrutiny – which was non-existent in Finland, are to be central features of the model.

The Swedish science governance system provided a clearer separation between relevance and excellence than either Finland or the UK. The separation between the two in Sweden may be explained as a result of

Sweden's old-fashioned and fragmented science governance system. The lack of engagement, or lesser engagement, than seen in either of the two other countries alongside the lack of an innovation system and public involvement and engagement rather shows Sweden as non-conforming to either a Mode 2 or Strategic Science model. The Swedish non-conformity does form a basis upon which it may be questionable as to whether NPK, Strategic Science, or any other alternative line of reasoning would be suitable for application in countries where the science governance system is fragmented or otherwise poorly developed. However, Sweden could, potentially, be a very interesting case study for the co-production of knowledge in that nanotechnologies and nanosciences seem to emerge and develop alongside a Swedish attempt at developing an innovation system.

Overall, the chosen research question has proven valuable in that the junction where discourse, perceptions, and opinions around promotion and innovation and safety, risks and regulation meet with regards to nanosciences and nanotechnologies has helped in highlighting the role of these topics and the interviewees themselves within the development of an emerging technologic and scientific field. The observations made are chiming in tune with the analysis presented here concerning the Mode 1/ Mode 2 thesis and Strategic Science in that the one governance system that is working the most in accordance to Gibbons et al.'s and Rip's predictions – the UK, also has had the most balanced discourse. Sweden, on the other hand, would be at the opposite spectrum, with little discourse in either direction, no *balance* to speak of, and a fragmented governance system that fits neither Mode 2 or Strategic Science. Finland is the odd country out in that discourse is 'loopsided' in favour of promotion and innovation, while there are traits that would fit a Mode 2 or Strategic Science world of science governance. That said, culture – if it is to be considered a valid explanatory variable, was never accounted for by either Gibbons et al. or Rip. Following this line of reasoning, culture could, perhaps, be a feature that would affect the Mode 2 thesis and/or the Strategic Science model by introducing grey-scales or tires to their application in describing specific science governance systems such as Finland's.

## Chapter 10: Conclusions

*As the concluding chapter of this thesis and relating to Chapter 8 and 9, Chapter 10 will focus on the conclusions that can be drawn on the basis of the empirical research presented. Reflections will also be made with regards to the limits of the study, and the chapter will end with a discussion that aims to draw up potential lines for future enquiry.*

### 10.1 Conclusions

The main conclusion drawn in this thesis is that one should be careful when generalising, assigning, and applying knowledge production theories, theses, idioms, or models of science governance to different countries, without basing one's generalisation on empirical research. Though this study is specifically looking at nanotechnologies and nanosciences as an example, it looks into how these new sciences and technologies are received by an already existing governance structure, and works on the basis that it is likely that other emerging technologies and scientific disciplines would have been greeted in a similar fashion in Sweden, Finland, and the UK. Instead of similarities, which could have been expected due to their pre-existing similarities in terms of socio-economic characteristics, geographic location, the importance of R&D to their economies, and frequent interaction within the EU and other international policy-related circumstances, this study found that the policy-making processes and policy outcomes were very different in Sweden, Finland, and the UK. While interviewees in Finland and Sweden had little to say about risks and regulations, the UK interviewees, apart from perhaps Richard, had plenty to say about how it had dominated the UK debate. Where there were trading zones and inclusiveness in the UK, the range for the sae variable went from less in Finland to non-existent in Sweden. The notion of public engagement often had to be explained in the Nordic interviews, while all UK interviewees had taken part of public engagement exercises or knew about them. The differences were reflected in the policy-documents and nanotechnologies and nanosciences strategies produced in each country.

When explored through the interview and the IPA case study, the differences between the countries rather seem to depend on the structures that were in

place in their respective science governance systems when nanotechnologies and nanosciences first entered the scene such as expertise-driven institutional structures in Sweden and Finland, a more pluralistic effort in the UK that was brought on due to previous controversy, and Finnish culture – though fully exploring culture as an explanatory variable requires a separate study in its own right to do it justice. That national conditions, infrastructure, and policies proved to have an effect on the governance of nanotechnologies and nanosciences in this study offers evidence to confirm Shinn's criticism of NPK, as discussed in Chapter 2.

Though this study does not aim to test the robustness of each of the nanotechnologies and nanosciences strategies produced, several of the UK interviewees described the UK Strategy as being rather 'watered down', while the Finnish strategy came across as being fairly straightforward, expertise-led, and enforced, and Sweden had yet to produce a Strategy. The previous attempts at producing a strategy had failed due to fragmentation and the lack of coordination. However, comparing the quality of the strategies to their reception, when filled in Themes Matrix in Figure 8.1 it does not look as if more organisational diversity or social accountability, at least not with the indicators chosen here, would necessarily result in a more broadly endorsed strategy. However, by the same token, one could make the argument that a system with well-functioning interactions between actors where there was little openness and transparency produced the most endorsed and robust of all strategies, but this, again, may have been due to a centralised system in a culture where 'people don't get excited about everything' and where a high level of trust among all parties involved including the public, would leave decision-making in the hands of experts. If that assumption was true and applicable to all countries, then the UK would probably struggle to produce any robust strategies at all in the midst of discussions among multiple partners, and a robust Swedish strategy would be very unlikely in the foreseeable future, or at least until the establishment of trading zones and a gathered rather than fragmented system of governance.

However, with regards to the balancing of promotion and regulation in policies and policy-discussions, there was evidence to suggest that organisational diversity and social accountability could support such a balance. While there was no balance to be seen in either Sweden or Finland, due to the almost complete lack of regulatory, risk, or health and safety discussions, the UK Strategy and the policy-discussions as recalled by the interviewees offered a more nuanced picture where discussions about regulations and risks had taken place. That said, all interviewees did not necessarily consider the discussion balanced in the right way or balanced enough, but there seemed to be evidence of an attempt at striking a balance having been made by UK decision-makers despite the criticism expressed by the interviewees.

The level of organisational diversity and social accountability had less of an effect on the perception of the role of others, though it was clear that the UK interviewees had communicated more with both the public and NGOs due to there being trading zones in place, more inclusion in the policy-making process, and public engagement exercises in the UK. As for the relationships between academics, government, and industry the differences between the UK and Finland were less apparent, while the lack of interaction between industry and academia was continuously flagged as a problem in Sweden. The lack of interaction with industry did not make Swedish academics any more or less critical of working with industry than their British and Finnish colleagues however.

In examining ‘reality’ this study did not aim to prove or disprove the claims made by Gibbons et al., Nowotny et al. or Rip in their entirety – but sought to explore chosen aspects of their science governance models empirically in three chosen countries, using nanotechnologies and nanosciences as an example. What this study has delivered in this sense, beyond pointing out that one should be careful in generalising these concepts to different countries, is that there is merit in both the proposed Mode 2 world order and Strategic Science, if grey-scales are permitted.

The way the Mode 2 model has been described by its authors is not grey – or flexible, enough to cater for the differences in culture and institutional arrangements as found in Finland (culture and institutional arrangements) and Sweden (institutional structures), for instance. Assuming, as they claim they do, that the barriers between Mode 2 society and Mode 2 science have disappeared and that culture, politics, and the market is working in more open and diverse playing-fields (see for instance Nowotny et al. 2009:4), does not help in fully making sense of nanotechnologies and nanosciences governance in either of the three countries. Institutional structures are of importance in the UK as well, as Scott – for instance, referred to the way in which decision-making had been done by the decision-makers (e.g. politicians) and he had not felt listened to. Even if Scott remained positive and hopeful about future influence, his account underlined that there are clear structures in place that do not seem to fully fit the Mode 2 model. Further, in neither country, not even in the UK, which seemed to fit the Mode 2 model the best, had investment into knowledge for its own sake fully disappeared. However, the authors offer little help with understanding variations or Mode 1/Mode 2 mixes, which again would require the grey-scaled flexibility their model is lacking.

The Strategic Science model seems to offer more flexibility in that the lines between what is and what is not Strategic Science are not as clearly drawn in Rip's writing as the difference between Mode 1 and Mode 2 is in Gibbons et al.'s and Nowotny et al.'s work. Relevance and excellence can co-exist, and Rip has made a reference to the effects of national or localised variations such as institutional culture and industry structures, for instance (Rip, 2011:2). This could cater for the cultural and institutional differences found in the cross-country comparison conducted in this study, which could be an indicator of the usefulness of the Strategic Science model in cross-country studies of science governance.

Overall, this study – when looking specifically at the chosen variables as indicators of Gibbons et al.'s and Rip's models suggest that nanotechnologies and nanosciences governance in the UK is more in line with both Mode 2 and

Strategic Science predictions due to more diversity and public scrutiny in decision-making. More so than in Finland where some aspects seem to follow suit – such as the existence of trading zones, and trust levels, but where public engagement is non-existent alongside openness, and partially, interaction. This while Sweden fell entirely outside of what was predicted for either Mode 2 or Strategic Science. If anything, the Swedish situation could resemble that of Mode 1 more than Mode 2, at least on the basis of the data presented in this study.

As for other models of science governance and knowledge production, only one of the theories of knowledge production did come up at least by name, in interviews – the Triple Helix. In fact one of the interviewees directly related herself to the concept in being a government representative who had worked in both industry and academia. The concept seems to have gathered speed also in Finland as a suitable model for the encouragement of innovation. It is worth noting, however, that the Triple Helix does not push for social accountability. Rather this would move it into a 'Quadruple Helix', as described by for instance Carayannis and Campbell (Carayannis & Campbell, 2012).

With regards to the co-production of knowledge, the conclusion drawn would run along the same lines as the observations made with regards to social accountability and inclusiveness above in that the social order, or including 'the social' in science, and their interaction – or trading zone, seemed nearly non-existent in Sweden or Finland. What seemed to be happening during the time of the interviews though was that Sweden, which was lagging behind possibly through being so fragmented, seemed to develop nanotechnologies and nanosciences simultaneously to its innovation system and strategy. Exploring this in more detail through, for instance, ethnographic studies, could potentially have been an interesting study of co-production in the making. Sadly, however, it fell outside of the scope of this study.

## 10.2 Reflections

This was a rather large study considering the amount of data gathered through the 42 interviews and the IPA study, which had to be limited to one extract per interviewee chosen. Consequently some of the data collected remained unused. However, the number of interviewees was necessary in order to get a valid picture of the policy-making process and policies as related to nanotechnologies and nanosciences in the three countries, considering the variety of actors involved with policy-making, but also due to the limited printed material available in Finland and Sweden. Additionally, a study of news stories in Swedish newspapers published up until 2009 in relation to nanotechnologies or nanosciences was performed but was not included in this study due to the overload of data.

As for the choice of interviewees, it would have been desirable to interview NGOs in Sweden and Finland even through they were not involved with policy making if only to get their side of the story as to why they were not involved. It would also have been interesting to know how they perceived new technologies and the scientific field in general, if not nanotechnologies and nanosciences in particular, and how they perceived the science governance system in place. More importantly, the study would have been enriched had more industrial representatives agreed to take part, and particularly companies that conducted nanotechnologies and nanosciences research. Attempts were made to include them, but I rarely received replies to my requests.

Every effort was made throughout this study to keep all interviewees and their accounts entirely anonymous. This proved a very real challenge as many of them knew one another by name or more intimately than that, especially in Finland and Sweden. Marja-Leena did, for instance, name people she thought I was seeing, and Christine and Suzanne knew I was seeing them both and therefore suggested a joint interview. My standard reply, however, was that all interviews were anonymous, and that I did not want to confirm or deny that I was going to interview people who were named by interviewees.

With regards to the interview situation, conducting interviews went well and overall interviewees seemed happy with the format of the interviews. However, a couple of interviewees would have preferred more structured interviews as they did not like to 'speculate' or risk making statements that were really not their place to make. One of the Swedish government representatives was particularly concerned about this issue. I therefore tried to formulate the questions according to her wishes in order to make the situation more comfortable for her, but it did not help much unfortunately. Her discomfort may have been due to the nature of the questions, or quite probably the nature of Sweden's fragmented decision-making climate.

The IPA case study was an interesting tool for qualitative analysis in this respect as it provided an opportunity to go more into depth with regards to Scott's, Christer's and Jari's experiences, and it added depth to the study overall. It is important to notice, however, that the method rests on an interpretation made by the person undertaking the analysis, and that the outcome is likely to reflect the 'self' of the person interpreting the data. I tried to be careful in keeping my 'self' out of the picture, but in putting the case study into a context that included other parts of Scott's, Jari's and Christer's interviews that had already been accounted for, I may have implicated myself more than intended. It is also worth noting that IPA was a rather time-consuming methodology that provided a large mass of data that due to the time and space limitations for this thesis could not be used. Though interesting in many ways, it is worth considering whether or not extending it further than its limited inclusion earlier would have added much to this study.

Finally, though many of the interviewees in both Finland and Sweden spoke English, it was invaluable to be able to conduct the interviews or part of the interviews in the native language of the interviewees as it produced more spontaneous answers. Some of the interviewees in Finland were keen to conduct the interviews in English and seemed to have rehearsed the vocabulary and to some extent the potential responses to the interview questions, which could affect the data collected during their interviews. In these cases, however, I deliberately added questions or topics for discussion

in English, Swedish or Finnish as appropriate, which made the interviews flow more freely. That said, some were genuinely good English-speakers and their interviews therefore did not raise such concerns.

As to the choice of interview questions, adapting them from those developed for the measurement of social capital in communities, seemed to work well as they corresponded rather well to the themes found for this study. However, a the intention was not to do a fully fledged study of social capital as found in the decision-making contexts in the three countries, it has not been discussed here, but it could make a very interesting future study in relation to the governance of nanotechnologies and nanosciences.

### 10.3 Future potential lines of enquiry

While narrowing down the study to its final shape, several lines of enquiry were considered and rejected, or left for a later date or another project. From the remaining data it would be interesting to study the role of the media in reporting on nanotechnologies and nanosciences, and explore why the Swedish and Finnish media was considerably quieter than the UK mass media. It would also be interesting to look into the perceptions of the media among interviewees, and explore their experiences of either speaking to journalists or seeing their research reported in the media.

The field study also produced a significant amount of data related to the framing of social and ethical issues and discussions as related to nanotechnologies and nanosciences in the three countries, which could have been discussed alongside a research question that aimed to capture what an ‘ethical concern’ is. Considering the various backgrounds and professional profiles of the interviewees, this could be an interesting study.

Transdisciplinarity in research, whether conducted within academia, in industrial settings, or both in collaboration, could have been an interesting theme to pursue and what the potential challenges were. This was touched on in this study, but more data was available to explore this theme in its own

right. It could also link to the applied vs. basic research issue, which many interviewees discussed in relation to the emphasis on innovation and promotion. How does that discussion look in the context of a transdisciplinary research environment, and what are the challenges associated with conducting basic research?

Another interesting study could be a an evaluation of how the various national nanotechnologies and nanosciences strategies were perceived 5-10 years after they were published, and whether indeed nanotechnologies and nanosciences are still considered separate fields of research, or whether they are discussed and promoted within separate academic fields and rather considered a 'method' – in line with Scott's 'point' made in the extract included in the IPA case study. It would be interesting to explore how that point would fare particularly in Finland where nanotechnologies and nanosciences were very much labelled as 'a new exciting field of research', at least at the time for this study.

As for potential research particularly related to Sweden, it could be of interest to explore whether or not the fragmented system is as fragmented now as it was in 2009, or whether trading zones have been set up and if they are effective in encouraging collaboration across old-fashioned administrative borders. It would also be worthwhile exploring the issue about top-down versus bottom-up initiatives and whether or not research could be driven by enthusiasm and researcher's initiatives in the future, and if not, why not.

In relation to NPK, Strategic Science, and the knowledge-based economy/innovation systems approach, it would be interesting to go into greater depth with regards to empirical research into the existence and use of social capital in knowledge production. Social capital as put in relation to the governance of science remains rather unexplored territory, and particularly so with regards to how it manifests itself during the entry of an emerging technology onto the R&D scene, and how new connections and actors get included into an already existing trading zone.

The list of future potential lines of enquiry could be significantly longer, but these are the main areas that this study has flagged as areas of interest. Overall the governance of nanotechnology and nanosciences is a very broad field of study that, due to its multi-actor environment, its national economic interests and potential, the transdiciplinarity they bring, and the current push for responsible innovation should be of interest to political science, science and technology studies, and economics alike.

*10.3.1 Overview potential research directions based on post-2008 research*

In the pursuit of potential future research directions, a quick bibliometric review through the Web of Science yielded 83,274 results overall when searching for *'nanotechnology' OR 'nanotechnologies' OR 'nanoscience' OR 'nanosciences'*. This was narrowed down by 'Social Science' and for research published between 2009 and 2014, the yield shrunk to 1,642 articles (out of 2,832 when all years were included). The number of articles has slightly more than doubled since 2008, and going through all of them has not been feasible here, but some articles have been selected for their relevance to the themes that came out of this study.

Judging from the articles found during the search, there seems to be more published empirical research available with regards to, for instance, the regulatory discussions in some countries. Kurath et al. have for instance written about the cultures and strategies as related to the regulation of nanotechnologies in Germany, Austria, Switzerland and the European Union (Kurath et al., 2014), while de Bakker et al. published a study concerning the responsible innovation and research with regards to 'nanofoods' in the Netherlands, also earlier in 2014 (de Bakker, et al., 2014).

Responsible innovation seems to be quite a popular topic for further study, which ties in somewhat to Tom's eagerness to pursue a Responsible nano code, and to reframe the UK risk discussion into one about responsible innovation – or rather, responsible nanotechnologies. Owen and Goldberg's

article on Responsible Innovation as perceived through funding applications to EPSRC seems to follow a similar line of thinking (Owen & Goldberg, 2010).

With regards to governance, an interesting contribution was made directly from the decision-makers themselves with regards to how nanotechnology influences decision-making (Morris et al 2011), a topic that could be of interest to pursue considering the claims of co-productionists. There is data in this study that could take this topic further.

As for exploring public engagement and social accountability further, quite a lot of research has been done, including country-specific studies such as Dudo et al.'s review of nanotechnology in US newspapers (Dudo et al., 2011) or Metag and Marcinkowski's comparative account of the media coverage related to nanotechnologies in Austria, Switzerland, and Germany (Metag & Marcinkowski, 2014). Other aspects of public engagement or science communication that could be of interest to this study is the reference that hs been made to the culture of the audience with regards to their perception of nanotechnologies. For instance, does Vandermoere et al. argue that the view on nanotechnologies in food are determined by already held views on science and technology (Vandermoere et al., 2011), and Kahan et al. point towards the evolution of public opinion to be due to the shaping of public attitudes by the psychological dynamics related to the cultural backgrounds of the audience (Kahan et al. 2009). This could be an interesting study to pursue particularly with regards to Finland's, allegedly, strong cultural determinism.

Another aspect with regards to public engagement exercises that could be of interest regards Kleinman et al.'s (2011) discussion about the rationale behind inviting 'blank slate' participants to consensus conferences or other public engagement activities. This could be an interesting theme to pursue in the UK or Sweden as some of the UK and Swedish interviewees questioned the reason for public engagement exercises. If nobody is asking for it, is it worth doing?

Finally, with regards to the research question, Cacciatore et al. calls for a switch of focus from a risks versus benefits discussion to one that focuses on real-world applications (Cacciatore et al., 2011). This argument is also made by Nordmann and Rip, who want to see a switch in focus within nanoethics from ‘speculative ethics’ about what the future may or may not hold, to actual ethical issues related to current nanotechnologies as they are developed in real-time (Nordmann & Rip, 2009). Now, looking back at 2007 when this study was first initiated, the atmosphere is very different. Nanotechnologies and nanosciences seem less ‘emerging’ in 2014 than they were then and time may be ripe to focus on more specific research questions related to actually existing applications of what is a group of very exciting technologies and sciences.

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## APPENDIX I: Standard set of interview questions

Looking back at your own experience:

1. In what way are you involved with nanotechnologies and nanosciences policy-making in Finland/Sweden/the UK, and how would you describe your role?
2. Do the policy-discussions you are taking part in relate to both promotion and regulation, and what issues are discussed in relation to both? (e.g. commercialisation, ethical or social issues, health and safety, regulating the manufacture of engineered nanoparticles etc.)
3. Do you find that there is a balance between the two, or is something missing?
4. Who takes part in discussions, and do you know one another well (e.g. have you met and collaborated in the past in a non-nano-related context)?
5. Which party usually takes leadership in discussions and how do you think they are doing?
6. If there are conflicts or disagreements during policy-discussions, how are they dealt with and/or resolved?
7. Do you feel you get your voice heard in discussions and do you feel 'included'?
8. If you disagree with policy outcomes, what can you do in order to get your opinion across?
9. Are there both formal and informal discussion in the policy-making community that you take part in?
10. How do you perceive the other people around the table, and do you have historical links to them?
11. Are there any local, cultural, and social norms that shape discussions or interaction, and if so, how would you describe them?
12. Would you describe the policy-making environment as 'open' or 'closed' with regards to the access to information and communication between parties?
13. How do you interact with external parties, such as the public or civil society organisations?
14. Are there any relevant disagreements or cleavages with external parties or stakeholders, if so, why would you say they exist, and what is done to resolve them?
15. Would you say that there are social, cultural or legal constraints that limit participation of specific groups in discussions? (E.g. government, industry, academia, corporate entities, civil society organisations, NGOs, or the public)
16. Are or have you been involved with public engagement exercises, and if so, how do you relate to this experience?
17. Do you see a role for the public or civil society in nanotechnologies and nanosciences policy-making?
18. Is the media covering nanotechnologies and nanosciences, and how do you perceive their role and media reporting thus far?
19. Would you say that there is a 'trust gap' in wider society in relation to nanotechnologies and nanosciences policies, and if so, what do you think causes the trust gap?

# APPENDIX II: NVivo coding matrix

| Theme | Nodes | Child-nodes | Grand-child-nodes |
|---|---|---|---|
| Role | Self | Academia | Research<br>Administration<br>Applied<br>Basic<br>Seniority |
| | | Industry | Speaking for industry<br>Industrial scientist<br>Lobby |
| | | Government | Decision-maker<br>Adviser<br>Public service |
| | | NGO | Consumers<br>Environment<br>No NGOs |
| | | Dual roles | Gov't/Aca<br>Gov't/Ind<br>Ind/Aca |
| | | Other | Professional body<br>Civil society<br>Consultancy<br>Other past |
| | Others | Academia | Opportunities<br>Education<br>Basic focus<br>Old-fashioned<br>Competition<br>Experts |
| | | Industry | Innovation-driven<br>Platform for interaction<br>Quiet |
| | | Government | Leadership<br>Centralised/Fragmented<br>Who are the policy-makers?<br>Politicians – lack of education<br>Politicians - interest<br>Civil service – lack of education<br>Civil service - expertise |
| | | NGO/Civil society | Lack of interest<br>Behavioural point<br>Science focus<br>External |
| | | Public | Awareness<br>Not interested<br>Represented by NGOs<br>Scaremongering<br>Love technology and science<br>Why important? |
| | | Other | University leadership<br>EU<br>Media<br>Professional bodies<br>Other countries<br>Research funders |
| Organisational diversity | Inclusion | Decision-making | National/regional<br>Experts make decisions<br>Triple helix<br>Rubbish politicians<br>Fragmentation<br>Dealing with change |
| | | Advisory capacity | Value of advise<br>Committees/working groups<br>Specific questions<br>Not heard |
| | | Excluded | Limits to decision making<br>Not listened to |
| | Interaction | Formal | Meetings<br>Groups |

| | | | |
|---|---|---|---|
| | | Informal | Seminars<br>Breaks<br>Knowing everyone<br>Friends |
| | | Domestic | Bottom up/top down interaction<br>Conflict<br>Successful projects |
| | | International | Competition<br>Comparison<br>Small country<br>Norden<br>EU |
| | Openness | Secrecy | Uninformed – Misinformed<br>Nothing new<br>Against the law |
| | | Club/Network | Friends<br>Network of networks<br>No club<br>Membership/Ownership<br>Political culture |
| | Transparency | Decision-making | Process not open<br>Easy to find information<br>Contacts |
| | | Decisions | Right-to-access law<br>Website references |
| | | Documents | |
| Social accountability | Trust | Public | Culture<br>Citizens' view on science and technologies<br>Controversies/No controversies<br>Science barometer |
| | | Towards others | Lack of expertise<br>Dominance of a few<br>It's the way it is<br>Structural problem/institutional culture |
| | Public engagement | Own involvement | VA<br>Citizens jury<br>Nanodialogues<br>Other UK dialogue |
| | | Science communication | Awareness<br>Information |
| | | Purpose | Sell science<br>Avoid controversies<br>Not sure<br>Clear purpose<br>Increase interest |
| | | Limits | Errors in material<br>No point or purpose<br>Badly organised<br>We don't do PE |
| | | Examples | |
| Topics | Promotion | Innovation | Innovation policy<br>Slowing down innovation<br>Economic history<br>Lack of innovation system<br>Important, but |
| | | KBE | For the future<br>Politicians think important<br>OECD |
| | | Commercialization | SMEs<br>Large companies<br>Commercial push<br>Domestic industry |
| | | Business Interest | Less fragmentation<br>Mix with academia<br>Regional interests<br>Urban area/clusters<br>Regulations |
| | Regulation | Risks | Risk assessments<br>Life cycle assessments<br>Sharing information<br>Important for business |

| | | | |
|---|---|---|---|
| | | | Responsible nano code<br>Voluntary Reporting Scheme |
| | | Health and Safety | In laboratories and universities<br>Industry assessments<br>Nanosafety |
| | | Domestic legislation | Lack of domestic regulation<br>Not sure who does this |
| | | International legislation | EU-level<br>REACH<br>Cosmetics directive |
| | | Guidelines | |
| | Research | Basic/Applied | Brain drain<br>Enough research funding<br>Lack of funding<br>Both basic and applied |
| | | Collaboration | Geographic distance<br>No collaboration<br>Large multi-partner projects<br>Competing bids<br>Political decisions |
| | | Subjects | Nanotoxicology<br>Nanometorology<br>Nanomedicine<br>Nanophysics<br>Biotechnology<br>Nano-forestry<br>Environmental science<br>Pharmacology<br>Optics<br>Smart materials |
| | | Infrastructure | Sharing labs<br>Cleanrooms<br>Large equipment<br>Industrial partnerships |
| | | Social and ethical implications | International comparison<br>No technology yet<br>Ethical review board<br>Social responsibility |

# APPENDIX III: Master table of themes for IPA case study

| **Master table of themes for the group paired with extracts from IPA analysis** | |
|---|---|
| **A. Focus on self** | |
| *Perception of own role/identity* | |
| Scott: what you do is, you push all the sector areas | |
| Jari: And then there is also, um, er, [inaudible] advisory panel of nano-sciences, it's, um (…) I think it's managed by the Ministry of Education and the members are then… Ministry of Social Affairs and Health, the Academy of Finland, Tekes of course, and the Ministry of Defence, and then I'm one of the members. | |
| Jari: I was a member of the Euroscience [?] Committee and [unclear] identified… emerging and newly identified health risks | |
| Christer: I've after all been a researcher all my life | |
| Christer: alltså jag hade suttit då i NFRs styrelse det som var en del av det som nu är VR va | |
| *Perception of self in relation to others* | |
| Scott: Ive been trying to make the current government aware of the mistake they're making with this, and I do see a possibility of a turnaround now | |
| Scott: Most of them have not got, uh, a proper qualification, as I would put it. | |
| Scott: It was one of the worst written documents I've ever seen, so it didn't say very much for their standard of report writing | |
| Christer: I thought it would be an advantage for us to turn up as researchers, and not as administrators, | |
| **B. Focus on others** | |
| *Perception of others* | |
| Scott: I've been trying to make the current government aware of the mistake they're making with this, and I do see a possibility of a turnaround now | |
| Scott: Most of them have not got, uh, a proper qualification, as I would put it. | |
| Jari: And Tekes policy is that what's interesting to companies is interesting to Tekes. And that what's not interesting to companies is not interesting to Tekes | |
| **C. Focus on negotiations** | |
| *Ownership of topic* | |
| Jari: I don't know. At least I've been asked. (…) I mean, it's not on a daily basis, but on a weekly basis. | |
| Jari: all these organisations, er, identified nanosafety as a very important issue, but none of them was ready to take an overall responsibility for safety in nanotechnology. | |
| Scott: I do see a possibility of a turnaround now | |
| *Looking beyond own interests* | |
| Jari: it's managed by the Ministry of Education and the members are then… Ministry of Social Affairs and Health, the Academy of Finland, Tekes of course, and the Ministry of Defence | |
| Jari: it 's always been like that… | |
| *Own feelings* | |
| Christer: well at least that was the worst cold shower I've had with regards to, and I've had more cold showers, but I actually, but, I thought it would be an advantage for us to turn up as researchers, and not as administrators | |
| Christer: we felt everything fall to pieces, and I guess our activities decreased after that | |
| Scott: but setting up even more [laugh], as though that solved a problem | |
| Scott: It was ignored | |
| Scott: I know they saw it, because I saw the drafts on my email. | |
| *Explanations for adverse event* | |
| Scott: at a higher level, and its very hard to penetrate what thoughts are going on at that high level | |
| Scott: So I think this …it's taking a long time for the message to get across | |
| Christer: we're obviously locked into our systems [of science governance], and it's impossible to get away from all of that | |
| Jari: And Tekes policy is that what's interesting to companies is interesting to Tekes. And that what's not interesting to companies is not interesting to Tekes, it 's always been like that… | |
| Jari: Well, they ask for my opinion but they don't take it into consideration | |
| **D. Focus on change** | |
| *Self doubt* | |
| Christer: I'm not the only nanophysicist in this country, but… | |
| Christer: she may have considered us unclear too | |
| *Change in others* | |
| Scott: I've been trying to make the current government aware of the mistake they're making with this, and I do see a possibility of a turnaround now | |
| *Change in system* | |
| Christer: with more collaboration among researchers and also, er, in larger discussions with politicians and funders, we should be able to change [the system] but if, if it will happen it will take many years obviously | |
| *No expectations* | |
| Jari: But it's the way it is. | |