Ethics in practice: responding to an evolving problematic situation of nanotechnology in society

Clare Shelley-Egan

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ETHICS IN PRACTICE: RESPONDING TO AN EVOLVING PROBLEMATIC SITUATION OF NANOTECHNOLOGY IN SOCIETY

DISSERTATION

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the degree of doctor at the University of Twente,
on the authority of the rector magnificus,
prof. dr. H. Brinksma,
on account of the decision of the graduation committee,
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by

Clare Shelley-Egan

born on 29th April, 1982
in Cork, Ireland

This dissertation has been approved by the promotor prof. dr. Arie Rip
and the assistant promotor dr. M. Kirejczyk.

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1. Introduction

The development of a new and emerging science and technology (NEST) such as nanotechnology poses a number of challenges because it introduces novelty and uncertainty. Various actors are faced with how to respond to this novelty and uncertainty. Responses to the situation of novelty will initially take the form of 'tried and tested' approaches to previous new technologies. For example, when concern emerged about the health and safety risks of nanoparticles, the response of regulatory actors was to fall back on standard regulations to deal with new materials. At the level of societal debate, responses to new and emerging science and technology take the shape of characteristic patterns of argumentation, which were played out in earlier experiences with new technologies (Swierstra & Rip, 2007).

At the institutional/collective level, "organized irresponsibility" is an effect of standard responses to novelty because the explicit and implicit responsibilities of the past may not be adequate in the new situation. "Organized irresponsibility" is a key feature of Beck's (1995) diagnosis of risk society; late modern society allows scientists, engineers and industry to develop and introduce a variety of new technologies, while at the same time it lacks the means to hold anyone accountable. Moreover, this is not easy to do because technological innovation and its consequences involve the work of many actors and the outcome depends on their interactions, i.e. the outcome occurs at a collective level, for which no individual actor can be held responsible (Von Schomberg, 2007). While individuals might act responsibly, such responsible behaviour need not add up to responsible outcomes at the collective level. In order to overcome "organized irresponsibility", ongoing organisation of responsibilities occurs (Merkx, 2008) but this cannot always keep pace with ongoing advances in science, technology and industry.

In nanotechnology, there is recognition of the problem of 'organising' responsibilities, for example, in discourse on the 'responsible development' of nanotechnologies (Rip & Shelley-Egan, 2010). This discourse on 'responsible development' is striking as it comprises a novel response to the novelty and uncertainty of nanotechnology at the institutional level. At present, 'responsible development' is primarily a policy discourse and is a substantial element of current debate on nanopolicy (Ferrari, 2010). The notion of 'responsible development' has been extended to 'responsible research' (Robinson, 2010) as in the EU Code of Conduct for Responsible Nanoscience and Nanotechnologies

Research.[1] The Code “assigns responsibilities to actors beyond governments, and promotes these actors’ active involvement against the backdrop of a set of basic and widely shared principles of governance and ethics” (Von Schomberg, 2010, p. 66).

At the individual level, various actors are faced with how to respond to the discourse of ‘responsible development’ of nanotechnologies. Although ‘responsible development’ is not operationalised and there are no specific, dedicated activities associated with it, actors nonetheless feel the pressure to respond. Actors who actively pursue the development of nanoscience and nanotechnology have a particularly interesting position in this regard because they are co-constructing the novelty and are thus a key part of the dynamics that lead to “organized irresponsibility”.

In this thesis, I will focus on scientists and industrialists and their responses to the evolving situation they find themselves in, both as individuals and on a collective level. I will map the responses of scientists and industrialists in relation to the challenge of the novelty and uncertainty of nanotechnology and evaluate their responses with regard to opportunities and possibilities for responses which go beyond just adding to ‘organized irresponsibility’. This research was carried out as part of the ‘Ethics in the Real World’ workpackage in the EU - funded DEEPEN (Deepening Ethical Engagement and Participation in Emerging Nanotechnologies) project.[2]

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[1] European Commission 2008. A code of conduct for responsible nanosciences and nanotechnologies research. A Commission Recommendation of 07/02/2008.
See http://ec.europa.eu/nanotechnology/pdf/nanocode-rec_pe0894c_en.pdf

[2] The DEEPEN project was a three year European research project which involved researchers from ethics, philosophy and the social and political sciences and aimed at deepening understanding of the ethical dimensions of emerging nanotechnologies and their significance for civil society, governance and scientific practice (Davies, Macnaghten, & Kearnes, 2009). In retrospect, project partners commented on the project as having brought together diverse research partners who shared a vague dissatisfaction with the process institutionally cast as the “responsible development of nanoscience and nanotechnologies” and with the framing of the debate and the roles assigned to social scientists and philosophers in the process (Nordmann & Macnaghten, 2010). This dissatisfaction led to new ways of exploring the meaning of “responsible development” through social science analysis of how ethics and responsibility are understood within the nanoscience community and the bringing together of social science methodology and philosophy aimed at understanding how lay publics view the ethical import of emerging nanotechnologies. Overall, this interdisciplinary approach aimed at deepening

Scientists and industrialists are active stakeholders in the development of nanotechnology. While these actors have different ethical perspectives and divisions of labour, their worlds do intersect; professional societies which have links with both worlds act as a conduit of interactions between both worlds, enabling 'trading zones' (cf. Galison, 1997) between the different spheres of action. In the world of nanotechnology, the 'trading zones' are often there from the beginning, with nanoscientists moving easily in the world of industry. This is further enabled by the umbrella-term character of 'nanotechnology' which acts as a conduit between science and industry. Both types of actors are involved in constructing the novelty of nanotechnology.

In responding to the discourse of responsible development, scientists and industrialists will fall back on the particular ethical stances and commitments which are appropriate to their role and context as a scientist or industrialist. However, their ethical stances and commitments may no longer be sufficient in the face of new problems brought on by nanotechnology. The different strands in the co-evolution of technology, society and morality do not move equally quickly. As noted already, responsibilities and ethical stances may lag behind the development of new technologies.

Technologies shape the societies in which they are introduced and *vice versa*. The co-evolution of technology and society (Rip & Kemp, 1998) includes morality (Swierstra, Stemerding, & Boenink, 2009). The novelty of new and emerging science and technology (NEST) can lead to the uprooting of moral routines. The moral routines that were once unproblematically accepted may be opened up by new problems and dilemmas which are made visible by the new technology (Swierstra & Rip, 2007). In the latter's parlance, morality becomes ethics, that is, ethics constitutes critical reflection and discussion on morality. Ethics is 'hot' morality while morality is 'cold' ethics (Swierstra & Rip, 2007; Swierstra et al., 2009).The 'cold' ethics of actors may be 'heated up' by developments around the new technology.

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ethical understanding of issues related to emerging nanotechnologies and allowed for the formulation of new perspectives for nanoethics
(Ferrari & Nordmann, 2010).
http://www.geography.dur.ac.uk/Projects/Default.aspx?alias=www.geography.dur.ac.uk/projects/deepen

How will this work? There is always co-evolution of technology and society taking place. The novelty and uncertainty of new technologies such as nanotechnology may destabilise 'tried and tested' responses to new technologies. Actors will try to anticipate how nanotechnology and society will co-evolve, to be prepared for eventualities and/or in a more reflexive way, as is visible in the move towards 'responsible development' of nanoscience and nanotechnology. Such responses shape further action and choices but are themselves embedded in existing roles, repertoires and mutual dependencies. In that sense, future developments are 'endogenous' (Rip & Te Kulve, 2008; Robinson, 2010), predicated on (but not completely determined by) the forcefields and dynamics of the present.

The co-evolution of technology and society is a common theme in Science and Technology Studies. Just as morality is implicated - co-evolution "does not halt at the door of morality" (Swierstra et al., 2009, p. 120) - the insights of STS should not halt and refuse to consider normative aspects. Indeed Winner (1993), Radder (1992) and others have diagnosed a "normative deficit" in STS. It is necessary to include ethical analysis but not just any ethical analysis: pragmatist ethics offers a promising approach as it recognises the co-evolution of technology and society and considers the normative implications of this co-evolution (Keulartz, Korthals, Schermer, & Swierstra, 2002). Pragmatist ethics constitutes an ethical perspective that allows for an open treatment of novelty and uncertainty; this is in contrast to a deontological approach in which responses to novelty and uncertainty are judged according to given rules or principles.

While pragmatist ethics can be used to address the topic of my thesis, it needs to be developed further, in particular by adding a sociological dimension, before I can deploy it to address the questions in this thesis. I will develop this in the following sections so as to show how my research questions are embedded in a diagnosis that draws on co-evolutionary dynamics and pragmatist ethics.

1.1 Pragmatist ethics and new and emerging science and technology

Pragmatist ethics starts with a specific problematic situation and emphasises the manner in which actors address the situation and can develop novel constructs and hypotheses with which to approach emergent problems (Keulartz, Schermer, Korthals, & Swierstra, 2004).

This is in contrast to principle-based ethics in which established ethical principles are applied to new moral problems as they emerge (Van de Poel, 2008).

Principle-based ethics offers a 'tried and tested' response to the moral problems which NEST can bring to light but the 'tested' aspect of the response may no longer be applicable. Principle-based ethics does not address the co-evolution of technology and society and thus closes (at least, attempts to close) what is still an open, fluid situation.

Pragmatists argue that one should not expect 'tried and tested' responses to be adequate. Due to the openness of the world, such responses will be challenged by situations which present unexpected problems or obstacles. Individuals then find themselves in a situation in which they are required to revise their beliefs and habits. Due to the emergent nature of these situations, they can rarely be solved by employing existing rules and routines but necessitate new concepts and vocabularies (Keulartz et al., 2002).

Pragmatist ethics, in particular the pragmatism of the American philosopher John Dewey, emphasises an experimental and empirical approach to ethical inquiry within specific problem situations (Minteer, Corley, & Manning, 2004). [3]

For Dewey, moral subject matter is always experienced as part of a "situation" (Pappas, 1998). Moral theory should be grounded in individuals' experience. Morals are "not a catalogue of acts nor a set of rules to be applied like drugstore prescriptions or cook-book recipes" (Dewey, 1920, p. 170). Moral theory is developed from the particular facts and the deliberation that are characteristic of a particular moral situation (Pappas, 1998).

There are three main stages in Dewey's model of moral inquiry. In the first stage, the agent finds him or herself in a morally problematic situation; a morally problematic situation is one in which a "felt moral

[3] Dewey was a dominating presence in the fields of political theory, philosophy and education. However, his influence went into eclipse following World War II. Dewey's insights received renewed attention from social and political philosophers and philosophers of education from the 1980s onwards (Caspary, 2000; Hickman, 1998). Interest in Dewey's pragmatist ethics is visible in environmental ethics (cf. Light & Katz, 1996), animal ethics (Kupper, 2009; McKenna & Light, 2004) and ethics tailored to modern technological culture (Keulartz et al., 2002).

perplexity controls and pervades the development of the situation as a whole" (Pappas, 1998, p. 118). In the second stage, the agent engages in a process of moral deliberation. In the third stage, he or she arrives at a judgement that results in a choice (Pappas, 1998).

For Dewey, "All reflective inquiry starts from a problematic situation" (Dewey, 1929, p. 189). Problems trigger reflective inquiry and those engaged in reflective inquiry seek out problems, that is, they problematize their experiences as a means of understanding them more fully (Hiebert et al., 1996).

The basic characteristics of reflective inquiry can be formulated as 1) problems are identified; 2) the inquirer stands within the problematic situation and actively engages with it; and 3) inquiry proceeds from doubt to the resolution of doubt as problems are (at least partially) resolved (Hiebert et al., 1996; Schön, 1992).

For the purposes of this thesis, Dewey's pragmatist ethics, in particular his notion of a 'problematic situation' and his emphasis on reflective inquiry, offers important entrance points.

The notion of 'problematic situation' offers a means of understanding the ethical perspectives of actors and their responses to novelty and to respect their attempts to address this situation. I will also use the notion of 'wicked problem' (cf. Rittel & Webber, 1973) in order to emphasise that some problems thrown up by the novelty and uncertainty of nanotechnology may be intractable. Dewey's notion of 'reflective inquiry' also has to be articulated further because in Dewey's writings reflective inquiry centres on actors identifying a problem and actively engaging with it in order to devise some sort of solution. As I will argue in the following section, the conditions for reflective inquiry might not always be present. In Chapter 2, I will elaborate on how I will use the notion of 'reflective inquiry' in this thesis.

1.2 The 'problematic situation'

For my purposes of mapping the ethical stances and commitments of actors in relation to a problematic situation, Dewey's notion requires some re-thinking. Dewey supposes that people can more or less oversee the situations in which they find themselves, that is, actors will *know* when they are faced with a problematic situation. However, actors look at/respond to the world in terms of how they are located in the world; their location might preclude them from recognising that there is a

problematic situation. In other words, what is "objectively" (i.e. for observers) a 'problematic situation' may not be recognised as such by actors in the midst of the situation. Moreover, even if they *do* recognise that there is a problematic situation, they may still respond with typical ethical stances and commitments which they do not see as problematic or unproductive, while they may actually be so.[4] Such a response may create a further and in a sense, second-order, problematic situation.
The reasons behind why and how this happens can be taken as a question of psychology and sociology. This is not the whole story, however. People are never completely bound by their position and role and some people can take a leading role in diagnosing the problematic situation and making others aware of it. Institutions (in the sociological sense) exert constraints through their rules; however actors at the collective level may be able to take initiatives that create openings for individual actors in institutions. This is what happens in the push for responsible development.

My re-thinking of Dewey's notion of a 'problematic situation' implies a need for sociological reflexivity, i.e. recognition of the context in which one is embedded and co-evolution at the collective level. I can illustrate this with the case of the recent call for responsible development of nanotechnology.

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[4] There is an analogy with Hughes' (1983) concepts of 'reverse salients' and 'critical problems'. In an expanding technological system (in his case, electricity networks from the late 19th century onward), a reverse salient can occur which impedes the growth of the system and which would require dedicated action if expansion of the system is to continue. Engineers and other system builders may or may not recognise the reverse salient for what it is. If they do, they define it as a "critical problem" which has to be attended to. In the case of nanotechnology, scientists and industrialists often think in terms of obstacles to expansion. For example, if there is opposition (actual or expected) to the further development of nanotechnology, scientists and industrialists will view this as a critical problem that has to be attended to, by elaborating on nanotechnology and its promises and/or accepting the need to also consider risks and societal implications. While this is important, it is still predicated on the goal of removing impediments to growth. This goal is not problematized, while the opposition (or just reluctance to go along with the promises) relates to the presumption of further expansion. Actions to assure expansion may then not be productive. Moreover, they constitute a missed opportunity for reflective inquiry about the situation.

The call for 'responsible development' of nanotechnologies has a dual role. On the one hand, it is a response, largely at policy level, to the novelty of nanotechnology and an attempt to put 'responsibility' on the agenda. On the other hand, the call is something that impinges on the present roles and practices of actors in the nano-world. In this way, it creates a problematic situation for the actors because they may not think in terms of the creation of novelty as leading to problematic situations and see no need to change their ways. However, they cannot just negate the call for responsible development. From their point of view, this is another external pressure that has to be addressed somehow (e.g. on paper), in order to continue with their practices. The broader problematic situation of nanotechnology in society is reduced to the problem of how to handle further external pressure. There is little sociological reflexivity.

This is not the whole story, however. While the general call for 'responsible development' is diffuse, it is now becoming more concrete, e.g. in the EC Code of Conduct for Responsible Nanoscience and Nanotechnologies Research, which may literally impinge on practices when Member States accept the Code. The arguments for the Code itself include a reference to a 'general culture of responsibility' which is necessary in view of the uncertainties posed by nanoscience and nanotechnologies research. This places the Code squarely in the overall *problématique* of organized irresponsibility and how to do better. The development and possible implementation of the Code has certain legitimacy, especially at the collective level. Individual actors cannot argue against it but can try to position it as creating problems for another responsibility, i.e. to advance science.

While this can lead to a struggle with present positions and interests, it can also lead actors to consider a broader definition of the problematic situation, problematizing their present roles and responsibilities. They might need help to make this move. This is actually being tried out, independently of the EC Code of Conduct, in Constructive TA exercises (Robinson, 2010) and in interactions with social scientists and philosophers on the lab floor, as is happening in the Socio-Technical Integration Research (STIR) project.[5]

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[5] Rip (2009) offers a critical evaluation of various approaches, broadly subsumed under ELSA (Ethical, Legal and Social Aspects) studies, aimed at contributing to ongoing research and to reflection on research agendas.

1.3 Responses to new technologies: a multi-level perspective

There is a second step to be taken in my sociological extension of Dewey's pragmatist ethics. The interaction between responses to novelty and the ethical perspectives of actors is part of larger co-evolutionary changes.

The multi-level perspective of socio-technical change in society (Rip & Kemp, 1998; Geels, 2005) is important for understanding overall dynamics and as I will show, also allows a further explication of how morality can change.

Technological developments are situated in a socio-technical *landscape,* comprising infrastructures as well as institutions and cultural and normative values, all of which change only slowly. Ongoing technological developments are shaped by their socio-technical *regimes*, similar to the paradigms (as Kuhn, 1962, phrased it) in science. Regimes tend to generate incremental innovations. At the *niche* level, novelties emerge and are nurtured in protected spaces (Geels, 2002).

The salient point of the multi-level perspective is as follows: "the further success of a new technology is not only governed by processes within the niche, but also by developments at the level of the existing regime and the sociotechnical landscape" (Geels, 2002, p. 1261).

This multi-level perspective can be used to understand the interaction between technology and morality, as Stemerding et al. (2010) have outlined.
At the macro-level of society, the co-evolution of technology and society has stabilised, as is visible in the current division of moral labour in science. On the meso-level of institutions and practices, there are concretisations of this division of moral labour, in which standard repertoires and practices are part of regimes. On the micro-level, actors must find novel ways of dealing with concrete problematic situations brought to light by the new technology.

The macro level of the moral landscape (which includes the current division of moral labour) forms the backdrop to the micro and meso levels. The meso level of institutions and established practices enables and constrains actors in their responses to the new technology. However, at the same time, the ethical perspectives of actors may change as they attempt to respond to the call for 'responsible development' of nanotechnology. It is on the micro-level of concrete problematic situations that novel choices and decisions are made. While these changes may be local and incidental, they also add up and initiate more structural change on the levels of moral regimes and the moral landscape.

1.4 Outline of the thesis

The aim of this thesis is to map the ethical stances and choices of scientists and industrialists in their responses to an evolving problematic situation of nanotechnology in society and to evaluate these responses in the light of productive ways of 'organising' responsibilities and divisions of moral labour.

My two research questions are specifications of these broader aims:

- What are the ethical stances, ethical choices and justification of interests and positions of actors (scientists and industrialists) who have a stake in the development of nanotechnology? What kinds of responses to the novelty of nanotechnology do they have?
  What is the current role of ethical stances and choices in the development of nanotechnology?
    - These questions concern an analysis at the micro level of responses to the problematic situations related to the 'responsible development' of nanotechnology

- Given the ethical stances and choices of actors in the world of nanotechnology and the dynamics of the current division of moral labour, what kinds of choices and responses might lead to new ways of 'organising' responsibilities and a 'better' division of moral labour? How can this be done, if at all?
    - This question reflects an analysis at the meso and macro levels (at the collective level) of institutional context and practices and the current division of moral labour, respectively.

Chapter outline

Chapter 2 addresses the descriptive aim of the thesis, i.e. to trace and map the ethical stances and commitments at the micro-level of responses of scientists and industrialists to the novelty and uncertainty of nanotechnology. First, I describe how 'ethics' is used in this thesis; this is important as my use of 'ethics' informs the data collection. Then I map what is known in the literature about the moral stances of scientists and industrialists in their practices and interactions in order to understand the particular context in which these actors are embedded. Next, I describe the particular perspectives scientists and industrialists bring to problematic situations and discuss the way in which these perspectives differ from other actors such as consumers and regulators. Finally, I set out the research design and methods.

In Chapter 3, I report on findings from discussions with two groups of scientists on accountability/responsibility of scientists. The emphasis on increased accountability/responsibility of scientists comprises a problematic situation related to the 'responsible development' of nanoscience and nanotechnologies. I describe how one group of scientists articulate/justify their accountability/responsibility and report on a discussion with a second group of scientists about the 'problematic situation' constituted by the call for greater accountability/responsibility in ongoing practices in science. This chapter offer insights into the status of ethics in science and the importance of the institutional context of science for scientists' responses to problematic situations.

In Chapter 4, I present empirical research which describes how 'responsible development' of nanotechnologies is articulated by industrial actors. I describe how recognition of the 'wicked' problem of how to 'do' responsible development varies for different sectors, leading to different approaches to dealing with this problem. I argue that differing perspectives and the predominance of short-term self-interest make (partial) resolution of the 'wicked' problem difficult to achieve. However, new practices and interactions with stakeholders show promise in terms of opening up spaces for learning and the broadening of responses and perspectives of industrial actors.

Chapter 5 is a 'bridging chapter' in that is summarises the empirical findings and sets the scene for a discussion of further questions. This chapter has three objectives. First, it synthesises the findings of the two previous empirical chapters in order to see the 'bigger picture' in relation to responses to problematic situations at the micro-level. Second, the chapter offers a forward look by providing an argument for why change is necessary and identifying possibilities and opportunities for change. Third, the chapter concludes with a discussion of the shaping effect of patterns and dynamics at meso-and macro-levels on reflective inquiry at the individual or micro-level and sets out building blocks for sociologically informed reflective inquiry, to be taken up in chapters 6-8.

The first cluster of building blocks offered in Chapter 6, starts with the ambivalence of promising technology; phrased as an ethical issue it is about whether "to exaggerate or not to exaggerate". This is a general issue but nanotechnology highlights existing ambivalences as promises which may turn into hype and introduces new ambivalences such as "size matters" and "nano inside". Ambivalences "imply that there is no simple resolution: an attempt to go for one side of the ambivalence brings out the problems linked with the other side" (Swierstra & Rip 2007, p. 16). Thus, it forces actors to be somewhat reflective about the situation and to recognise its problematic character. Further data from interviews with industrialists (see Chapter 4) are used to map their responses to this particular problematic situation. Due to the importance of multi-level analysis, I include an addendum by discussing the meso-level of the 'regime of economics of techno-scientific promises'.

The second cluster of building blocks in Chapter 7 discusses approaches to enhancing ethical reflexivity as a means of modulating responses at the individual level. Enhancing the ethical reflexivity of scientists facilitates the 'heating up' of scientists' perspectives by encouraging them to articulate their reflexivity and offering them tools to do so. Scientists are a key part of the dynamic that leads to "organized irresponsibility". With this in mind, I discuss possibilities for enhancing ethical reflexivity of scientists (at the micro-level) as a larger process of reflexiveness (at the meso-level).

The third cluster of building blocks, addressed in Chapter 8, concerns current divisions of moral labour for science and industry which form a backdrop to problematic situations faced by scientists and industrialists and are a problematic situation in themselves (cf. 'organized irresponsibility'). I discuss whether current divisions of moral labour are still adequate in the face of the novelty and uncertainty introduced by newly emerging science and technology and argue for the opening up of the taken-for-granted nature of existing divisions of moral labour.

The final chapter, Chapter 9, looks back at the story so far and offers a discussion of the sociological extension of Dewey's pragmatist ethics and a brief reflective inquiry into the contribution of sociology. In the second part of the chapter, I develop a forward look in relation to how current efforts and activities around the 'responsible development' of nanotechnology might play out in the future.

2. Literature and research design

This chapter addresses the descriptive aim of the thesis, i.e. to trace and map the ethical stances and commitments at the micro-level of responses of scientists and industrialists to the novelty and uncertainty of nanotechnology. In order to understand the responses of individual scientists and industrialists to the novelty and uncertainty of nanotechnology, it is necessary to understand the particular context in which these actors are embedded. To that end, I will map, in sections 2.2 and 2.3, what is already known about the moral stances of scientists and industrialists in their respective practices and in their actions and interactions in the outside world.

The literature survey emphasises ethical perspectives in context from the 'inside' and on the 'outside' of the world of nano-actors. The 'inside' context relates to the role of ethical perspectives in the everyday practices of the actors and in the justifications they give for their interests and positions. The 'outside' context concerns the way in which actors relate to the outside world and the manner in which the ethical perspectives of actors are perceived in the outside world.

Before I discuss the literature, I need to indicate, in section 2.1, what is meant by 'ethics' in this thesis. This is necessary because nano-actors tend to use 'ethics' terminology in ways that differ from ethical analysts. Following on from that, I will describe how 'ethics' and 'morality' are conceptualised in this thesis, following Swierstra's idea of morality as 'cold' ethics, and ethics as 'hot' morality. This conceptualisation of ethics informs the collection of data.

I return to some of these issues in section 2.4, in my discussion of 'lay' ethics and the perspectives of enactors. This discussion is necessary in order to position my research design.

2.1 Ethics

Actors appear to use 'ethics' terminology in ways that differ from ethical analysts. Actors use 'ethical' and 'unethical' to argue for what is good or bad to do. Swierstra & Rip (2007) offer an example of this type of argument in a quote from Philip J. Bond, US Under-Secretary of Commerce in his contribution to a 2004 SwissRe workshop on 'Responsible nanotechnology development':

> Given nanotechnology's extraordinary economic and societal potential, it would be unethical, in my view, to attempt to halt scientific and technological progress in nanotechnology. (…) Given this fantastic potential, how can our attempt to harness nanotechnology's power at the earliest opportunity – to alleviate so many earthly ills – be anything other than ethical? Conversely, how can a choice to halt be anything other than unethical? (Bond, 2005, cited in Swierstra & Rip, 2007, p. 4).

When actors in the nano - world call for ethics and ask ethicists to help them, they expect advice about what should be done and what should not be done. In the same vein, ethical issues are often predefined in the form of a checklist, where single issues can be ticked off, one after the other, as Strassnig (2009) observes. Actors' use of 'ethics' differs from the way in which 'ethics' is used by ethicists; ethicists may refer to actors' use of ethics as moral choices and ethical stances, rather than ethics, as *they* address and study ethics. Ethicists focus on the justification of various claims about what is 'good' and 'bad' to do, rather than on the claims themselves.

A further way in which 'ethics' is used is as a contrast with, or an addition to, other aspects and considerations, such as the importance of market dynamics and economic growth. An example of this use of 'ethics' is visible in the use of the acronym 'ELSA' for 'Ethical, Legal and Social Aspects' which introduces three different aspects.[6]

In my usage of 'ethics', I move away from actors' terminology of 'ethical' and 'unethical'. The effect of actors choosing for 'good' or 'bad' is a focus on specific issues, rather than the discovery of new ways with which to deal with emerging problems, which I would emphasise. The *justification* of ethical stances and ethical choices is the important aspect.
For this reason, I will focus on 'ethical stances', which relate to the justification of interests and positions and on 'ethical choices'. In interviews and discussions, this terminology moves closer to questions of justification and avoids immediate recourse to what is good and bad to do. It also induces reference to concrete examples from actors to explore ethics in the real world.

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[6] Swierstra & Rip (2007) point out that so-called 'non-ethical' arguments ultimately refer to stakeholders' interests and rights and/or to views of what the 'good life' could be and are thus ethics. This is particularly important for health and environmental risk issues because these are often treated as technical issues.

Secondly, I build on the pragmatist ethics of Dewey and Swierstra. In line with Swierstra & Rip (2007), who follow Dewey's philosophical pragmatism, I take ethics as 'hot' morality. Dewey viewed moral life as a process: "In his view, the "rhythm" of our moral life is one of disruptions followed by reunions and then by phases of "confident, straight-forward, organized" activity… These "breaks" in the "flow" are problems that often call for moral decisions" (Pappas, 1998, p. 108). Such breaks in the flow of moral life emerge when people go against moral routines, when conflicts arise between routines, leading to a moral dilemma or when moral routines are no longer adequate to respond to new problems (Swierstra & Rip, 2007).

In the world of nanotechnology, there are indications that the 'cold' ethics of actors is 'heating up'. The EC Code of Conduct for Responsible Nanosciences and Nanotechnologies Research is an example in its call for a renegotiation of the current division of moral labour in science, implying that current ethical stances and ethical choices of actors require reflection.

In Chapter 1, I offered my comments on Dewey's notions of 'problematic situation' and 'reflective inquiry' for the purposes of understanding the responses of scientists and industrialists to the novelty and uncertainty of nanotechnology. Now that I have specified my notion of 'ethics', I can define my use of 'reflective inquiry' in this thesis. It is particularly relevant for the responses to the call for responsible development of nanotechnology.

Often, short-circuiting occurs in the response to problematic situations related to the 'responsible development' of nanotechnology, for example, the attribution of praise and blame by actors and the positioning of issues as 'good' and 'bad'. In this way, opportunities for reflective inquiry are missed. The recourse to morality or 'cold' ethics allows the actors to do the short-circuiting. By stimulating reflexive inquiry, their morality can be 'heated' up. This can be initiated by some actors disagreeing with others and getting a hearing. It can also be initiated from the outside, as when the EC Code of Conduct calls for 'a general culture of responsibility' (see Chapter 1, Section 1.2).

'Heating up' is also visible in the field of nano-ethics, which is moving away from the compilation of lists of ethical issues of nanotechnology to the creation of a new agenda for nano-ethics which recognises the co-evolution of ethics, technology and society (cf. Ferrari, 2010). Although discussions take place among *ethicists*, they are also interesting for my mapping and analysis of ethical stances of actors as the items discussed here can occur in actors' reflective inquiry as well.

One item relates to the dominant approach of bioethics, as in Beauchamp & Childress (2001), as it can be taken up in the ethics of nanotechnology. The specific approach of bioethics is very visible in the compilation of inventories of ethical issues (Ebbesen, Andersen, & Besenbacher, 2006; Lewenstein, 2006). There is little or no reflection on the specificities of nanotechnology and the overall effect is that ethical debate on nanotechnology is reduced to the listing of basic concerns.

The dominance of consequentialist frameworks, another item to consider, is visible in the focus on issues linked to the risks of nanoparticles and has the effect of framing ethical problems in terms of willingness or unwillingness to accept these risks (Ferrari, 2010). As Ferrari notes, authors are increasingly acknowledging the narrowness of the consequentialist framework; they are calling for a heightened focus on the motives and scope of technological development and reflection on issues such as sustainability and responsibility as a means of dealing with the uncertainty of nanotechnology.

As I have argued in Chapter 1, the call for responsible development of nanotechnologies is an attempt to cope with this uncertainty. Nordmann & Macnaghten (2010) criticise the conversational mode which they argue the notion of "responsible development" has adopted. Stakeholders and citizens are invited to participate in an on-going conversation about nanotechnology and to contribute, together with nano-researchers and policymakers, to its responsible development.[7] The limitation of such a conversational mode, they argue, is that the discussion remains vague and lacks focus: "…the participants in the conversation create room for considerable disagreement on the basis of the shared understanding that responsible development of nanotechnology is possible and desirable in the first place, and that one contributes to it by articulating concerns" (Nordmann & Macnaghten, 2010, p. 136). This has the effect that concerns can be expressed in an open-ended way, without the need for mutual articulation and feedback into action.

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[7] Similarly, Ferrari & Nordmann (2010) talk about ethics becoming a *lingua franca* that functions to bring stakeholders together, rather than discovering ethical concerns (which is what they would advocate).

Ferrari & Nordmann (2010) see the EC's Code of Conduct for Responsible Nanoscience and Nanotechnologies Research as an indication of impatience with the conversational mode of responsible development. It is definitely provocative in that its guidelines question the long-accepted division of moral labour and suggest a renegotiation of the contract between science and society, particularly in relation to the attribution of responsibility (Ferrari & Nordmann, 2010).

The Code of Conduct has heterogeneous elements but it does recognise a new ethics of collective co-responsibility (Von Schomberg, 2010) which goes beyond role-responsibility ethics and an emphasis on individual responsibility. Being collectively co-responsible involves developing transpersonal assessment mechanisms which go beyond "an analysis solely informed by the possible intentions of use or misuse of applications by individuals" (Von Schomberg, 2010, p. 63). Moreover, since being collectively co-responsible goes beyond role responsibility, it means that actors can no longer fall back on their mandate and just argue "As a scientist, I must do this…" or "As an industrialist, I can't avoid this…." Justifications for adhering to 'cold' roles and positions are now insufficient. The "organising" of responsibilities (Merkx, 2008) which collective co-responsibility necessitates will lead to reflective inquiry and might eventually lead to a change or shift in responsibilities.

The speculative nature of much current nanoethical debate has been criticised by Nordmann (2007) who argues that speculative nanoethics squanders ethical resources which could be better directed towards developments that are actually taking place rather than those that are still hypothetical and speculative. Speculative ethics diverts attention away from 'less exciting' yet no less important developments. Nordmann & Rip (2009) offer the same argument and warn that speculative ethics has led to a new gap between ethics and nanotechnology. Important for this discussion is the idea of a "re-appropriation of the present" (Ferrari, 2010). In another paper, Ferrari & Nordmann (2010) elaborate on what this implies for nanoethics:

> Instead of gazing only at what might come out of nanotechnological research, nanoethics needs to consider and evaluate what, concretely, goes into nanotechnological development. That is, it needs to look at funding priorities, research programs, technological visions, long-term trends like medicalization or ethicalization, old and new hopes, abstract and concrete fears (p. 175).

Clearly, the recent discussions of nano-ethics offer resources for reflective inquiry and can stimulate heating up of morality. The 'tried and tested' approaches to ethics in nanotechnology are insufficient and alternatives are being formulated. The need to look at the development of nanotechnology in the here and now rather than the outcomes or *possible* outcomes of development is another important proposal. My focus on scientists and industrialists as key actors, which I outlined in Chapter 1, can be further justified in this way.

2.2 The moral stances of scientists

A striking characteristic, emerging in the 16th and 17th centuries and by now fixed in the institutions of science (and thus in the outlook of scientists), is the strong boundary between inside and outside science. This boundary will structure my review of literature on moral stances of scientists.

2.2.1 Within the world of science

The literature demonstrates how, within the world of science, a complex moral language has emerged "which appears to focus on certain recurrent themes or issues; for instance, on procedures of communication, the place of rationality, the importance of impartiality and of commitment, and so on" (Mulkay, 1979, p. 71). This language functions as a forceful repertoire and continues to be drawn upon, as in the discussions of 'scientific integrity', endangered because of links with outside interests, bias and fraud.

Norms and 'paramount values' (Kuhn, 1962) are part of this moral language. Indeed, there have been attempts to summarise central norms, in particular in the so-called CUDOS norms drawn up by Robert Merton in the early 1940s (Merton, 1942/1973; Merton, 1976). Merton argues that it is the entire structure of technical and moral norms which implement the institutional goal of science, i.e. the extension of certified knowledge. There are four 'institutional imperatives' – universalism, communism, disinterestedness and organized scepticism – which together comprise the ethos of science.

While these norms have been viewed as universal and strict principles, they are essentially ambivalent, as Merton himself later emphasised. The ambivalence is the result of a particular feature of social institutions whereby "they tend to be patterned in terms of potentially conflicting pairs of norms" (Merton, 1976, p. 33). The individuals governed by the institution are required to manage these imposed inconsistencies and blend them into reasonably consistent action. According to Merton, while these values are not real "contradictories", they do suggest opposed kinds of behaviour. Ambivalence about norms, however, is not necessarily incongruent with how science 'should' be done. For example, Merton argues that the desire for recognition also demonstrates concern with the advancement of knowledge (as well as individual advancement) and so is in fact an *expression* of dedication to science.

Mitroff (1974) developed Merton's concept of sociological ambivalence into a search for a set of counter-norms for science. In a study of scientists working on the Apollo moon project, Mitroff shows that scientists also respect 'counter-norms', which are rough opposites of Merton's norms. Indeed, the scientists identified positive value in these counter-norms. For instance, they valued secrecy, as a "before-the-fact acknowledgement to oneself and others that one has something in the works worth protecting" (Mitroff, 1974, p. 593).

While norms are essentially ambivalent, they appear to be important for the successful functioning of science as an epistemic endeavour: "… the normative structure of science is seen as ensuring, as far as is humanly possible, that the external world is allowed 'to speak for itself'" (Mulkay, 1979, p. 64). Such a view informs the justifications that scientists and other inhabitants of the world of science put forward to uphold these norms and comply with them. In a sense, norms function to protect the scientific endeavour from undue interference.

Scientists can use norms to define specific responsibilities and to exclude others; thus norms can be said to exhibit 'interpretative flexibility' (Sismondo, 2004). For example, scientists argue that it is their duty to produce scientific knowledge by upholding the norms of objectivity and disinterestedness. In doing so, they actively underline their role, together with its attendant responsibility, that is, to work towards progress. However, at the same time, placing such emphasis on the norms of objectivity and disinterestedness closes off space for responsibility for broader social and ethical issues:

> [ethical] debate is banished from academic science itself by Merton's norms of "disinterestedness". In pursuit of complete "objectivity" (…) the norm rules that all research results should be conducted, presented and discussed quite impersonally, as if produced by androids or angels (Ziman, 1998).

This is not the way science works in practice, in the 'real' world rather than in a world of androids or angels. However, it demonstrates an implication of the strict version of Mertonian norms for the formulation of responsibilities. If scientists are responsible for producing objective, disinterested knowledge, they cannot be responsible for dealing with broader considerations, such as broader ethical issues.

Protected spaces

Sociologically, Mertonian-type norms facilitate a sort of 'protected space' (Rip, 2002b, 2011). Institutionally, 'protected spaces' offer relative autonomy and disciplinary authority and the reduction of interference from the outside world. Protected spaces have material, socio-cultural and institutional features. This is visible in the notion of a laboratory as a place where experiments can be carried out under restricted conditions; such conditions include the disciplining of its inhabitants and the exclusion of unwanted visitors (Rip, 2002b).
The laboratory comprises a micro-protected space to work on one's object of study. The paradigm of the specialty one works in also enables and constrains as a protected space. As Mulkay and others have emphasised, at the work level "Scientific theory and methodological rules operate as a dominant source of normative control" (Mulkay, 1979, p. 64). Daily research practices also provide normative guidance, as Whitley (1977) observes: "For many scientists, educational experiences and current tasks provide the basis for intellectual identity. The day-to-day exigencies of research direct their actions and views far more than any 'research programme' or community paradigm" (p. 24). This point has been borne out by the detailed laboratory studies that have been carried out since the late 1970s.

Given the emphasis on daily research practices and methodological rules, it is understandable that ethics (in the common sense of the word) can be easily seen as irrelevant or, as in the case of working with human subjects or doing animal experiments, to be translated into the procedural equivalent of methodological rules (cf. Strassnig, 2009).

The normative structuring of the scientific world remains strong, even while the macro- and micro- protected spaces of strategic science are opening up (Rip, 2002b, 2011) as a result of new regimes of distributed innovation and the 'recontextualisation of science in society' (Rip, 2007b). However, "…the relative protection of the world of the lab remains, and is functional…"(Rip, 2007b, p. 40).

There may be additions or modifications to the protected space but no basic changes. For example, there have been attempts to broaden the approach of researchers in the protected space of the lab. Fisher, Mahajan & Mitcham (2006) show that interactions between a social scientist and a natural scientist in the laboratory can lead to the consideration of broader issues in research. However, these issues relate to specific laboratory-related research objectives and environmental health and safety considerations rather than broader issues related to the outside world (Schuurbiers & Fisher, 2009).

Standard repertoires in science

The separation of science and ethics is visible in standard repertoires on which scientists draw. A repertoire is a cultural "toolkit" of habits, skills and world-views which people use in varying configurations to construct "strategies of action" (Swidler, 1986). Strategies of action comprise "persistent ways of ordering action through time" (Swidler, 1986, p. 273). A repertoire enables individuals and groups to position and justify different actions in different circumstances. For example, repertoires of risk have structured debates between proponents and opponents around technologies such as nuclear technology and recombinant DNA technology (Rip & Talma, 1998). Repertoires can become stabilised in culture and assume an authoritative or forceful nature. Such 'standard' repertoires are visible in science and Mertonian-type norms are part of them.

Gilbert & Mulkay (1984) explore the repertoires used in scientific practices. They show how scientists draw selectively on two interpretative repertoires. The 'empiricist' repertoire depicts scientists' actions and beliefs as "following unproblematically and inescapably from the empirical characteristics of an impersonal natural world" (p. 56). This form of discourse abstracts from the person of the scientist and interpretative flexibility of action. The 'contingent' repertoire, on the other hand, depicts scientists' actions and beliefs as "heavily dependent on speculative insights, prior intellectual commitments, personal characteristics, indescribable skills, social ties and group membership" (p. 56). The contingent repertoire is drawn upon in informal interactions to position own work and other scientists. While the 'empiricist' repertoire allows 'rational' justifications, as in published papers and in interactions with outsiders, the 'contingent' repertoire supports ongoing search and communication practices within science.

The two repertoires are linked because they refer to the same range of phenomena and activities (Rip, 2006b). The contingent repertoire is restricted to insiders; it functions within a social world and contributes to its coherence but should not be used for or by outsiders (Rip, 2006b). 'Rational' repertoires - or 'R'- repertoires as Rip terms them, in order to avoid the normative connotation of the term 'rational' - are public and non-local, thus individual actors cannot use the repertoire flexibly, as they would wish. The scientific world which is represented by the R-repertoire is linked to the outside world through societal acceptance of the mandate to do science, relatively protected from outside interference. The R-repertoire is also a constraint on the inside world; without it the practice of science could shift and move in any direction (Rip, 2006b). There might be a need for reflective inquiry, though: as Rip points out, some constraints are better than others.

Three elements in the present standard repertoire in science which implicitly or explicitly set out roles and responsibilities of scientists warrant discussion, given their ambivalent status of being productive (protective) but also debated, especially from outside science. I will formulate them as "recourses", to the technical, to the procedural and to a mandate of progress.

The 'recourse to the technical' is one component of scientists' standard repertoire characterising and justifying their own roles and responsibilities. For example, health and environmental risk issues are not articulated as societal (ethical) issues but as technical questions. Following the acceptance of risks of nanoparticles as a legitimate issue (in which Swiss Re's 2004 report *Nanotechnology: Small Matters, Many Unknowns* played an important role),[8] there was a focus on handling the risks of nanoparticles technically and developing new regulations for nanoparticles which backgrounded broader considerations about the actual desirability of developing and using nanoparticles in the first place (Swierstra & Rip, 2007). When asked about risk issues and how to address them, scientists will mention further research and sometimes attempt to do such research. This kind of recourse to the technical was visible in the proposal to include a component dedicated to studying toxicity, environmental issues and 'implications' more broadly, in research at the Center for Biological and Environmental Nanotechnology at Rice University, Texas.

[8] For the full story see Rip & Van Amerom (2009).

Another example of recourse to the technical is visible in Felt et al.'s (2009) study of a public engagement exercise involving lay people and life scientists. Felt et al. (2009) observed that reference to "facts" - be they scientific or societal - was an important resource framing discussions on ethics and values in relation to genome research. Mobilising "facts" facilitated the reframing of a problem such that ethically motivated concerns no longer had a place. In a discussion on obesity treatment, the question as to whether obesity should be viewed as a medical condition or whether - as the lay people often argued - it could also be addressed in a broader psychosocial manner or by lifestyle changes was considered. The scientists immediately framed obesity as a major health problem, about which scientific facts had to be assembled. Thus, the health problem was located in the domain of scientific authority, allowing the discussion to remain closed until enough facts are available.

When scientists have 'recourse to the procedural', they translate ethical issues into good practice rules and procedures and refer to their adherence to these rules and procedures as a means of fulfilling their responsibility. Strassnig (2009) argues that this comprises a rhetorical strategy, whereby scientists displace moral questions into the legal domain, thus shifting responsibility outside science. A further formalisation of ethics in research practice are the (often pre-defined) ethical checklists in funding proposals, whereby ethical issues have to be ticked off one by one, without any need for ethical reflection (Strassnig, 2009).

Scientists' (partly self-defined) mandate to work towards progress comprises another standard repertoire setting out the roles and responsibilities of scientists. Scientists have recourse to this mandate and can then focus on the advancement of science, while other actors are expected to look after other considerations, such as ethical considerations. This is linked to a widespread discursive ploy of scientists which is deployed when the promises they have made about the results - including further applications - of their ongoing research do not materialise. This is not an occasion for reflection and perhaps doing better the next time but an argument to call for further research.

The acceptance of these recourses to the technical, the procedural and the mandate to work towards progress signify a division of moral labour between science and society. In this division of moral labour, work in the lab is positioned as having no direct link with ethical and societal issues (Rip, 2007b). Ethical questions are 'displaced' to 'ethical expert systems' and ethics is pushed downstream to the moment when concrete applications should be discussed by society (Felt et al., 2009). The present call for responsible development of nanotechnology may open up this division of moral labour but one can expect that the initial response from scientists will be based on the present standard repertoire and the accompanying division of moral labour.

2.2.2 Outside science

In terms of interactions between science and society, the effect of the macro-protected space for science has been to stimulate and justify prudential acquiescence by scientists to the demands of powerful institutions, including the state (Haberer, 1969). Haberer (1969) describes three cases in which he traces the political behaviour of scientists from Bacon to Oppenheimer and argues that, in their endeavours to protect their enterprise from the interference of politics, scientists historically have disengaged themselves from politics by withdrawing or else acquiescing to the demands of the state (Nelkin, 1987; Rettig, 1971; Schmandt, 1973). An example of prudential acquiescence by scientists was the fatalistic response of non-Jewish German scientists to the purging of Jewish scientists from German universities by the Nazi regime in the 1930s. Rettig (1971) argues that there are exceptions; however, these are indeed exceptions. Thus the macro-protected space of science not only protects scientists but also confines them.

Prudential acquiescence on the part of scientists is always coupled to an argument about the importance of the advancement of science, not just as an individual pursuit of knowledge that one wants to sustain but as a human or societal goal which must be pursued, which then justifies acquiescence to the powers that be. The argument about progress through science will be used in initial resistance towards attempts to "curb" science. For example, when there is a call for a moratorium, e.g. on nanoparticle R&D, the overwhelming response from scientists goes as follows: "You can't, and shouldn't, stop progress" (Rip, 2007b; Swierstra & Rip, 2007). Once there is a legal constriction in place, scientists will follow the rules, or try to find loopholes in them (as the development of stem cell research in the US has shown).
To be allowed to continue to work towards the advancement of science and actually get support, promises are made about scientific research, which are necessarily speculative and subject to amplification of claims about outcomes and their relevance. The quote from US Under-Secretary Bond with which I opened Section 2.1 is illustrative of the level of hype to which people are willing to go when defending the advancement of science. Promising is endemic in science and thus also amplification, up to

hype. This can be discussed and assessed as a matter of strategic choices: should one sustain the hype and profit from it for the time being, or be more moderate in presenting the promise of new technology in order to avoid disappointment later? It is also a matter of moral stances – what is the responsible course of action to take? Ethics of promising is concerned not only with the morality of exaggeration but has a distributive-justice component; research investment as a result of inflated promises may be directed into unfeasible areas of research, to the detriment of other research communities which might be doing research of greater benefit.

A further entrance point to understanding the moral stance of scientists is the ethics of professionals, even if research scientists are not regular professionals in the sense that they do not offer expert services to clients and receive professional recognition from their peers. In Talcott Parson's sociology of the professions, the societal mandate for their autonomy is based on their "superior "technical competence"" (Parsons, 1939, p. 460) and their high moral standing, implying that professionals can be trusted. Independent of Parsonian sociology, it is clear that professionals hold authoritative positions and feel that they deserve trust. They are sensitive to signals that might indicate lack of trust. This is also visible for research scientists, who might complain about actual and projected attitudes of publics in this respect.[9]

Professional norms, e.g. for engineers, lawyers and the medical profession, are often well articulated. They even play a role in court cases about professional errors and misconduct. There is a move towards such professional norms in science, e.g. about conflicts of interest and other issues of research integrity. This is one way in which responsibilities are further organised. They do not speak directly to the problematic situation of novelty and uncertainty of nanotechnology.

2.3 The moral stances of industrialists

While the boundary between a firm and its context will be strong, industry as an institution has much weaker boundaries with society than science as an institution has. The primary reason is that firms produce for external customers, while scientists, in the first instance, produce for their colleagues in the world of science. The idea and practice of Corporate Social Responsibility - extending relations to include additional

[9] Rip (2006a) argues that nanotechnologists suffer from 'nanophobia-phobia' in which there is an exaggerated interpretation of public concerns about the new technology, despite a lack of empirical data indicating public concern about nanotechnology.

stakeholders than customers - is common in industry but almost absent in science. It is less easy to divide a literature review into “inside” and “outside” the world of industry. In addition, there may be additional tensions between the stances of individual industrialists and firms, due to the strong role of the profit motive at the level of the firm. Even if there are arguments as to why following the profit motive will support the greater good of society (as I will briefly mention below when discussing business ethics), concrete actions of a firm may conflict with the moral stance of a member of the firm. In the institution of science, the role of organisations like universities has been more to facilitate the work of scientists and their links with research areas and disciplines (although this might be changing a bit now).

2.3.1 Inside the world of industry: business ethics and Corporate Social Responsibility

There is an extensive literature on business ethics, which includes some studies on ethical stances and moral argumentation but predominantly attempts to articulate one or another form of business ethics, or to persuade industrialists to be more “ethical”. One way in which to do so is to consider ongoing business practices as being ethical already but based on an ethics of self-interest, i.e. profit-making and sustainability (in the sense of survival of the firm).

One basic point is that each business pursues its own interest, with executives and the corporation showing different degrees of prudence (Beauchamp, 1988). For example, many corporations have adopted “enlightened self-interest” policies, through which they respond to community needs and promote worker satisfaction, as they believe their actions will improve their image and ultimately increase their earnings (Beauchamp, 1988).

One justification for pursuing self-interest goes back to Adam Smith’s argument that a restrained ethical egoism is necessary to achieve the public good. When individuals are granted what Smith terms the “natural liberty” to pursue their own interests and compete, these individual pursuits will - although unintended by the actors - frequently produce social and economic good (Werhane, 2000). As long as there are markets with the “invisible hand” of free competition, self-interested economic actors will end up creating economic growth and well-being such that no individual actor or group of actors can take advantage for very long (Werhane, 2000).

The free market argument is too simplistic to be deployed as a justification. For one thing, real-world markets do not create perfect competition and need government intervention to remedy such market failure. Even so, in the view of the business community, business ethics is "the ethics of a suitably restrained egoist" (Beauchamp, 1988, p. 20). It is egoistic because it is based on the active and sometimes ruthless pursuit of one's own interest. It is restrained because self-interest must remain within the bounds of the prevailing rules of business practice (the recent introduction of various Codes of Conduct is an example).

Businesses can also assume broader responsibilities than profit-making and this can be linked to longer-term strategies for sustainability of the firm. The move towards Corporate Social Responsibility (CSR) is particularly interesting in this regard and for this thesis. CSR does not only relate to a prudent approach within industry but also includes bridging views within industry to views outside. If CSR is extended to include technological innovation, there will be overlap with the notion of 'responsible development' of (nano) technology. For these reasons, I will devote some space to discussing CSR.

Corporate Social Responsibility has been conceptualised in a variety of ways,[10] from the neo-classical economics position that profit-making is a social responsibility (Friedman, 1970) to going beyond profit-making (Davis, 1973) to a voluntary corporate commitment (Falck & Heblich, 2007).

Carroll (1979) offers a definition of social responsibility aimed at addressing a range of obligations business has to society: "The social responsibility of business encompasses the economic, legal, ethical, and discretionary expectations that society has of organizations at a given point in time" (p. 500). The ethical and discretionary responsibilities are those that extend beyond adherence to the law. Ethical responsibilities are articulated in interaction with expectations of society. Discretionary responsibilities are voluntary roles that business assumes but for which society has no clear cut-expectation; the assumption of these responsibilities is left to the discretion of the business. Examples of CSR actions include progressive human resource management programmes that go beyond legal requirements, the development of non-animal

[10] The term Corporate Social Responsibility (CSR) can be traced back to Howard R. Bowen's (1953) book *Social Responsibilities of the Businessman* in which he posed the question "What responsibilities to society may businessmen reasonably be expected to assume?" (Bowen, 1953 cited in Carroll, 1999).

testing procedures, reducing pollution and supporting local businesses (McWilliams & Siegel, 2001).

The practice of Corporate Social Responsibility contains an element of prudent self-interest as it is described by Falck & Heblich (2007): "Used well, it is a way of actively contributing to the society's basic order and, in doing so, enhancing the company's reputation" (p. 248). Sims (1992) argues that an organisation cannot function if its prevailing culture and values do not correspond with those of society: "… an organizational culture that promotes ethical behaviour is not only more compatible with prevailing cultural values, but, in fact makes good sense" (p. 512).

Corporate Social Responsibility includes responsibility to employees and to stakeholders more generally. 'Stakeholder' refers to agents who may affect, or be affected by, an organisation (Crane & Matten, 2007) and thus includes suppliers, customers, employees, stockholders, the local community and management (Evan & Freeman, 1988). Independent of Corporate Social Responsibility, the stakeholder theory of the firm reconceptualises strategy and management of the firm on the basis of Freeman's (1994) 'Principle of Who and What Really Count'.

Issues of environmental sustainability and the impact of business practices on developing countries can be brought into the ethical fold. For the former, there is the 'People, Planet and Profit' phrase which reflects the 'triple bottom line' (cf. Elkington, 1997), which in turn advocates novel types of economic, social and environmental partnerships in order to achieve sustainability in business. For the latter, Prahalad's "Bottom of the Pyramid" strategy offers new business models which can improve the lives of billions of people at the bottom of the economic pyramid while also enhancing the profitability of companies (Prahalad & Hammond, 2002; Prahalad, 2004).

2.3.2 Variety at individual and firm level

Individual industrialists

Business ethics and Corporate Social Responsibility focus primarily on the level of the organisation. Ethical consideration is taken care of by the organisation and this offers a *prima facie* justification for the corresponding ethical stance of the individual. If a firm has a Code of Conduct, it is the responsibility of the individual employee to adhere to the Code.

In general, role morality is an important factor in the institutionalisation of ethical consideration; "role morality describes and evaluates the extent to which one succeeds in meeting the demands and obligations of one's role" (Werhane & Freeman, 1999, p.3). In organisations (whether bureaucracies or other types of organisation), one is expected to perform the duties of one's role as defined by the organisation or else face sanctions of one form or another (Werhane & Freeman, 1999).

While there is commonality in ethical stances and commitments, derived from a shared position, there are also instances of individual ethical stances and positions. Individuals within a firm may have their own ethical position and want to sustain that position. An extreme example is whistle-blowers who step out of the repertoire of promises and 'nothing unusual' to voice an early warning and feel justified to do so because a public interest is at stake. There is increasing support for whistle-blowing in the public interest, up to some legal protection. In January 2011, President Barack Obama signed into law the FDA Food Safety Modernization Act, which includes protection for whistleblowers in the food industry. The stated goal of the WikiLeaks organisation (which, amongst other actions, released US State Department diplomatic cables in November 2010, leading to the WikiLeaks 'affair') is to ensure that whistleblowers are not jailed for providing sensitive or classified documents.

Variety among firms

Companies can adopt different ethical stances. Firms vary considerably according to culture, size, available resources and contexts. For small firms, their concern is to survive. Small firms tend to be 'doers' not 'thinkers' and respond to what happens; ethics is viewed as a restraint on action and only incidentally, as an opportunity. It is easier for bigger firms to take a long-term view and consider ethical issues. They are definitely willing to enter into interactions with society, including NGOs. For example, Unilever developed a 'hybrid space' through engaging with environmental and consumer NGOs in the early 1990s. In 1994, Unilever and Green Alliance, an environmental NGO, established a small 'Contact Group' between representatives from the firm and NGOs. The Contact Group operated informally over a period of seven years and close working relations were established between Unilever and the British NGO community over the issue of GM foods (Doubleday, 2004).

When firms (of whatever size) take up ethical issues, this also reflects a prudent approach so as to assure a better profile and to anticipate future requirements and potential credibility issues. Being prudent is viewed as strategically important in relation to new and emerging science and technology. In the domain of the bioscience industry, in which corporations are faced with a plethora of ethical issues, ethical behavior is pursued through different mechanisms which include ethical leadership, external ethics expertise, internal ethics mechanisms, external ethics engagement and ethics evaluation and reporting mechanisms (Finegold & Moser, 2006; Mackie, Taylor, Finegold, Daar, & Singer, 2006). Questions have been raised about the effectiveness of companies' ethics mechanisms (Mackie et al., 2006) and the link between enhanced ethics and improved financial performance (Agres, 2006). Novas (2006) adds an interesting observation about the firms studied by Mackie et al. (2006): some of the firms appeared not to have any products on the market yet "… current and anticipated ethical concerns are shaping their corporate practices and bottom lines in the here and now" (Novas, 2006).

Prudency, in relation to the possibilities of new and emerging science and technology, was positioned here as willingness to be pro-active and consider ethical issues. There is also "inverse prudency", i.e. playing it safe by not taking up new options. The food industry, faced with promises of nanotechnology, is an example. Reporting on conferences on nanotechnology, food and health, a journalist working for *The Observer* noted:

> Nano-food and nano-food packaging are on their way because the food industry has spotted the chance for huge profits: by 2010, the business, according to analysts, will be worth $20 billion annually. (…) the food industry is hooked on nano-tech's promises, but it is also very nervous. (…) It's obvious why they are edgy. Consumers are not ready for nano-food. Among some scientists in the field there is a real sense that nano-technology, in food at least, is a revolution that may die in its cradle – rejected by a public that has lost its trust in scientists and its patience with industry's profit-driven fooling with what we eat (Renton, 2006).

There are attempts to break through such waiting games around novel nanotechnology applications. Te Kulve (2010) discusses an instance of institutional entrepreneurship, where Kraft Foods Inc. - one of the largest food and beverage firms in the world - established the Nanotek consortium in 2000, which aimed to link the development of food and food packaging products with nanotechnology research (and to sustain a leadership position in food science for the company). However, when concern about the risks of nanotechnologies emerged in the mid- 2000s, Kraft distanced itself from the Nanotek consortium, significantly weakening the consortium.

The variety we see here is a variety in responses across firms and over time in responding to the uncertainties about strategic possibilities and societal acceptance of newly emerging science and technology. Ethical stances and choices must be positioned as part of attempts to reduce such uncertainties.

2.3.3 Industry and the outside world

Firms, stakeholders and third parties all act reflexively and justify their actions also with reference to larger concerns. "The" environment and now "sustainability" are cases in point (the quotes are added to emphasise that these are terms to be invoked and to function as legitimation). There is interplay between anticipation, interaction and various risk-taking strategies. Regular market incentives play a role and eco-efficiency offers an interesting example. Even there, incentives derived from credibility pressures and strategic games with uncertain outcomes are just as important.

This is very visible in the world of nanotechnology and has attracted the attention of analysts. For instance, Rejeski (2007) argues that companies need to be prudent in their dealings with customers in order to overcome the trust deficit. Lee & Jose (2008) highlight forms of CSR – transparency, stakeholder communication and ethical consideration – which may prove to be the most effective means to fill the regulatory void in nanotechnology.
Prudent approaches (sometimes embedded in CSR) are visible, particularly in the chemical sector, in the various initiatives including a Code of Conduct (BASF), a nano guideline (Degussa) and a position statement on nanotechnology (DSM), all emphasising the 'responsible development' of nanotechnology. At the moment, responsible development is operationalised by these companies as safe-handling of nano-production and nano-products, along with the need for some transparency (Rip, 2008).

There are also novel interactions taking place to address uncertainties. The collaboration between DuPont and Environmental Defense to produce a risk framework is an interesting example. DuPont is a chemical manufacturing company which has been at the forefront of developing new ways of handling risk. Environmental Defense[11] is a non-profit group which forms alliances with corporations in order to "produce tangible environmental results". The unique history and culture of the two organisations has made it easier for such normally quite adversarial actors to collaborate in a partnership.

In 2005, DuPont and Environmental Defense formed a corporate partnership to work together to produce a nano risk framework, aimed at evaluating and addressing potential environmental, health and safety risks of nanomaterials across the entire life cycle of the materials. The framework - deemed appropriate by both organisations - was published in early 2007. Both organisations have issued a call for feedback on the framework and have encouraged companies to adopt the framework. While some organisations did provide feedback, others argued that the partnership was not impartial and would be unable to develop regulations sufficient for the protection of the environment, workers and the public (Walsh & Medley, 2008). In response to the publication, a 'civil-society labor coalition'[12] issued a public statement condemning the efforts of DuPont and Environmental Defense, urging "all parties to reject the public relations campaign" aimed at usurping the government oversight of nanotechnology policy and voicing their concern that voluntary regulation comprises a strategy to delay required regulation and hinder public involvement. On the other hand, Kundahl (2008) welcomes the partnership between DuPont and Environmental Defense; it is a "rare communications partnership" and represents a "forward-looking and transparent approach to communications between traditionally adversarial stakeholders" (p. 188).

The further question is whether this partnership heralds new forms of interaction and thus a gradual change of the moral landscape (see Chapter 1, Section 1.3) or whether it is a one-off affair. This also depends on how one interprets the strong response from the civil-society labour coalition. In their response, the coalition did not analyse the content of the risk framework but used it as an opportunity to reassert the traditional boundaries and divisions of moral labour which exist between industry and civil society organisations. One can posit two possibilities; perhaps the landscape is changing and the coalition is fighting a rearguard action by asserting old divisions, or the landscape is not changing and the response of the coalition is an indication that the

[11] See http://www.edf.org/home.cfm
[12] See http://www.etcgroup.org/upload/publication/610/01/coalition_letter_april07.pdf

partnership of DuPont and Environmental Defense depends on the situation at the time and the specifics of the two organisations and so will not be repeated. Given the willingness of other firms like Evonik and DSM to at least consider interaction with NGOs and community groups, I suggest that the moral landscape is opening up. It then depends on actual interactions and their outcomes as to what sort of change will occur.

This is in line with the diagnosis of changes in governance of nanotechnology in Rip (2010a). In the chemical sector, companies are developing and implementing their own Codes and nanotechnology initiatives against a backdrop of debate about how new materials and nanoparticles should be regulated. Rip (2010a) argues that actors' efforts – in this case, those of chemical companies – may have a *de facto* governing effect without being necessarily linked to intentional governance arrangements.[13]

2.4 Lay ethics and other considerations

The literature reviewed here underlines the importance of a sociological approach to Dewey's problematic situation. Scientists and industrialists will bring particular perspectives to problematic situations and respond to the problematic situations through the 'lens' of these perspectives.

For scientists, the Mertonian norms linked to the functioning of science as an epistemic endeavour constitutes the dominant perspective and (rightly or wrongly) the mandate to work towards the advancement of science is pushed, to the exclusion of other, broader responsibilities.

The ethical stances of industrialists derive from the firm's ethics of self-interest (profit making and survival of the firm). However, broader issues such as CSR and responsible development of nanotechnology can also be taken up. The justification for the ethical stance taken by companies and individuals is usually sought in terms of being prudent, along with the importance of role morality.

Scientists and industrialists share an enactor perspective: they invest in realising novel nanotechnology. Such a perspective differs from that of customers and regulators and I will briefly discuss this distinction before

[13] Rip describes this type of governing effect as '*de facto* governance' "which includes the outcomes, at a collective level, of actors' strategies and interactions" (p. 285).

taking the next step to consider lay ethics and the interaction between enactors and selectors.

Garud & Ahlstrom's (1997) conceptualisation of the position of insiders and outsiders, extended by Rip (2006a), indicates the different perspectives of enactors (insiders) and comparative selectors (outsiders). Insiders, trying to realise or 'enact' a new technology, work in "enactment cycles" in which they construct scenarios of progress to be made and identify obstacles that must be overcome. Such 'enactment' cycles highlight the positive aspects of the new technological option and often rely on an illusion of control, i.e. that enactors should be able to assure that the product is successful. Outsiders, who are presented with such an option, also see other options and will thus engage in "selection cycles", in which they compare the option with alternatives.

Rip (2006a) has modified the terminology to speak of "enactors" and "comparative selectors" to characterise the functional perspectives and avoid reference to a boundary between insiders and outsiders. The important point for both Rip (2006a) and Garud & Ahlstrom (1997) centres on the structural difference between the action perspectives and related views for the two positions. There will be communication problems when messages from 'enactors' to other actors are framed in terms of their enactment perspective and do not take the comparative-selection perspective into account. Garud & Ahlstrom show that "bridging events" occur where the cycles linked to the two perspectives interact, sometimes productively (cf. Robinson, 2010).

The two perspectives are structurally different and rely on different and by now standardised repertoires (cf. Chapter 2, Section 2.2). The best one can do is to find opportunities for 'trading zones' and 'bridging events'.

2.4.1 Lay ethics[14]

Compared with experts in ethics who have devoted themselves to the study of ethics, scientists and industrialists are lay persons in ethics, just as much as members of the public are. When there is reference to lay ethics, however, 'lay' only refers to broader publics who have little or no expertise in science and technology. There is an unspoken assumption that in order to discuss ethics of new and emerging science and technology, one should know and understand what is going on in the science and technology development. Scientists and industrialists possess such knowledge. While they are not 'experts' in ethics, their ethics is still

[14] This section draws on Rip & Shelley-Egan (2007) and benefits from Arie Rip's ideas.

positioned as being more important than the ethics of lay publics. At least, their ethics are not questioned, while the ethics of lay publics are (this explains why there has been little or no mapping of the ethical/moral stances of scientists and industrialists.)

The moral stances of scientists and industrialists are often contrasted with those of the general public. 'Lay' is equated with members of the public; industrialists and nanoscientists do not count as 'lay' because they are insiders. This returns in Levitt's (2003) comment that there is a tendency for ethicists themselves to adopt a respectful attitude to science and draw on scientific evidence as "facts" to provide a necessary background to their own work. If there is a respectful attitude to members of the public, it is positioned in terms of 'giving voice' or 'empowerment' rather than competence or expertise. As Strassnig (2009) and others have observed, ethics, especially in its dominant practice as institutionalised ethics, excludes lay people from ethical decision-making. Such exclusion of lay people is justified by the argument that "expert rationality associated with ethics is assumed to be *a priori* more "rational" than "moral sentiments" of lay people" (Felt et al., 2009, p. 357). [15]

The defining characteristic of the lay person is the outsider, perhaps critical, perhaps fatalistic but certainly different from the insider, who is presumed to be expert and can speak for everything regarding (nano) technology. The inquiry into 'lay' ethics is then structured in terms of the differences with what insiders say and do (Banks, Leach Scully, & Shakespeare, 2006; Wiedemann, Clauberg, & Schütz, 2003). Arie Rip has argued that it would be more productive to move away from the lay versus expert categorisation to the distinction between identification with a new technology ('enactors') versus non-identification, i.e. the freedom to move to other technologies and opportunities ('comparative selectors'), so that broader considerations can be taken into account.

Nevertheless, one can learn from studies of 'lay' ethics. Banks et al. (2006) studied the ways in which non-professionals (those not professionally involved as scientists or bioethicists) make ethical

[15] There are other considerations as well. Ethics is concerned with values and what society "ought" to do. In the context of genetic research, Levitt (2003) suggests that even if bioethicists could agree on the "ought" in specific applications of genetic technology, if the "ought" does not correspond with people's feelings and attitudes, then such applications may not be realised in practice. This may be problematic if bioethicists want to contribute to public policy.

evaluations regarding a contested area in genetics. They define 'ethical evaluations' as "the broad process of identifying, exploring and prioritising the ethical issues at stake, offering a judgement on what is regarded as right or wrong and/or what ought or ought not to be done, and giving reasons or justifications for these judgements" (p. 290). Thus, ethical evaluation goes further than the articulation of attitudes and opinions and includes justifications for holding certain views.

A key finding relates to how analogies and parallels comprise an important resource. When direct experience is lacking – as will be the case with new technologies – people can employ analogies.

> Analogies are useful for the analysis of unfamiliar ethical areas because they show how a situation with a similar ethical structure has previously been tackled – who is taken into account, what is morally salient, how priorities are arranged, and so on (Banks et al., 2006, p. 295).

This applies just as much to 'lay' people as to enactors of (nano) technology.

Lay people/publics will use general analogical reasoning about new science and technology and draw on a repertoire in which technology is seen as coming in from the outside and in need of containment. The quote from a focus group discussion on nanotechnology is illustrative: "It'll get out of the cage I'm sure" (Kearnes, Macnaghten, & Wilsdon, 2006, p. 53); nanotechnology is compared to a wild beast that needs to be contained. Enactors, with their direct experience of technology, will also use analogies when they refer to GMOs and their sorry fate (at least for the case of green biotech). It is an analogy, as well as a lesson in how to avoid such an impasse for nanotechnology. I will return to this point when I discuss 'folk theories' of nanotechnologists but first offer further considerations about 'lay' ethics.

Studies on risk perceptions have shown that there are significant differences in the risk narratives held by experts and lay people (Wiedemann et al., 2003). Experts perceive risks as probabilistic chains of cause-and-effect. For experts, the crucial point concerns whether and with what degree of confidence the risk can be assessed; scientific evidence is of paramount importance to show that a harmful effect does in fact exist. From the layperson's perspective, risk is primarily perceived in a social and relationship-oriented context: who is to blame, who is to be trusted?

Similarly, the ethics narratives of lay people will focus on attribution of praise and blame and on trust and trustworthiness of institutions. For risk, experts have recourse to the technical. For ethics, scientists and other professionals have recourse to their (partly self-defined) mandate. In other words, for risk, as well as for ethics, scientists/professionals will refer to things that are larger than themselves and for which they do not have individual responsibility. Lay people will experience a lack of agency (and be fatalistic) with respect to new and emerging science and technology but have no other role than that of recipient. Thus, they look towards institutions (and authorities) and fall back on cultural repertoires (e.g. of new science and technology as intruder into a lifeworld).

Enactors have their narratives of praise and blame as well. Illustrative is Ravetz's aphorism: "Scientists take credit for penicillin, but Society takes the blame for the Bomb" (Ravetz, 1975, p. 46). To avoid being blamed, enactors can tone down their agency but then cannot be praised for the positive impacts of their actions anymore. I will return to this when discussing patterns of moral argumentation (cf. Swierstra & Rip, 2007).

2.4.2 Folk theories and patterns of moral argumentation

Folk theories emerge when actors endeavour to capture patterns in what is happening in their world and be reflexive about them, so that they can do better the next time. A striking example is the diagnosis of an impasse in 'green' biotechnology, coupled to statements about the need to get nanotechnology "right the first time". There is a claim that such patterns will recur "if we don't change our ways", so a generalisation is made and one can speak of a folk theory: "Calling it a folk theory implies that it evolves in ongoing practices, and serves the purposes of the members of the various practices" (Rip, 2006a, p. 349).

Folk theories provide direction for future action. Their robustness derives from their being generally accepted; they form part of a repertoire of a group or a larger culture. Folk theories are conservative because they build on past experiences. Actors can be "captured" by their own folk theory; it colours their view of the world and they interpret everything in terms of this theory (Rip, 2006a).

One folk theory is the enactor perspective with its concentric problem definition: the focus is on the new development and further issues are arranged concentrically around it, to be dealt with one after the other (Deuten, Rip, & Jelsma, 1997). Immediate users, end users, regulators and wider society are seen as potential roadblocks to further development. In order to overcome future roadblocks, technology developers try to enrol others through promises. It is only when they experience resistance to their message that they begin to pay attention to the wider world.

Another folk theory relates to the "wow-yuck pattern" and its generalisation. One aspect of this folk theory is the depiction of the public as fickle, being easily impressed ("wow") but being disappointed just as easily ("yuck"). The GMO experience is mobilised as an example of a general pattern and this is important as it allows lessons to be drawn for nanotechnology. However, the assumption that the "wow-to-yuck" trajectory comprised the reason why things went wrong with GMO is not checked.

The concern about a possible backlash against the promises of nanotechnology is part of a pattern of moral argumentation between (presumed) opponents and proponents of a new technology. Swierstra & Rip (2007) describe a sequence of actions and interactions between proponents and opponents, which creates a specific pattern of moral argumentation. First, there is the announcement of a new technological option, or a new technology more generally, and its promise. Big promises will raise concerns about the impacts of the new technology. The same novelty that constituted the promise is then emphasised by those calling for prudence and precaution, with the argument that there is a dearth of information concerning the effects of the new technology. The proponents of the new technology are then forced to downplay the novelty and present the new technology as nothing unusual. The 'revolution' which was initially referred to is now toned down to 'business as usual'.

Subsequent arguments are the *habituation* argument and the *slippery slope* argument. If the nothing-unusual argument is not convincing, proponents will acknowledge that the new technology may be frightening at present but argue that morality will adapt in time and that society will habituate itself to the NEST. Opponents can then mobilise the slippery slope argument: such gradual acceptance of the new technology will undermine morality and end up with unacceptable situations, as have been considered for cloning and for human enhancement.

This brief discussion of folk theories of enactors and the way in which these comprise an aspect of patterns of moral argumentation between proponents and opponents of a new technology, indicates that moral stances of actors are a combination of earlier roles and their justifications and their (reluctant) evolution in the face of new interactions and pressures. Thus, it is important to map what is happening now, in the real worlds in which actors have to survive.

2.5 Research Design and Methods

In order to address my overall theme and the specific research questions formulated in Chapter 1, Section 1.4, I follow a two-pronged approach. I will collect empirical data to trace and map the ethical stances and choices of scientists and industrialists, in addition to the organising of responsibilities that occurs and I will reflect on the evolving patterns, offering an analysis of the sociology and ethics involved. A large part of the data collection and part of the reflection and analysis was carried out in the framework of the DEEPEN project and was thus shaped by the questions of the workpackage in which I was involved. These questions actually coincided with the research questions of this thesis, although there was a greater emphasis on the question of enhancing ethical reflexivity of scientists and industrialists in the DEEPEN project than in my thesis (see also Chapter 7).

Semi-structured interviews, informed by theoretical and empirical expectations of the ethical perspectives of actors as discussed in this chapter, were the main form of data collection. In addition, document analysis, observation during meetings and a small focus group exercise were carried out. While I referred, in Chapter 1, to the different worlds of scientists and industrialists coming together under the umbrella term of nanotechnology, there were good reasons to consider them as different groups and to analyse their ethical stances and choices separately. As became clear in my literature review and analysis in this chapter, their repertoires and types of justification are different.

In the interview instrument, we included general issues, such as social acceptance and the precautionary principle, for example, and then moved to more specific items for actors. In the interviews with industrialists, I started with substantial topics (for example the Responsible Nano Code[16] and other initiatives in nanotechnology) and then made my questions part of the ongoing conversation with respondents. In the interviews with scientists, I followed the questions in the interview instrument but with

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[16] The Responsible Nano Code was published in 2008, as an initiative of The Royal Society, Insight Investment, the Nanotechnology Industries Association and the Nanotechnology Knowledge Transfer Network.
See http://www.responsiblenanocode.org/index.html

sufficient leeway to facilitate modification, elaboration and occasional digressions. This approach was designed so as to elicit specific justifications from respondents.

Eliciting responses of scientists and industrialists in semi-structured interviews was a joint articulation process with me as the interviewer. This process can lead to shifts in their views and choices but given the expected strong positions of the interviewees, this was not likely. However, a better articulation of positions and justifications would occur and thus some encouragement of ethical reflexivity on the part of the interviewees.

Interviews with industrialists were carried out in order to investigate how 'responsible development' is articulated by industry. In total, 21 interviews were carried out with representatives from 14 companies across the three main domains in nanotechnology. The majority of these interviews were carried out face-to-face, with interviews lasting approximately one hour. Only 6 of the respondents were researchers or product developers; the remaining respondents were managers in various departments, including PR, regulatory affairs, communications and public affairs. In all, data from 15 interviews are used in this thesis. The interviews were recorded and permission was requested for the use of quotes.

Interviews with scientists were conducted in three steps, each subsequent step based on experiences in the earlier step. We were able to start with a good overview of ethical stances and patterns of moral argumentation and the position of the scientists, based on the literature and observations and experience of Arie Rip and other members of the DEEPEN project. We developed an instrument to interview scientific researchers on that basis. In our tests and in two pilot interviews, the responses were in line with the ethical stances and patterns of moral argumentation which we expected (although the respondents' arguments were not simply proponents' arguments and respondents were willing to consider the possibility that scientists take up some of the moral labour.)

We decided not to carry out further dedicated interviews, as it appeared that these would only confirm what we knew already (also drawing on our ongoing interactions in the world of nanotechnology). Instead, we took a next step - an exercise to enhance reflexivity - which was also part of our workpackage in the DEEPEN project. A focus group method was used to try out such an exercise. The topic of the focus group was the call for increased accountability/responsibility of scientists - a problematic situation related to the 'responsible development' of nanotechnology. The focus group lasted four hours.

Interestingly, given my question about organising responsibilities, I experienced some difficulty in finding participants for the exercise. Contacts in the Dutch NanoNed consortium were used to direct us to potential participants. 41 scientists from six different flagships were contacted. In addition, 4 leaders of centres involved in the NanoNed consortium were contacted and 8 scientists from various groups at MESA+. [17]

Out of the 53 scientists contacted, 42 scientists responded to the invitation to the workshop.
Only 4 scientists - from the research fields of molecular sciences, micro - and nanofluidics, solid state physics and bionanotechnology - were able to participate in the focus group.

As the focus group was very small, additional interviews were carried out with 5 scientists (researchers in the NanoNed consortium) in order to gather supplementary data. Preliminary findings from the focus group were used as input for the interview questions. All but 2 interviews were carried out in person, with each interview lasting approximately 45 minutes. The focus group and 5 individual interviews allowed us to gain some insight into the articulation and justification of accountability/responsibility.

A year later, a third step was taken when I interviewed 9 flagship captains from NanoNed, in order to investigate whether there might be any changes occurring with regard to the articulation of accountability/responsibility, particularly in relation to changes in research practices. Most of these interviews were telephone interviews and lasted approximately 30 minutes.

Overall, taking the three steps together, my dedicated interviews sampled a population of scientists working at the micro - level, i.e. individual scientists and scientists working in research groups and scientists operating at the meso - level, with responsibilities within a scientific programme.

The multi-level approach visible in my research questions addresses responses to problematic situations at the individual (first half of the thesis) and collective levels (second half of the thesis), respectively.

[17] MESA+ is the Institute for Nanotechnology at the University of Twente.

Findings from the first half of the thesis will be taken up in later chapters in the second half.

The topics of the reflection and analysis in the chapters in the second half of the thesis were selected because it transpired (in our interaction with scientists and industrialists and when moving about in the world of nanotechnology and ethics) that they captured important issues. To put it briefly, when standard repertoires meet novelty and uncertainty of nanotechnology, things start to move (a bit).

3. The 'problematic situation' constituted by the call for increased accountability/responsibility: findings with scientists

3.1 Introduction

Scientific research and technological innovation are becoming ever more intertwined, particularly in an emerging field such as nanotechnology. At the same time, there is a heightened emphasis on social accountability and reflexivity of researchers, with an increasing demand for scientists to contribute to the responsible governance of science. 'Accountability' refers to giving account to funding agencies or to society at large. 'Responsibility' refers to being responsible for what one does and for the directions in which one proceeds. Accountability and responsibility merge into each other; this can be seen at the European level, in the EC Code of Conduct for Responsible Nanosciences and Nanotechnologies Research for instance, and at national level, e.g. the Code of Conduct for Scientific Practice developed by the Association of Universities in the Netherlands (VSNU). [18]

While the current environment of the responsible governance of science means that there is something at *stake* for researchers with regard to the proliferation of codes of conduct for nanotechnology and new funding stipulations which require some attention to issues of accountability/responsibility, it is not clear whether researchers themselves *recognise* that a problem situation exists to which they must attend.

The increased focus on accountability/responsibility indicates a reflexive response to the responsible development of nanotechnologies, at least at the EU level. The Code of Conduct developed by the EU constitutes a response to the novelty of nanotechnology; by putting a call out to researchers and research organisations, the EU is communicating that a problematic situation exists in relation to this novelty, particularly in terms of assigning responsibilities.

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[18] In 2004, the VSNU published its Code of Conduct for Scientific Practice, which outlines principles of good scientific teaching and research. The Code of Conduct sets out five principles – scrupulousness, reliability, verifiability, impartiality and independence – for good scientific practice.

In order to explore whether researchers recognise such a problematic situation, I engaged two groups of scientists in a discussion on accountability/responsibility of scientists. The aim of engaging the scientists was to understand their response to the call for 'responsible development' of nanoscience and nanotechnology. I wanted to probe their responses as a means of uncovering whether they see the increased call for accountability/responsibility as a problematic situation. An important aspect of engaging the scientists involved eliciting *justifications* for their ethical stances and choices.

An emphasis on justifications for ethical choices and stances is a particularly important research design feature of a focus group exercise we conducted with scientists for the DEEPEN project. The focus group exercise was developed and implemented in order to facilitate discussion of the arguments and justifications behind the increased call for accountability/responsibility of scientists. A further aim of the workshop was to come up with 'considered arguments' rather than strong positions on ethical issues; we wanted to move away from actors' notion of 'ethics' as to what is 'good' or 'bad' to the *justifications* of what might be good or bad.

The focus group exercise comprised three steps.

First, we explored ethical dilemmas faced by scientists both as a probe and in order to provide participants with an opportunity to reflect on their own experiences with issues of accountability/responsibility. Such dilemmas included the tension between Mertonian norms and commercialisation and the tension between precaution and progress. These dilemmas enabled us to create a strong link between the individual scientist and the institutional context of science. The EC Code of Conduct and discussions around responsible development of nanotechnology were used as probes to explore such dilemmas (and as input for the argumentation scenarios described below).

Second, we provided the participants with argumentation scenarios as a tool with which to develop their ethical perspectives in a more structured manner and to enable them to be able to provide justifications (cf. Rip, Smit, & Van der Meulen, 1995). Argumentation scenarios identify links between arguments and help to identify where further justification is necessary. We created argumentation scenarios around the issue of accountability/responsibility of scientists, using Toulmin's scheme (see Appendix). The philosopher of science Stephen Toulmin looked at how argumentation occurs in the real world in order to develop a general form for a well-structured argument (Toulmin, 1958). Arguments are structurally constituted of six parts, namely *data*, *claim*, *warrant*, *backing*, *qualifier* and *reservation*. In fact, Toulmin's scheme is not a model of day-to-day arguments, rather an ideal pattern for argumentative clarity and precision; this is what made his model attractive for our purposes. Furthermore, the scheme is particularly useful for ethical argumentation. The argumentation scenarios were introduced over half way through the discussion in order to map arguments in the discussion and to demonstrate the structure of the arguments, in terms of claim, warrant and reservation.

Third, we provided participants with a space in which to develop their perspectives and, importantly, the justifications for these perspectives in interaction with others. Design for difference was a key requirement; we wanted to look at how deliberation in a focus group is shaped by the different positions/actors that/who are involved.

The focus group included four scientists from the research fields of molecular sciences, micro-and nanofluidics, solid state physics and bionanotechnology. Although we tried to select the participants on the basis of the fields in which they were involved, as it turned out, the fact that they were scientists was more important than the fact that they were physicists, chemists, etc.

In our preliminary analysis of the focus group transcript, we saw a number of issues emerging from the data, such as promising in science, the status of ethics in science and the division of moral labour in science. We used these findings as input for interview questions in 5 semi-structured interviews we carried out with individual scientists, as supplementary data to the focus group data.

A year later, I interviewed nine flagship captains from the Dutch NanoNed consortium[19] in order to investigate whether there might be any changes

[19] NanoNed (Nanotechnologie Nederland) is a Dutch R&D consortium which was established informally in 2001 in order to consolidate ongoing efforts to mobilise government funding for nanotechnology research and research infrastructure. The program was funded by so-called BSIK funding (derived from governmental earnings from the sale of natural gas, earmarked to be spent on infrastructural projects, including knowledge infrastructure) and ran from 2005-2010. The NanoNed consortium contains an infrastructural program (NanoLab NL), eleven thematic subgroups covering a range of basic and strategic nanoscience research and a twelfth subprogram, TA NanoNed, which carries out projects in Technology Assessment of the interaction between science, technology and society (Rip, 2010b).

occurring in relation to the articulation and justification of accountability/responsibility and the kinds of changes they perceive to be taking place, arising from the push towards 'responsible development' of nanoscience and nanotechnology. These flagship captains comprise a well-defined set of senior scientists across a range of domains in nanoscience and nanotechnology. Moreover, the flagship captains are promoters of nanoscience and nanotechnology and sometimes move about in the 'outside world', thus they will have some overview of developments.

The focus group and the interviews with the flagship captains provide insight into two different aspects of the call for increased accountability/responsibility. The focus group offers insight into the status of ethics in science and the associated implications for the articulation and justification of accountability/responsibility. In addition, the focus group data highlights the salience of standard repertoires in science. The interviews with the flagship captains provide insight into the practical implications of the call for accountability/responsibility.

3.2 The use of standard repertoires in the justification of accountability/responsibility

Throughout the focus group discussion, scientists drew on standard repertoires which are part of the culture of science in order to articulate and justify their accountability/responsibility as scientists. These standard repertoires derive from the institutional context of science and include views on the status of ethics in science. Standard repertoires enable productive work, in this case, justification work. They also constrain, in the sense that they provide 'tried and tested' responses to novel and uncertain situations, in which it is not inevitable that such responses will still be adequate. In this section, I focus on analysis of the responses but also include an evaluation as to how far the 'tried and tested' responses are considered reflexively and the standard repertoire is opened up.

3.2.1 The status of ethics in science

The limited status of ethics in science manifested itself in the participants' difficulty in linking issues of accountability/responsibility which they recognised to be coming up, to what they are doing. They did not make the link and perhaps lacked the competence to do so because of the limited status of ethics in science.

One of the participants was satisfied that he had not encountered any issues in his research area that he should really be concerned about. In response to this, another participant suggested that perhaps he had not seen the issues. A third participant went further, providing a concrete example of where ethical issues – the problem of pollution in the developing world, caused by metal extraction from mobile phones – arise in the first scientist's area of research. The third participant felt that scientists often insulate themselves from ethical issues:

> I think that's what a lot of us do, say 'This is what we do and what we do is not bad, it's good or at least, it's neutral' but that's because you've built a wall around yourself and you've limited the scope of your technology to ... simply to the developments, and say the applications – that's somebody else's issue…

This participant was also the scientific director of a research company and had a degree in philosophy, thus he was willing and able to take a distantiated view and indeed continued to do so throughout the discussion.

Even when scientists *were* cognisant of potential ethical issues in their research, they did not know how to approach the issues. One of the participants, for example, was concerned about potential ethical issues in the application of forensic analysis techniques – a new area into which he was moving – but did not know how to address the issue other than offering "some cynical remarks here and there in discussions".

This discussion made it clear that the consideration of ethical issues is not a common feature in the practice of science. Indeed, the participants spoke explicitly in these terms. With regard to the status of ethics in science, one participant remarked:

> ... I think raising ethical questions in the normal work situation is not very usual to say the least.

He explained that "... it's all about getting money for projects…" Another participant commented:

> ... there is also ethics but it's not at all instrumentalised, so it's just some other world and then there is the normal world and there is no… there's hardly any connection between the two.

He continued by saying

> I really have to philosophise about the world… in order to come to ethics.

The participants underlined the invisibility of ethics in science when they continued to refer to their 'world' and the 'culture' of science on a number of occasions.

3.2.2 The phenomenon of standard repertoires

When the participants *did* reflect on ethical issues – either by themselves or when pushed by us – their reflection was built on and supported by considered arguments which are firmly located in the scientific world. These considered arguments derive from standard repertoires in science.

Three main repertoires were visible; scientists had *'recourse to the technical'* and '*recourse to the procedural'* and alluded to their (partly self-defined) *mandate to work towards progress in science*.

The manner in which ethical issues are dealt with in science was evident in 'recourse to the technical' and is visible in the following quote from a scientist we interviewed who spoke about

> … so-called ethical issues, like the dangers of nanoscience… if there was a true danger, then I think we would sit down and do it… *you turn the guns of scientific research onto that* [emphasis added] and you carry out your studies and you come to the conclusion that we can't find any evidence for it.

'Recourse to the technical' protects the scientist from the burden of having to take non-technical considerations into account. This, in turn, has the effect of creating a division between science and ethics and of specifying the responsibility of the scientist as being about the technical.
A further separation between science and ethics was visible in how one participant referred to ethical issues in terms of good practice rules/procedures when he spoke about how he was 'confronted' with ethics in relation to animal experimentation:

> … you have a lot of regulations, meant to control the use of animals to minimise suffering and we are faced with it because we have to write these 'Dear Experimental Commission' applications, they're called DEC applications before you do an animal experiment. It can take up to three months for every animal experiment you want to do, you have to prepare three months ahead of time in order to get through all the committees that can approve it and make changes, et cetera.

As a recourse, this 'recourse to the procedural' is similar to 'recourse to the technical'. In the case of 'recourse to the procedural' ethical issues *are* acknowledged but only in terms of rules and procedures which must be adhered to. Scientists can fulfil their responsibility by falling back on adherence to rules and procedures.

Interestingly, the respondent's use of the word 'confronted' indicates that he views these procedures as obstacles which must be dealt with in order to proceed with his work. Such a view derives from scientists' mandate to work towards progress; obstacles to continued progress in science must be identified and overcome (cf. Chapter 2, Section 2.4, on the enactor's perspective).

Scientists' mandate to work towards progress was particularly visible in the discussion about promising in science (see following section); the scientists pushed the strategy of 'pimping' proposals as justified in order to fulfil their mandate.

The standard repertoires just described can be said to function from the 'inside out' in the sense that they are part of the institutional context of science (the 'inside' world of science) and are used to address accountability/ responsibility issues that come in from the 'outside' world.

3.2.3 The enabling and constraining nature of standard repertoires

The participants in the focus group identified with the standard repertoires when contributing to the discussion.

The recurrent recourse to the standard repertoire of the mandate to work towards progress is visible in the reference to the advancement of science as an overarching goal of scientific work. This leads to differential treatment of strategic action in 'selling' one's research. On the one hand, the scientists showed easy acceptance of the 'necessary role' of 'pimping' the benefits of one's research in the writing of funding proposals. One participant explained that he had written modest proposals and had not received any funding. Following his lack of success in acquiring funding, his boss had advised him to 'pimp' his proposals:

> My… [boss] tells me like, you have to pimp it, you know, come on… I was never good at it but I'm getting better and better… it's a culture.

Thus 'pimping' proposals was seen as necessary to overcome the negative outcome of failing to acquire funding, which would affect scientists' mandate to work towards progress.

Then, when we introduced the topic of possible requirements for indications of ethical and social aspects of research in funding proposals, the scientists became concerned about the possible negative implications of flagging only the beneficial aspects of their research, as the following quote illustrates:

> If you make it a compulsory part of the programme, first of all, you have to think, invent some enormous beneficial [aspects] of your work, of course it's good for mankind or whatever and I think you would be tempted not to write down any possible negative consequences.

The participants were concerned that if this requirement were to become compulsory, scientists would be forced to be strategic. However, it was precisely this kind of strategic action which they had embraced and espoused as part of the promising/'pimping' culture in science.

Thus, the standard repertoire of the mandate to work towards the advancement of science facilitates 'non-responsibilities' (Strassnig, 2009): working towards the advancement of science absolves one from other responsibilities. They positioned their responsibility as including the presentation of their research in a positive light in order to acquire funding to get on with the business of doing science, while rejecting the responsibility to think about broader issues of their research. Such a division of moral labour may be acceptable, or at least accepted.

As Felt & Fochler (2008) demonstrate, such positioning of responsibilities may not be accepted outside the world of science. In their study of a year-long interaction between bioscientists and citizens in Vienna, the authors observed a division of moral labour whereby:

> (...) scientists (...) more or less explicitly rejected taking responsibility for any consequences of the knowledge they produced beyond quite narrowly defined imminent risks arising from their work (such as transgenic mice escaping from their lab). Taking any role in the governance of these consequences was not part of how they envisaged their professional role. Their argument for not doing so was to be only doing basic research, without any concrete focus on application. Any applications would need to be developed by other actors at a later stage, and such implications would then have to be decided 'by society'
> (p. 495).

Felt & Fochler (2008) report that the citizens involved in the exercise did not accept this division of moral labour: "… while this issue was not that disturbing for the scientists, because they only felt marginally concerned by this question, many citizens were quite upset by the scientists' refusal to consider their responsibility as an issue to reflect on…" (p. 495).

Scientists do not appear to realise that drawing on the standard repertoire in this particular way may not receive a good reception in the outside world.

This leads to a further question as to whether such a view of responsibilities is thought through as such (and thus justified), or just references a standard repertoire (Rip & Shelley-Egan, 2010). The latter is a definite possibility, given how scientists have a tendency to cash in on the good things but refuse responsibility for the bad things (cf. Chapter 2, Section 2.4.1 Ravetz's (1975) aphorism: "Scientists take credit for penicillin, but Society takes the blame for the Bomb").

3.2.4 The centrality of professional role

I return to Felt & Fochler (2008) and zoom in on one of their findings: "Taking any role in the governance of these consequences was not part of how they envisaged their *professional role* (*emphasis added*)". In other words, a distinction is made between the professional role as scientist and possible individual ethical stances.

Individually, scientists may have all sorts of views (ethical and otherwise) but these are not seen as relevant to their professional role. The scientist who had spoken about the need to 'pimp' funding proposals felt that there could be a link between "becoming better at pimping" and "becoming better at being unethical" if

> … you say… it could become this, you know… you're going towards the side of it's all very good and nice… so you go out of equilibrium, in a way…

The personal nature of this view and its lack of standing in the world of science were evident in the scientist's willingness to forgo his personal view and 'pimp' his proposals. The professional role as scientists embedded in the institutional context of science overwhelms individual ethical stances.

3.2.5 Opening up standard repertoires

At certain junctures in the discussion, the participants appeared to be aware of the constraints implied by their role as scientists and suggested instances in which scientists can expand their role and become more responsible.

In the discussion on whether the present division of moral labour in science is functioning well, the scientists felt that 'organized irresponsibility' (the term was introduced by the moderator of the focus group) was not ideal. One of the participants pressed the question "What can you do about organized irresponsibility in your role as a scientist?" Another participant offered a suggestion:

> Well, I think one of the things you could do is… you could do this for example at the KNCV, which is the Royal Dutch Society for Chemists… if you identify certain things, you know, like this or that is a problem and you identify it together, for example, an environmental problem, then you could influence funding agencies, in order to make it a point for research because together you have more power than you do as a single individual. And you would be taken more seriously, that would be a viable thing, I guess.

The difficulties of actually implementing an initiative or an approach which might lead to the opening up of standard repertoires were also acknowledged by the scientists. They spoke about the practical difficulties of making the link to broader issues at an early stage of students' education and then pursuing a practical approach:

> … I mean you read a newspaper and … you see something and you say "Oh gee, that's terrible, how did that ever happen?" and then you go on with your daily work. If you then try and formalise this and say "Gee, well shouldn't we do something or make this part of my own programme, shouldn't I challenge my own students?" I think that's probably a bit too difficult.

Thus, the 'problematic situation' can be recognised but participants find it difficult to envisage concrete action. This may be an artefact of the focus-group context, however, because there are actions being tried out (see Section 3.3).

3.2.6 The importance of context and position

The effect of different contexts in which scientists function on the articulation and justification of accountability/responsibility was evident in our focus group, in which one of the participants who was scientific director of a university-based research company was able to see the 'bigger picture' during the course of the discussion, while the 'lab-bound' scientists found it more difficult to venture outside the 'protected space' of the lab.

Within the lab, there is also a difference between group leaders and junior staff and postdocs. The latter focus on their career, rather than broader issues, even if they may be willing to think about them, for example, in a pilot interview. The former have a greater responsibility and more interactions with the outside world and will address these broader issues.

Broader issues are the concern of promoters of nanoscience and nanotechnologies; directors are faced with the 'recontextualisation' of science in society which requires greater involvement in activities such as outreach and public engagement (Rip, 2007b). Still, the lab remains a protected space. Rip (2007b) notes how Mark Welland, director of the Interdisciplinary Research Collaboration (IRC) in Nanotechnology at Cambridge University, was actively involved in a NanoJury experiment but did not communicate his involvement to the staff and students at his institute, who only learned about the NanoJury from the newspapers. Thus while Welland proclaimed on the NanoJury website, "As responsible scientists, we need to debate both positive and negative aspects of nanotechnology transparently and in full view of the public", he had not felt it necessary to initiate such debate with the scientists in his institute.

While there is some acknowledgement of broader issues and even some activity around these issues at the level of promoters of nanoscience and nanotechnology, such awareness and activity takes place at the institutional level as an 'add-on' and does not appear to have a 'trickle-down' effect to scientists at the 'coal-face' of the research. A division of moral labour exists where work in the lab is positioned as having no direct link with broader social and ethical issues, while spokespersons for a lab may have to take up such issues from time to time (Rip, 2007b).

3.3 The 'problematic situation' constituted by the call for greater accountability/responsibility in ongoing practices

In the interviews with the flagship captains, their views on accountability/responsibility were broader than those in the focus group discussion; however, as one would expect, much discussion took place in terms of standard repertoires. While there appeared to be some opening up, with flagship captains' reporting of increased interaction in the outside world and greater acceptance of broader issues, they also thought that, in terms of the effect of the integration of broader issues, there have not been any changes in research practices. In order for such change to occur, they argued, change would first have to take place at the institutional level.

3.3.1 Presentation of nanotechnology

One flagship captain spoke about how nanotechnology is presented differently to the outside world (within the scientific community, it remains the same) in response to the "big fuss" in the outside world on safety issues, particularly relating to nanoparticles:

> you see a bit more attention being paid to the sounds you get from the outside world… which means there is a response like, OK, we also have to spend time and effort on looking into the safety aspects of nanotechnology.

From the 'inside out' – from the direction of the institution of science to the 'outside' world – a change has taken place. This change is phrased on scientists' terms, e.g. 'recourse to the technical' to deal with concerns from the outside world.

3.3.2 Opening up: interaction with publics and greater awareness of risk issues

Interestingly, the flagship captains themselves spoke in terms of opening up to the outside world, particularly in terms of safety and interaction with publics.

One flagship captain described how the scope of his role is broadening in response to discussion with various groups in the outside world:

> It's easiest to see in the number of talks or the kinds of colloquia or invitations I get. So a few years ago, this was on my subject, it was on materials science and it was on equipment and on new materials, etc. When I look now, more than 25% of people who invite me are just on nanotechnology but more about what does this mean for us and what is the risk and what is the impact for society… especially impact on society, that's what people want to know.

He has observed a change in the types of publics he now addresses "from the more scientific people to a more general public or people who are interested"; he has participated in a number of Studium Generale[20] and Science Cafés in the Netherlands. Moreover, investors and stockholders are seeking information about spin-off companies. The experience of this flagship captain reflects the phenomenon described earlier, whereby senior scientists are faced with broader issues because they tend to move in wide circles.

A number of flagship captains spoke about a greater awareness of risk, both in terms of presenting the risks, as well as the benefits, of nanotechnology and increased competencies in dealing with risk. One of the flagship captains in particular elaborated on the greater competency in dealing with issues of risk which he had observed within the NanoNed consortium:

> So if you now ask the flagship captains, OK, I want to have a list of your research which is really important for risk… they come up with a complete list and a few years ago, they maybe… well, they didn't shut the door but they were hesitant to do so. So, I think that the awareness is much greater.

3.3.3 Greater acceptance of broader issues

A further change perceived by the flagship captains was the greater acceptance of broader issues. One flagship captain spoke about her research group in particular. A PhD student in the group had written a chapter of his thesis on how companies pick up ideas from scientific research. At the time – four years ago – his peers in the group did not take it seriously, asking him why he was not doing 'real' science. This attitude, the flagship captain explained, has now changed and discussions at the coffee table about broader issues of research are "really taken seriously".
This more open and serious approach to broader issues in research was visible in the participation of a PhD student from the same research group in the PhD+ programme. The PhD+ programme is part of the NanoNed programme and gives PhD students an opportunity to spend some time exploring the broader issues of their research. A PhD student in the flagship captain's group had dedicated time to writing a chapter on elaborating a methodology for turning open-ended promises into concrete challenges for research and networking. The flagship captain felt that his PhD would represent a symbolic message to other PhD students

[20]Studium Generale is an initiative in all Dutch universities in which lectures, discussions and courses in the fields of science, art and culture are organised, primarily for students and employees of the universities but also for other interested parties.

and change something in the culture or the thinking of PhD students. However, she explained that the overall position of the research group had not changed as a result of the PhD student's participation in the initiative. In fact, she felt that if she encouraged more PhD students to do the same, people in her group would start to question her and wonder "Why isn't she busy with real research?"

The existence of this PhD+ programme allowed further exploration of how necessary the flagship captains felt the 'integration' of broader issues is. I asked what the motivation for participation in such a programme would be. They struggled with this question, with one flagship captain explaining:

> Difficult to answer. It's more intuitive, I would say. We should do it; any scientist should pay more attention to the more philosophical background of nature, also in an historical perspective but also looking into the future. You cannot do only just physical or chemical or biochemical research without thinking about possible consequences.

Other responses stressed the importance for PhD students to broaden their scope in their area of science and in technology more generally and the need to evaluate individual PhD projects as to their scope for inclusion of a PhD+ component.

In terms of the effect of the integration of broader issues, one flagship captain's response

> As far as I can see, I think it's marginal so far...

was illustrative of the overwhelming view that there have not been changes in research practices. This was explained by them pointing out that scientists' core business is to do science. Indeed, one scientist explained that the goals of PhD researchers to do research, to publish and to finalise a thesis with good international impact "are absolutely predominant in the mental process". This response echoes discussions in the focus group in which the participants said that their responsibility was tightly bound up with their duty as scientists to advance science.

3.3.4 External requirements to include anticipation of embedding in society

In order to stimulate further discussion on possible future changes in research practices, the flagship captains were asked for their view of the possible requirement of funding agencies and other sponsors of research for anticipation of the adequate societal embedding of nanotechnology and the manner in which scientists might cope with these requirements. As in the focus group discussion, this question elicited a strong response from the scientists.

Predictably, concern was expressed that such an initiative would add a further bureaucratic load to scientists already quite heavily burdened with other tasks; this concern is exemplified by the following quote:

> People like me - leaders, coordinators - they are very pressured with administration… you wouldn't believe it… I think the most pressing problem for people like me in the future is to reserve sufficient time to do research, to think about research and if… honestly, at the moment… if now suddenly I would see NWO or the EU having additional… where I have to fill in things that are not directly related to research, I would be annoyed, to be honest.

As in the focus group discussion, flagship captains respond to requirements coming in from the 'outside' world as interfering with their daily business of doing research and viewed this with frustration. Their role and the institutional context of science are at play here and they can mobilise the mandate to work towards progress.

I mobilised the possible requirement to anticipate embedding in society again when I asked the flagship captains whether they could imagine 'subcontracting' this kind of work to social scientists, ethicists or humanists if such requirements were to become commonplace. The ensuing discussion was striking in that it demonstrated ambivalence with regard to how the flagship captains position the current division of moral labour in science, in which ethics is backgrounded.
My question received a strong response, with the majority of flagship captains saying that such a division of moral labour would *not* be a positive initiative as it would suggest a lack of genuine ethical reflection on the part of scientists, at whom the initiative would be aimed in the first place. Earlier on, however, they tended to refer to the traditional division of moral labour.

The "only sensible option", as one flagship captain phrased it, would be to collaborate with an expert in these matters. Another flagship captain felt that if such an initiative were to become institutionalised, more people would be willing to participate:

> … if you have a money pot that is dedicated to this sort of collaborative work, I think then more people would perhaps do that because they don't want it on top of their activities.

This same flagship captain had spoken earlier about the irritation that would be felt by research group leaders and coordinators if they were required to devote additional time to consideration of societal embedding in funding proposals. The quote above provides a practical view: although collaboration with social scientists or ethicists would also be time-consuming and detract time and energy from the core business of doing science, if some funding were provided and the initiative institutionalised, it would be doable and acceptable.

Clearly, there are different registers in which flagship captains speak. One is the register of keeping interference at bay, while the other is the register of looking for practical solutions to requirements.

3.3.5 Future changes in the practice of science?

The flagship captains were asked to reflect on the changes that had been discussed in the interview in order to project a future scenario of how a shift in the way in which science is done might occur. They generally found it difficult to project a scenario but all spoke about the need for institutional incentives and requirements in order for real change to occur. Financial incentives were seen as important in order "to stimulate a certain way of thinking".

Suggestions were made in relation to specific types of institutional incentives and how they might be mobilised to allow institutionalisation of reflection on the broader issues of research. One flagship captain spoke about the potential to create an additional criterion for the excellence of science, while another elaborated on the possible effect of including consideration of broader issues in Key Performance Indicators, as required in recent government–funded programmes. The PhD+ initiative was mentioned specifically:

> …. that's why I like it to be one of the key performance indicators because then it's much clearer… you say to your PhD, you have to write at least three papers in refereed journals or maybe five or six… it doesn't matter… but everyone says OK, yeah, logically. But now if it's also a key performance indicator that you are specialised or that you are looking at… or you go to a workshop or dedicate a chapter to… then that is really part of the… then it shows that it is part of this kind of programme.

There was also an awareness that change would have to be, in a way, "sanctioned" at the institutional level, as one scientist remarked

> … you need the support of people and if the deans and the boards of universities don't support it, then it's fighting against a big wall.

The influence of the institutional context is acknowledged here: in order for real change to occur, it has to be enabled and stimulated at the institutional level.

Overall, it was clear that the scientists viewed the changes that were discussed as possible add-ons to science, rather than changes in research practices. However, one scientist noted that there is already a precedent for change in the research system, with the move towards societal relevance:

> … there was such a tremendous shift during the last few years from forcing researchers not to submit proposals on their scientific questions but on problems or questions that have a direct relation to practical problems. First, there was a lot of scepticism and people saying "Why must I do this now, is this the right way?" but there was a money pot and then people write and they get used to it and the same could happen in the other respect also. If governments say - OK, researchers are sometimes sceptical about it – but governments say 'This is the way it is' and otherwise money is… researchers do not do everything only for money but without money then… people want to do research and I think they would also have fun with these aspects but they probably would not do it voluntarily.

One flagship captain (who moves in very wide circles), suggested that other topics might be taken up, such that "there will be much more involvement with down-to-earth research". His example was George Whitesides, one of the 'godfathers of nanotechnology'. Topics which concern Whitesides at present include working towards cheap alternatives to lab-on-a-chip based on paper, for example, a device for testing for HIV for less than 1 euro. The existence of such role models can indeed be important for changes to occur.

3.4 In Conclusion

Both sets of scientists *recognised* that a problematic situation exists. The scientists in the focus group discussion recognised this implicitly when they spoke about the status of ethics in science and explicitly when they asserted that present 'organized irresponsibility' is not ideal. The flagship captains' recognition of a problematic situation was visible in their reporting of their awareness of the need to open up to the outside world and to consider concrete activities.

While they recognised the problematic situation, the responses to it tended to build on existing roles and their justification with reference to the standard repertoire of science, protecting the 'core business' of doing science. Two elements - recourse to the technical and the mandate to work towards progress in science - were particularly visible. At the same time, both groups of scientists demonstrated a *willingness* to think about the opening up of standard repertoires.

In the focus group, the scientists discussed the constraints deriving from their role and institutional context to address 'organized irresponsibility' and considered ways in which they could use their role in order to become more responsible. However, they concluded that given the demands of daily scientific work, it was difficult, if not impossible, to put such ideas into action.
The flagship captains, on the other hand, saw a more dynamic situation. One flagship captain did not experience his role as a constraint when he spoke about the broadening of his role with regard to the topics and publics he now engages with. Another flagship captain spoke about the implementation of a PhD+ project in her research group.[21]

Position and context account for this difference. Scientists who conduct their daily work in the protected space of the lab are less exposed to broader issues than flagship captains, who, as promoters of nanoscience and nanotechnology, have to take up broader issues from time to time. This is supported by the fact that the one participant in the focus group who is more exposed to broader issues also took up (and was able to take up) broader issues. To some extent, the difference may have been an effect of the set-up of the focus group and the individual interviews. The scientists in the focus group were asked to comment on the general theme of accountability/responsibility and could thus offer views without having to translate them into action. The flagship captains, on the other hand, were offered quite concrete scenarios of possible future developments to which they in turn could respond in more concrete terms.

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[21] Such a possibility was discussed in the focus group as well. The participants felt that it would be difficult to find PhD students willing to try it but were prepared to explore possibilities.

An interesting finding, explicitly visible in the interviews with the flagship captains, is how different registers could be used, in particular about interference with the daily work of doing science. This creates openings for further change.

The recurrent problem definition was one of external pressures on the ongoing work of doing science,[22] and this shaped the responses to the 'problematic situation': how to respond to such pressures?

The responses can be differentiated using the notions of 'fit' and 'stretch' strategies, as discussed in the strategic management literature (cf. Hoogma, 2000). A 'fit' strategy involves shaping or adapting one's goals in order to accommodate to the context and its requirements and survive in that way. A 'stretch' strategy involves attempts to change the environment so that one can survive and realise one's goals. The 'fit' strategy in its pure form is not visible with the nanoscientists. The 'stretch' strategy is visible but in the specific form of mobilising resources through promises about intended research. In other respects, nanoscientists accept the context and prudentially acquiesce (see Chapter 2, Section 2.2.2 for this terminology).

In the discussion on possible changes in future research practices, there appeared to be a third possible strategy, i.e. maintain one's goals (the core business of doing science) while adapting one's practices so as to appear to accommodate new requirements. The flagship captains were prepared to say that if requirements for anticipation of societal embedding from funding agencies were to become the norm in scientific practice, they would collaborate with social scientists, ethicists and humanists rather than hire these experts to do the work for them. They would thus demonstrate their willingness to accommodate new requirements. It is a strategy to change the add-ons of science so as to be able to continue with the core business of doing science.[23]
Current ways of working in science can be 'stretched' in order to adapt to requirements from the outside world in a more substantial fashion, such that accountability/responsibility is integrated, rather than being part of

[22] These pressures are not limited to the call for increased accountability/responsibility but include pressure to contribute to innovation. See Robinson (2010) for further discussion.
[23] This is similar to how Lakatos (1970, 1978) analysed specific "research programmes" in science as having a core approach which remains unchanged and a "protective belt" of additional hypotheses and shortcuts to enable the research programme to continue, until the burden of add-ons becomes too heavy and the core comes in for revision.

the ‘protective belt’. While this is a possibility, flagship captains thought this would happen only if relevant changes at the institutional level were to occur (to be put in place).

Thus, actors themselves use a (partial) multi-level perspective. As an analyst, I can highlight the importance of interaction between the different levels (micro, meso and macro). Reflexivity at the meso level of institutions might have implications not only for the current division of moral labour in science (the macro level) but also for the micro level of repertoires and practices.

4. Nanotechnology as an occasion for business to explore responsible development[24]

4.1 Introduction: the present situation in the 'responsible development' of nanotechnologies

The commercialisation of innovations from nanotechnologies offers huge opportunities for business. However, at the same time, the development and use of nanotechnologies present great challenges to industry in terms of technical and commercial uncertainties (Lee & Jose, 2008; Sutcliffe, 2008). In addition to these uncertainties, there are social uncertainties, as various stakeholders have different views and priorities concerning the development of nanotechnology.
The combined force of these uncertainties has led to a 'wicked' situation; investing in development early presents a risk in terms of one or more of the uncertainties mentioned, while waiting to use nanotechnologies in their developments is also a risk in terms of lost opportunities (Deuten et al., 1997). Thus industry is faced with a 'wicked' problem which is difficult to resolve (wicked problem #1). [25]

This wicked problem is not new but has become more pressing with nanotechnology living on promises. There is a new development in which there is increasing reference to the 'responsible development' of nanotechnologies. A second 'wicked' problem arises: how to responsibly develop when there is little or no idea as to what this means and entails, while there is some pressure to do so (wicked problem #2). At present, this second 'wicked' problem is only salient for those companies that link up with responsible development. However, in the future, responsible development of nanotechnologies may be a problem for more companies than are visible now; indeed this might be a positive occurrence.

At the moment, 'responsible development' of nanotechnology is primarily a policy discourse and signifies a new feature in science policy programmes (Ferrari, 2010). There are definitions of 'responsible development' - the definition which featured in a review of the US National Nanotechnology Initiative is illustrative of mainstream thinking:

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[24] This chapter has been submitted (August 2010) to a special issue of the *Journal of Business Ethics* on 'Nanotechnology, Ethics and Policy'.

[25] One resolution (but an unsatisfactory one) is the 'waiting games' that can be observed in some domains of nanotechnology (Te Kulve, 2010) in which interdependent actors wait for other actors to reduce uncertainties before they proceed to invest.

> Responsible development of nanotechnology can be characterized as the balancing of efforts to maximize the technology's positive contributions and minimize its negative consequences. Thus, responsible development involves an examination both of applications and of potential implications. It implies a commitment to develop and use technology to help meet the most pressing human and societal needs, while making every reasonable effort to anticipate and mitigate adverse implications or unintended consequences.[26]

There is a strong consequentialist perspective in this definition. It does invite promoters of nanotechnologies to consider broader issues and allows other actors to ask questions about the directions in which development might proceed (Rip, 2010a). The actual operationalisation of responsible development, however, has tended to focus on risk issues, transparency and some public dialogue (Rip, 2008).
Some companies have linked up with this notion of responsible development. For example, the chemical company BASF has developed its own Code of Conduct for nanotechnology. Additional measures implemented by companies include spokespersons for nanotechnology and the establishment of issue management teams. Companies such as DSM and GSK have provided public position statements on nanotechnologies, while the chemical company Evonik has a company statement and a 'Nano Guideline'. In Codes of Conduct and position statements, responsible development is generally articulated in terms of dealing with environmental, health and safety issues, risk assessment and risk management. However, there is also some reference to dialogue with society in two chemical company initiatives (BASF and Degussa). The nano risk framework developed by DuPont and Environmental Defense (see Chapter 2, Section 2.3.3) was subject to a public consultation before its launch.

Responsible development of nanotechnology relates to a *process* of development, in terms of transparency, public dialogue and so on. In the case of the development of emerging technologies, it is not yet possible to know much about outcomes; however one can say something about the process by which the development proceeds. This is in contrast to 'responsible innovation' which focuses on *outcomes* and criteria for outcomes.

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[26] Committee to Review the National Nanotechnology Initiative, National Research Council. 2006. A Matter of Size: Triennial Review of the National Nanotechnology Initiative. Washington DC: The National Academies Press.

The notion of 'responsible innovation' appears to be a catch-all term for a number of innovation activities that aspire to bring social and environmental considerations into the innovation fold. The concepts of 'sustainability' and 'sustainable development' are linked to the notion of responsible innovation. Sustainability refers to 'the long-term maintenance of systems according to environmental, economic and social considerations' (Crane & Matten, 2007, p. 23) while 'sustainable development' emphasises meeting the needs of the present without compromising the potential for future generations to satisfy their needs. 'Responsible innovation' can comprise a number of initiatives such as companies "going green" or corporate environmentalism, clean technologies and appropriate technologies.

'Responsible development' of nanotechnology includes working towards responsible innovation but goes further by signalling a type of *direction* of development or as Ferrari (2010) describes it "an attempt to cope with (nano) technological uncertainty in an ethical manner" (p. 34).

This somewhat concerted move towards responsible development of nanotechnology by industry is interesting and laudable. However there is the wicked problem (#2) as to what responsible development actually *means* in practice (Davies et al., 2009). Important notions of responsibility, safety and being socially acceptable are unclear in the sense that there is no fixed consensus in relation to the meaning of the terms or how they should be applied in real-world situations (Davies et al., 2009). Thus the notion of 'responsible development' itself comprises a 'wicked' problem, in that something must be done, while it is unclear what should be done. This is a different 'wicked' problem to that faced by industry (wicked problem #1) – in relation to the uncertainties of the use and development of nanotechnologies – however, there is some overlap.

The notion of the 'responsible development' of nanotechnology refers to 'responsibility' as a general governance framework for development. The EC Code of Conduct for Responsible Nanosciences and Nanotechnologies Research[27] is illustrative of the move towards this kind of governance framework. From the perspective of ethics, the Code does not emphasise consequentialism (moral theories that call for the analysis of the consequences of a particular action, often phrased in terms of balancing

[27] European Commission 2008. A code of conduct for responsible nanosciences and nanotechnologies research. A Commission Recommendation of 07/02/2008.
See http://ec.europa.eu/nanotechnology/pdf/nanocode-rec_pe0894c_en.pdf

risks with benefits). Deontological ethics (moral theories that guide our choices of what ought to be done, given one's duties and the rights of others) is not as visible as it was in the early stages of stem cell research. Virtue ethics (which emphasises virtues or moral character) is clearly emphasised, with responsibility positioned as a virtue.

The Code favours a soft-law form of voluntary regulation of nanotechnology; thus the discourse becomes one of responsibility rather than of accountability (Ferrari, 2010). Such a change in discourse implies that companies can no longer fall back on laws and regulations alone but must position their actions and interactions in order to show that they are being 'responsible'. They then have to face the wicked problem (#2) of filling in what it *is* to be responsible.

This shift away from accountability towards responsibility is one new aspect in the development of nanotechnology. Another novel aspect relates to the opening up of the strategies and interactions of companies in their anticipation of the societal embedding of nanotechnology. Companies have to work towards the societal embedding (Deuten et al., 1997) of nanotechnologies, that is, their integration in relevant industries and markets, their admissibility in terms of standards and regulations and their acceptance by the public (p. 132). Societal embedding can be carried out in an instrumental way but can also be taken up as part of responsible development.
For my diagnosis in this paper, the important point about anticipating the societal embedding of nanotechnologies is that success cannot be realised within the traditional boundaries of the firm (Deuten et al., 1997). Companies have to anticipate societal embedding in interaction with other actors in wider society (consumer organisations, environmental groups, NGOs) who should also be viewed as stakeholders. Thus some of the goals that managers want to realise are out of their hands; it is this aspect which becomes important in responsible nanotechnology development. Traditional management structures within the firm will not be sufficient to realise a broader notion of success which refers to the societal quality of the product. Moreover, the process of the creation of societal embedding will depend on the strategies of external actors (Deuten et al., 1997).

This second new aspect in the development of nanotechnologies comprises the reason why responsible development of nanotechnology is different from earlier attempts at responsible (and sustainable) innovation, which remained within the firm. This novel feature of the responsible development of nanotechnology highlights the importance of distributed responsibility. Responsibility for the development and use of nanotechnology is distributed across a myriad stakeholders; thus the process of the responsible development of nanotechnology will include 'many visible hands' (Rip & Groen, 2001), rather than one invisible hand or firm steering the development. There is a collective, process-oriented (Malsch & Hvidfelt, 2009) form of responsibility or as Von Schomberg (2007) phrases it a 'collective co-responsibility'. Responsible development, therefore, relates to the overall process of development and the additional item of being co-responsible.

In order to be able to achieve their own goals and operationalise the responsible development of nanotechnologies, companies have to transcend their own immediate self-interest to an enlightened self-interest, to responsible development. Lee & Jose (2008) make a similar point, arguing that companies have to be able to manage the tension between their own self-interest in exploiting nanotechnology and 'exercising' ethical choices to ensure the responsible development of nanotechnology. Thus learning and new practices will be an important component in the responsible development of nanotechnologies.

In order to develop this first-round analysis further, I will present my empirical study which comprised part of the EU-funded DEEPEN project[28] and specifically, the 'Ethics in the Real World' workpackage. The research explored how 'responsible development' of nanotechnologies is articulated by industrial actors. Our findings and analysis present us with an opportunity to understand how various sectors across the three main domains in nanotechnology deal with the 'wicked' problem of 'responsible development' of nanotechnology. I will explore what kind of learning is occurring that may help to overcome this particular 'wicked' problem or at least make it manageable.

4. 2 Research design and methods

4.2.1 Methods

A 'survey', by means of semi-structured interviews, was carried out with companies across industry, in order to understand differences between sectors in relation to how they articulate/operationalise 'responsible development'. Semi-structured interviews facilitate the implementation

[28] See http://www.geography.dur.ac.uk/Projects/Default.aspx?alias=www.geography.dur.ac.uk/projects/deepen

of predetermined questions, while also allowing sufficient freedom for modification, elaboration and occasional digressions (Berg, 1989).
An interview instrument was prepared and included general issues such as social acceptance of nanotechnologies and the precautionary principle and more specific items for industry such as the challenges that nanotechnologies pose to companies. Informal discourse analysis was used to interpret the data.

4.2.2 Subjects

15 respondents from 11 companies located in the three broad domains in nanotechnology - micro/nanoelectronics, materials and surfaces and bionanotechnology - were interviewed. There were 3 companies in the micro/nanoelectronics domain, 3 companies in the materials and surfaces domain and 5 companies in the bionanotechnology domain. The respondents were representatives from multinational companies (excluding one company) including 3 companies located in the materials and surfaces sector (chemical company A1, A2 and A3), 2 semiconductor companies (companies B and C), a company with a broad technology product portfolio, a beverage and food stuffs company, a big conglomerate including a food company, a medical devices company, a corporate research organisation developing new technologies for the medical and healthcare sectors and a company developing therapies for cancer. The respondents included 4 researchers, 2 product developers, a corporate research department representative, an R&D director, a technology manager, a manager for environmental and regulatory affairs, a communications and government relations representative, a company spokesperson for nanotechnologies, a CEO, a vice president and a public affairs manager.

The three main domains in nanotechnology comprise different applications and dynamics. In the domain of nano-enabled materials and nano-structured surfaces, there are applications in ongoing development in the big incumbent chemical companies and in smaller companies. In the micro/nanoelectronics domain the big incumbents are active; in addition, there are new entrants who are pursuing the “Beyond Moore” trajectory and organic large-area electronics and foils. In the bionanotechnology and nanomedicine domains, there are various activities and promises and many SMEs involved (Rip, 2008).

There are a number of considerations about nanotechnology which were expected to shape responses from interviewees. Nanotechnology is an enabling technology which adds new functionality to existing materials and components. Nanotechnology just improves performance and sometimes enables new functionalities (e.g. surfaces that repel dirt) but the constitutional effects derive from the system and how it is embedded and used. Still, nanotechnology can lead to major differences when a certain threshold is passed. For example, when RFID (Radio Frequency Identification Devices) become smaller and cheaper as a result of nanotechnology and thus more widely usable and easier to implant, an "Internet of Things", where all products can be traced individually becomes possible, in addition to the implantable and "readable" human (Rip, 2010a).

4.3 Findings

A number of issues were brought up and discussed by the respondents in the interviews. These included industry's stance towards responsible development in nanotechnology, transparency and lack of trust in industry, the pressure to be visible in nanotechnology activities and feelings of ambivalence towards NGOs. Discussion of these issues provides insight into industry's attempts to deal with the 'wicked' problem of 'responsible development' of nanotechnology both within the company itself and in their presentation to and interactions in the outside world.

4.3.1 Stance towards responsible development of nanotechnology

The first question addressed to the respondents concerned whether their company's stance towards responsible development of nanotechnology was part of their overall Corporate Social Responsibility or additional to it. The aim of this question was to uncover whether industrial actors considered the development and use of nanotechnologies to be 'ethically special'. This inquiry into the 'ethically special' nature of nanotechnology in industry derives from a debate in the ethics of nanotechnology which centres on whether ethical approaches developed in other contexts can be applied to nanotechnology.

Most respondents replied that responsible development was a normal part of their Corporate Social Responsibility; this was tied up with the importance of being a 'good firm'. This can be illustrated by a quote from the respondent from the big conglomerate including a food company who replied "That's part of our DNA".

However, there was a striking difference between the three domains in relation to companies' *emphasis* on responsible development of nanotechnology. Chemical companies were very conscious about responsible development of nanotechnology and somewhat pro-active, while responsible development of nanotechnology was not a salient issue for companies in the bionanotechnology and nanoelectronics domains.
For companies in the bionanotechnology and nanoelectronics domains, nanotechnology was not viewed as special; the reasons provided for viewing the development of nanotechnologies as 'business as usual' included the role of nanotechnologies in product development and the specific measures already in place which can be mobilised to deal with environmental, health and safety issues around nanotechnology.

A respondent from the company developing therapies for cancer offered reasons for why responsible development of nanotechnology does not present any particular challenges to their business. One reason comprises the nature of nanotechnology for developments in nanomedicine, as the respondent explained:

> Nanomedicine and working with nanomaterials is really not interesting for physicians and clinical people. They are always looking for solutions for a certain medical problem and if you use nanotechnology to offer them a solution for their problem, then they will say, OK, nano helps us but it's not dependent on nano or whether it's nano – it should solve the problem.

A respondent from the medical devices company further emphasised this point by explaining that the company is not going out deliberately to try to exploit nanotechnology, other than their interest in it as a solution to their development needs.

A further reason is that businesses in the health and medical sectors are operating in an existing framework of responsibility which manufacturers of medical products have by law. This second point was elaborated by the respondent from the corporate research organisation developing medical and healthcare technologies:

> Of course everything that happens in the area of nanomedicine, as with any application in medicine, comprises a framework of ethical and legal consideration… for instance, there are the same aspects surrounding privacy… [these] are no different for nanomedicine… we do research worldwide and there are considerations everywhere around medical experimentation and introduction of medical devices, which is very well regulated – nanomedicine is not an exception, it is no different to medical applications or other medical developments.

Thus for the health and medical sectors, responsible development of nanotechnology does not warrant any special measures, given the nature of nanotechnology for development and the existing regulative and legislative frameworks under which nanotechnology can be subsumed.

Both respondents from the food companies said that their companies did not have any nanotechnology applications but emphasised the importance of nanotechnologies in R&D, for example, the use of electron microscopy to study natural systems at the nano scale. With regard to the responsible development of nanotechnologies in particular, both respondents said that responsible development was a normal part of their Corporate Social Responsibility. Moreover, one of the respondents stressed that nanotechnology applications fall under novel food legislation already in place. Interestingly though, both companies are involved in nanotechnology initiatives including an R&D initiative and an initiative aimed at developing best practices for industry. Such participation indicates an awareness of the potential of nanotechnologies for the sector in development and use.

The respondents from both semiconductor companies felt that there was a certain amount of hype surrounding nanotechnology. Similar to the companies in the health and medical sectors, nanotechnology provides a solution to a technical problem, as the respondent from company B explained. The respondent from company C explained that safety of workers is the primary concern for the company; the company is working with hazardous materials already, so if they move into working with nanomaterials it will be business as usual.

At first hearing, the response of representatives from the chemical companies seemed to concur with those from the two domains described above. All the chemical company respondents commented that nanotechnology was just the next step in their development. One respondent from a chemical company described the nature of nanotechnology for his company as “a natural step in the development” when nanotechnologies are defined as “the next step to control materials at an ever smaller scale”. The ‘business as usual’ status was also underlined by his next comment: “if you want to call it nano, fine, but it’s not necessary to do our job”. This ‘business as usual’ status extended to their stance towards responsible development of nanotechnology but only to a certain extent.

Thus on the one hand, responsible development of nanotechnology was viewed as

> … part of the total philosophy…it's a total attitude… it's part of the total way we do business.

(respondent from chemical company A1)

Moreover, the responsible development of nanotechnologies is part of the chemical industry's Responsible Care program®.[29]

On the other hand, there is a tension between 'business as usual' and the need to be seen to be open about their developments in nanotechnology; this is particularly pertinent for these companies, given the perceived lack of trust in the chemical sector. This tension was evident in the following quote

> People expect us to have a position on this topic but again it's part of our normal business.

A respondent from chemical company A3 elaborated on this tension. He explained that his company is working on a Code of Conduct similar to that of another chemical company, although nanomaterials do not differ significantly from the other materials they are working with:

> … the people within coatings say that – and it's more or less the general feeling I believe [within the company] – nanotech is not that much different than other dangerous materials. … I think the policy on how to deal with it is not very different than the policy that is used for using other chemicals or phasing out or introducing other new substances in the products we make… but on the other hand, we're working on a Code of Conduct, on a policy… so it's a bit contradictory to what I just said but it's also influenced by the discussion that's going on in society.

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[29]The 1980s posed many challenges for the US chemical industry. A series of major chemical accidents, most notably the 1984 disaster in the Union Carbide plant in Bhopal, India, reinforced a perception that the chemical industry was unable to carry out its operations without harming human health and damaging the environment (Prakash, 2000). A survey conducted by the US Chemical Manufacturers Association (CMA) around that time revealed that Americans' trust of the chemical industry equalled that of trust in the tobacco and nuclear power industries (Lyon, 2003). The Responsible Care program® was created in 1989 by the CMA. The creation of the program signified recognition by the industry that improved performance among chemical companies was crucial to its public acceptability and its viability. The Responsible Care program comprises two objectives: to improve the environmental and safety performance of CMA members and to improve the public perception of the industry. The program includes ten guiding principles and six codes of management practices (King & Lenox, 2000).

Thus, although responsible development of nanotechnology is a normal part of their Responsible Care program, the chemical companies that took part in the interviews had additional initiatives in various forms including an official spokesperson for nanotechnology, an issues management team dealing solely with nanotechnology and Codes of Conduct for nanotechnology.

These additional measures comprise a means for chemical companies to deal with the 'wicked' situation which nanotechnology presents them with. Nanotechnology is crucial for ongoing development in this particular sector, while at the same time, the uncertainties posed by the development and use of nanotechnologies bring to the fore issues of trust and a perceived lack of trust in the chemical sector which must be dealt with in a transparent and open manner. Chemical companies experience credibility pressure to maintain their image as 'good' companies; there is now additional pressure to do something about the responsible development of nanotechnologies. Thus the chemical sector is required to go above and beyond its usual measures of Corporate Social Responsibility and the Responsible Care program.

It appears that the chemical sector's endeavours to deal with the 'wicked' situation which nanotechnology presents them with actually generate a third 'wicked' problem (wicked problem #3) for the other two sectors, for which the responsible development of nanotechnology is not a pressing concern. The respondents from the companies outside the chemical sector had views about the chemical sector's emphasis on responsible development of nanotechnology, asserting that while this emphasis on the *responsible* development of nanotechnology is necessary, it also has negative consequences, in terms of sustaining the argument that nanotechnology is somehow ethically special and in contributing to the hype around nanotechnology. Thus a vicious circle has emerged, in which companies having a particular stance on nanotechnology actually reinforces the argument that nanotechnology is somehow special and warrants specific measures.

4.3.2 Transparency and lack of trust in industry

In the interviews, transparency and trust in industry was intimately linked with companies' stance towards responsible development of nanotechnologies and was again particularly pertinent for chemical companies, who suffer from a perceived lack of trust.

One respondent from chemical company A1 explained that while the company has a nanotechnology statement on their website, this is due to an external demand for such a statement. Moreover, the fact that the company has an official spokesperson for nanotechnology is a "response to the outside world":

> I mean the outside world makes a lot of fuss about nanotechnology and so we need to have a contact where you can ask questions and that's the idea, nothing more than that.

Another respondent from the same company spoke about their issues management team, set up to deal with nanotechnology, which was established

> … because of the societal questions asked by NGOs, by the unions, etc…. that means that it is important for us to consider the topic in all its dimensions.

The two quotes highlight the prudent approach of chemical companies involved in nanotechnology; they have responded to the pressure to be visible in their activities around nanotechnology as it is prudent for them to do so in order to create a better profile.

However, transparency was not only viewed in positive terms. While emphasising the track record of safety and environmental awareness and continued concern with safety issues at his company, the respondent from the technology company expressed his concern that one effect of transparency might be the creation of an atmosphere of fear:

> You engage with it but by raising issues that are so broad… for example, in our industry… calling us a nanotechnology industry when we're doing essentially the same thing we've done all along brings you under a somewhat dark-cloud umbrella, you know. So, here we are suddenly engaged in ethical conversations in things we've been doing for years, which have – as far as we're aware – nothing other than ordinary safety implications. You're sort of gathered into a growing pool of [mock panic] 'should we be doing this stuff?'

Although this respondent is speaking in general terms, there is an implicit criticism of chemical companies and their endeavours to be visible and transparent in their development of nanotechnologies; this criticism relates to the third wicked problem faced by companies outside the chemical sector. The respondent from the medical devices company also voiced his concern about the negative effect of transparency in nanotechnology in terms of sustaining the argument that nanotechnology is somehow different.

Transparency was also viewed as being double-edged. This was discussed in relation to the experience of a chemical company and the "nano-stigma" attached to the food sector.
A respondent from chemical company A2 explained why the company had decided to be so transparent in its activities. As a result of its experiences with other public debates, the company realised that it would be prudent to get involved at an early stage. However, this kind of early engagement with nanotechnology is difficult, as she explained:

> It is a risk and sometimes ends in reputational damage [of your company]. Those companies that are transparent are also the focus of NGO debates because nothing is known [of what other companies are doing].

Thus a third 'wicked' problem (wicked problem #4) is visible for the chemical sector. Even though chemical companies are expected to be transparent in their development and use of nanotechnologies, efforts to be transparent can backfire; indeed companies may even suffer reputational damage. This is not the original wicked problem of how companies should operationalise 'responsible development' of nanotechnologies; this wicked problem arises as a result of actually operationalising or 'doing' responsible development.

This observation made by the last respondent about the difficulties associated with transparency prompted a further question about the respondent's view of companies' strategic considerations towards nanotechnology. In her response, she noted the lack of visibility of many companies in the debate around nanotechnology:

> … you know [at a meeting in Brussels], someone said that nanotechnology is standard in R&D, so everybody who is not doing nanotechnology is not up-to-date… at the moment, I see only a few companies in the public debate. There are many companies that are not at all visible. … I would assume that they also do nanotechnology… but they do not take part in the debate.

Thus this respondent makes a clear link between visibility and transparency.

A nano-food expert we interviewed spoke about food companies' reluctance to be transparent in their nanotechnology activities:

> It may be the problem of the first company that starts to communicate getting all the publicity – negative publicity – regarding their products, so who is the first one to do it?

The chemical company's experience of the negative consequences of being transparent in its activities in nanotechnology is a concrete example of this problem. We followed up the response from the nano-food expert by asking whether the reluctance of food companies to be transparent in their activities may lead to a standoff between the big companies. He recognised this but hoped that one company would risk taking the lead and that others would follow:

> Yeah, probably. If everybody was to communicate about it or if the first one started to communicate and was able to communicate the benefits over the risks effectively, then probably more companies, like in cosmetics… a lot of companies follow the lead of L'Oréal because they have been able to communicate that nanotechnology has specific benefits for skin products…

A link with the collective level was made by the respondent from chemical company A3 when he referred to what "we" must do:

> … it's my feeling that we should open up because if we don't we get bitten in the tail and we are behind in the line and everything is arranged for you… not in a sensible way, it could hinder you a lot, I think, in the coming future, if you do not participate in the discussion and end up with very strict regulations for issues that are, from, say a toxicological point of view, not very sensible, which are costly and will limit the possibilities for further development also, so I think there's no other way than to open up.

This was actually the argument of branch organisations of nanotechnology companies in the USA, who, at one moment, attempted to push their members to participate in the Environmental Protection Agency's Stewardship program of voluntary reporting on nanotechnology-enabled products. This had little effect, so clearly the wicked problem around transparency remains.

The recent voluntary reporting schemes of Defra (UK) and EPA (US) (cf. Kearnes & Rip, 2009) demonstrate that it is not just a matter of a new government initiative. It is prepared through actors moving in new directions. Such actors can include firms that realise that they need to proceed cautiously and perhaps assure credibility by being more transparent. Regulatory actors can recognise that there are opportunities for regulatory action but do not know exactly how to proceed. The combination of the two creates a situation where soft law can be envisaged. However, even then, there may not be much receptivity; firms are reluctant to start reporting if they do not know how such data will be used. [30]

4.3.3 Ambivalence towards NGOs

The 'wickedness' of the situation also manifested itself in discussion about NGOs and their actions around the responsible development of nanotechnology.
We asked the industrial actors for their view of the NGO call for a moratorium on nanotechnology R&D[31]; this question elicited a strong response from the respondents. They all argued that a moratorium would prevent progress and referred to the benefits that nanotechnology can bring to mankind and the environment. However, this expected negative response became ambivalent at a later stage of the discussion.

Interestingly, given the criticism made upfront about NGOs and their call for a moratorium, the respondents were actually quite ambivalent towards NGOs. They felt that NGOs had the right to ask critical questions and indeed that somebody should ask questions on behalf of the public. [32]

The respondent from a big conglomerate including a food company felt that NGOs are "entitled to their position" even when they call for a moratorium on nanotechnology development. He referred to NGOs' efforts to help inform consumer choice and said "that's right", even if disagreeing on the solutions.

The respondent from chemical company A1 felt that NGOs' concern about nanotechnology is

> …a very good thing, in the sense that there are groups of people who watch the developments and look critically at them, ask questions to make sure that everybody is keen on, let's say, the balance between opportunities and potential risks. Well, that's the impression I have. Also,

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[30] By July 2008, only nine companies had registered with the Defra scheme and EPA had received four submissions under the basic program (and commitments from 12 more companies), whilst no company has agreed to participate in the in-depth program.
[31] In 2003, the ETC Group, a non-governmental environmental organisation, called for a moratorium on the commercial production of new nanomaterials.
[32] This is the enlightened view; there are also industrial actors who are furious over the activities of NGOs.

> I believe that even the groups that ask critical questions, my personal impression is that they are also looking for the balance and about what the issue is really about and only the ones who are very political will make a firm statement like there should be a ban until we know enough.

In this quote, the respondent introduces a distinction between what one could call 'good' and 'bad' NGOs (Rip & Shelley-Egan, 2010). In the interviews, 'bad' NGOs appeared to at the forefront of the industrial actors' thinking. Such NGOs were viewed as agitators, using misleading information to further their cause, failing to act in good faith, and painting different nanotechnologies with the same brush.

The respondent from the big conglomerate including a food company positioned some NGOs as successful agitators:

> People start to worry now about nanotechnologies, so the campaigners from the NGOs have done their jobs well… they are valid questions, most of them, they've done their sort of agitation work very well, so congratulations to them.

This respondent went on to talk about US NGOs' focus on nano-cosmetics; he felt that their focus "is the collateral damage of an independent problem, i.e. NGOs in the US are calling for cosmetics to be regulated". Thus his view was that US NGOs are using nano-cosmetics and misleading information as a means of calling for regulation of cosmetics in the US.

The respondent from the chemical company that had engaged in a dialogue with an NGO and had then been criticised by the NGO for being a frontrunner in the development of nanomaterials (see Section 4.2.2), positioned the NGO as failing to act in good faith.

The respondent from the medical devices company was concerned about NGOs failing to differentiate amongst different nanotechnologies, in particular between free nanoparticles and nanoparticles bound to a substrate.

Views about and interactions with NGOs indicate a particular resolution of 'wickedness' in which the distinction between 'good' and 'bad' NGOs was elevated to a strategy to deal with a complex situation. The industrial actors recognised and to an extent, appreciated the role of NGOs in the responsible development of nanotechnology. At the same time, they criticised those 'bad' NGOs who, they felt, were not playing the rules of the 'game', that is, 'bad' NGOs were positioned as being 'tricky' or even dishonest in their dealings with industry. This merges into an expression of frustration by industrial actors who are unhappy with those NGOs whose actions impede the pursuit of companies' interests.

However, the respondents were reflexive about the situation. The respondent from the medical devices company labelled the call for a moratorium "a bit of a knee-jerk reaction" but also conceded that "they're right in one sense… there's always a chance that we don't understand [the risks]…"

The respondent from the big conglomerate including a food company was pragmatic about the situation and asserted that NGOs, as well as industry, must play fair:

> So, talking about ethics, the controversy must be ethical on both sides.

However, he was also reflexive (and again symmetrical):

> Sometimes the industry is not very constructive, sometimes it is the NGOs who are not very constructive…. that's the life that we are living.

As is clear in the response from a respondent from chemical company A1, the "bad" NGOs will not go away:

> Will society – NGOs – be assured if industry says "You know, we've taken care of it, we've investigated – it's OK, yes we need a specific Code, we need specific regulation, or not"… not everybody believes industry immediately and even when you speak about industry, there are levels of trust, if you speak about chemicals or petrochemicals or nuclear… But it's very clear that there are certain groups who are very critical out there and you certainly need some sort of confirmation by other parties, including perhaps governments, to confirm what industry states. Or if you have certain rules, you need verification to see that people are practicing according to the regulations and that will give them some trust but that's… part of this is about trust, and part of this is very much subjective and some groups will never be reassured; they will always be suspicious about what industry says.

In other words, the good/bad distinction (here made by companies about NGOs but the distinction is also used by firms themselves, to distinguish "good" and "bad" ("cowboy") firms) will not resolve the wicked problem. One could say that is why it is a wicked problem.

4. 4 Analysis and Conclusions

I began by characterising the situation around nanotechnology as a wicked situation, definitely for firms in the area. This entrance point allowed me to position interview responses from representatives of firms in terms of strategies to resolve the wicked problems. If one takes a static view, the picture is not promising; contrasting perspectives and the predominance of short-term self-interest make resolution difficult. In a dynamic view, one sees (some) learning occurring and this will create openings. Ethically, this is an argument to take a pragmatist ethics perspective.

It is clear from the empirical data presented here that responsible development of nanotechnologies is particularly important for the chemical sector. By linking up with the notion of 'responsible development', chemical companies are endeavouring to deal with the first (and general) 'wicked' problem posed by the uncertainties around the commercialisation of innovation from nanotechnologies. While the chemical sector emphasises that responsible development is a normal part of its Responsible Care program, the various other measures which have been implemented by companies in the sector show how they are linking up, in a practical way, with 'responsible development'. They are proactively involved in responsible development of nanotechnologies. Their visibility in the responsible development of nanotechnologies derives from credibility pressures and the need to strengthen trust and transparency in the chemical sector. This increased visibility has made them industry leaders in the responsible development of nanotechnologies. However, this increased visibility has also led to two additional 'wicked' problems ('wicked' problems #3 and #4). Companies in the other two domains (nanoelectronics and bionanotechnology) are concerned that this increased visibility will have a knock-on effect on their companies' position on the development and use of nanotechnologies. If 'responsible development' is somehow viewed as special, companies that are currently rejecting the 'special' nature of responsible development will have to fall into line and develop new strategies. Being transparent - as one element of responsible development - can also have negative effects on the chemical companies that do so, i.e. by virtue of being visible, they will be first in line for criticism.

The situation is noticeably different for the companies in the nano - electronics and bionanotechnology domains; responsible development of nanotechnology is not a salient issue for them. Even though the nanoelectronics sector also works with hazardous materials, nanotechnology is viewed as business as usual, perhaps with some additional safety measures. However, semiconductor companies do not suffer from a perceived lack of trust, as do chemical companies. There was also an interesting contrast with the food sector. On the one hand, the food sector shares the chemical sector's heightened awareness of the public's response to nanotechnology, given the public backlash against GM foods. However, their concern about the public's reaction has not been translated into greater transparency; indeed the food sector is very reluctant to be transparent in relation to its development and use of nanotechnologies. For the medical technologies and medical devices sectors, a high level of regulation and strict safety tests for products means that nanotechnology does not warrant a special response. Given the strict safety and regulation measures that are already in place in the nanoelectronics and medical sectors, these sectors can afford to be forgetful of the responsible development of nanotechnology. Thus these sectors do not face the 'wicked' problem (#2) of how the development of nanotechnologies should be addressed when 'responsible development' is on the agenda.

While this is an empirical paper, it speaks to a business ethics question, the question of moral practices in business. This empirical study sheds light on the way in which the responsible development of nanotechnology may be changing how business practitioners think about moral practices in business. Business ethics is largely influenced by principle-based ethics; this paper is located in a pragmatist ethics approach, in which learning and new practices are important.

The empirical material in this paper describes the 'wicked' situation of the responsible development of nanotechnologies as seen through the eyes of industrial actors across the three main domains of nanotechnology. While I looked at a cross-section of industrial actors at a specific point in time, I can mobilise my empirical data, as well as general observations, to say something about the directions in which learning and new practices are moving. In new developments related to the responsible development of nanotechnology, there is, in addition to distributed responsibility, increased interaction with stakeholders in the outside world, requiring new practices and further ethical stances. This indicates the emergence of a new situation which business ethics will have to take into account.

How to go about this? I conclude this paper by briefly discussing precedents and prospects.

Companies have to anticipate societal embedding and interaction with other actors; companies are forced to learn or 'die' and it appears that companies are cognisant of this. A precedent can be found in the case of sustainable technologies. Hart (1995) shows that the motivating factor behind the emergence of new practices in the case of sustainable technologies and products is a combination of prudence and strategic positioning rather than considerations about public interest *per se.* However, the fact that a company addresses broader issues - even out of necessity - has implications for its future actions and interactions; the company cannot revert to earlier, more limited approaches without damaging its credibility (Rip & Groen, 2001). Hart (1995) argues that this explains the gradual inclusion of broader and more pro-active approaches by firms.

The development of Codes of Conduct for nanotechnology by companies may provide for such learning, in addition to an opportunity for the broadening of ethical stances (Rip & Shelley-Egan, 2010). The public space opened up by such codes does two things. One, it creates an opportunity where a subscriber to the code can be called to account by other actors referring to the code. Two, the public space can facilitate deliberation and 'probing each other's worlds' and can be used for learning by all parties (Rip & Shelley-Egan, 2010).
Such practices and learning can contribute to making the 'wicked' problem of how to articulate and operationalise responsible development manageable. Thus while the problem of how to "do" responsible development may not be resolved, it is the *process* of responsible development that is important. This process can stimulate critical reflection on issues that are often backgrounded, such as the direction of the development of nanotechnologies, i.e. do we in fact *want* or *need* nanotechnologies? Thus the responsible development of nanotechnologies may open up new avenues of moral practice for business practitioners.

In other words, there are openings. The question is will they be taken up? Are there incentives? Is there enough space for interactive learning? These questions can be usefully broached if one does not limit oneself to the issues of responsible development as such but looks at the whole landscape in which companies exist. The challenge of distributed responsibility which I outlined in the Introduction can be located in a more general move towards distributed innovation (and distributed governance), including some transparency.

This move includes "open innovation", as embraced by a number of companies. Open innovation (Chesbrough, 2003) emerged as a means of addressing a ‘wicked’ problem, i.e. innovation became so complex that it could not be completely done in-house. [33] Companies had to open their doors and engage in partnerships. There were further activities as well, like commercialising both their own ideas and the ideas of other firms and bringing their in-house ideas to market by employing pathways outside their current business (Chesbrough, 2003). In practice, open innovation is not so easy. Companies have to deal with Intellectual Property issues, they have to understand the needs and capabilities of their potential partners and there can be failure to build trust. Thus, the practice of ‘open innovation’ shows the potential as well as the difficulties of distributed innovation and governance.

This is the situation in which industrial actors/companies find themselves that *de facto* creates ethical behaviour. Firms carry out actions that can objectively be considered ‘ethical’ even when they are driven by enlightened self-interest. However, the net effect is that things go better.

[33] The traditional model of closed innovation requires control; thus companies created their own ideas that they would then develop, manufacture, distribute and service themselves. Factors including a dramatic rise in the availability and mobility of knowledge workers and the growth of the venture capital market allowed new models of innovation (Chesbrough, 2003).

5. Taking stock and a forward view

5.1 Introduction

In the two previous empirical chapters, I presented an analysis at the micro level of responses to 'problematic situations' related to the responsible development of nanotechnology. In this chapter, I look at the overall picture which emerges from this analysis. I then take a forward view and discuss possibilities and openings for change and argue for why there *should* be change. In the final part of the chapter I identify items relating to the 'problematic situation' at the meso- and macro- levels which require more in-depth analysis. This will set the agenda for the essay-type analysis in the second half of the thesis.

5.2 Looking back: taking stock

The picture which emerges from the empirical analysis begins with the observation that well-intentioned professionals are at a loss as to how best to respond to the 'problematic situation' of novelty and uncertainty of nanotechnology and particularly the pressure for responsible development. This way of summarising the situation draws on Dewey's notion of a 'problematic situation' that actors encounter and may recognise (cf. Chapter 1). Dewey also emphasises the importance of 'reflective inquiry' in addressing the 'problematic situation'. Once one recognises that micro-level 'reflective inquiry' will always be embedded in meso- and macro-level settings and their dynamics, it is no longer easy to identify what is to count as 'reflective inquiry'. Reference to the mandate of advancement of science (which leads to progress) can be seen as an irreflective shortcut to continue what one is doing but also as drawing on considered arguments about the role of science and scientists in society, as it is shaped by productive divisions of moral labour. Even if this is a standard repertoire, one can argue that the standard repertoire embodies accumulated experience and insight and so can and should be drawn on. However, then my observation returns: the standard repertoire does not appear to resolve the 'problematic situation' of novel nanotechnology and the call for its responsible development.

This is where sociology comes in. We have seen how actors fall back on 'tried and tested' responses to justify their visions and actions. Both scientists and industrial actors have recourse to their position and partially self-defined mandate. Scientists draw on a standard repertoire

whereas industrial actors - and chemical companies in particular - demonstrate enlightened self-interest in their response to the call for responsible development of nanotechnology.
Sociologically, one might hypothesise that such responses to the 'problematic situations' occur in the world of nanotechnology because there are no specific ethical issues or challenges and actors can thus fall back on their own positions and what they see as their mandate (Rip & Shelley-Egan, 2010). However, a number of findings suggest that there may be other reasons as well, or better, combinations of reasons, for example, the importance of institutional context which shapes standard repertoires and makes them forceful.

The influence of institutional context was an important factor in the actors' recourse to position and mandate. Scientists' reflection built on and was supported by considered arguments which are firmly located in the institutions of science. A clear example of this is the discussion on the necessary role of 'pimping' in writing research proposals and in the observation that, in order for real change to occur, it would have to be sanctioned or at least supported at the institutional level. Thus, in responding to the 'problematic situation' of the increasing emphasis on accountability/responsibility of scientists, individual scientists' responses refer to institutional and moral divisions of labour. The role of the institutional context is particularly strong for scientists because of the semi-autonomy of the world in which they operate.

In a sense, scientists 'sell their wares' to their com-colleagues within the scientific community and are largely independent of actors outside their community. Working within this 'protected space' allows them to continue with 'tried and tested' approaches and to exhibit the same response to external pressures such as increasing accountability (although adaptation also occurs). Industrialists, on the other hand, provide products and services to other kinds of actors, both within the company and outside and are dependent on such transactions. Thus, their institutional context is different and their response to the 'problematic situation' of the call for responsible development is shaped in terms of transactions.

Within industry, there are differences. The chemical company respondents accepted (to varying degrees) the call for responsible development and recognised the 'problematic situation' as to how to 'do' responsible development. Industrial actors from the micro/nano-electronics and (in a different way) bionanotechnology sectors did not view 'doing' responsible development as posing a 'problematic situation' for their companies. Thus while the chemical sector is implementing a raft of initiatives to support the responsible development of nanotechnology, the other sectors can afford to wait and see.

I can make a further step by considering the attempts at transparency with respect to nanotechnology that are visible in the chemical sector. In the micro-level analysis in Chapter 4, I described the 'wicked' problems (#3 and 4) this created for them. At the meso-level and from a co-evolutionary perspective, one sees action and interaction options being tried out, with some surviving and being imitated. Models and rules for how to 'do' transparency evolve and stabilise over time, so that one can speak of a new regime (cf. Chapter 1, Section 1.3).

5.3 Looking forward

Sociological consideration of 'problematic situations' offers more than simply empirical descriptions of what might be problematic for actors. It locates actors and their responses to 'problematic situations' in evolving contexts and allows some diagnosis, especially of opportunities for change. For example, scientists' falling back on their position and mandate when responding to the call for increased accountability/responsibility is almost unavoidable, given the way in which science is organised and institutionalised. 'Reflective inquiry' then takes the form of attempts to manage external pressures so that they do not significantly disturb the actual business of doing science. The corollary of this observation is that changes in the organisation of science and the business of doing research will have repercussions on actions of scientists and their justifications, whether these go in the direction of responsible development or not.

Actors may well *recognise* a 'problematic situation' for themselves, phrasing it in terms of pressures on what they traditionally do, rather than in terms of organized irresponsibility (cf. Chapter 1) linked to the functioning of institutions and/or the novelty and uncertainty of nanotechnology.

While this may be legitimate for the actors, it poses two challenges. One is that reference to existing roles and mandates as a warrant for actions and their justification also blackboxes them, so that they are not queried as to their justification. This would require another kind of 'reflective inquiry', more sociologically informed and not limited to an enactor perspective (cf. Chapter 2, Section 2.4). The other challenge concerns who is to take initiatives in a situation of organized irresponsibility. While it may be clear that the existing division of moral labour is insufficient to address organized irresponsibility (it may be part of the problem rather than part of the solution), the alternative is not clear either (or remains open ended, as in the call for responsible development of nanotechnology) and may be difficult to reach.

In the second half of the thesis, I will develop building blocks to address these challenges. I will offer sociologically informed reflective inquiry in an exemplary fashion and discuss reconfiguration of divisions of moral labour. The further question then is whether there are openings in the present positions and interactions (and institutions), so that such building blocks can be taken up. Since I offer a diagnosis, I also have to argue why I see a 'problematic situation' and a need for change.

In Chapter 1, I discussed 'organized irresponsibility' and its relation to the introduction of new science and technology and the need for processes to overcome organized irresponsibility. I use the word 'processes' because it cannot be a matter of dedicated organising. Rather, ongoing multi-level co-evolutionary processes have to be modulated (cf. Rip, 2002a). In those processes, enactors like scientists and industrialists play a key role in co-constructing novelty. Thus they might also be asked to contribute to reflexive co-evolution of technology, society and morality, which would require some broadening of the concentric enactor perspective (Robinson, 2010).

While some flagship captains and scientists demonstrated willingness to consider change, it turns out to be difficult to translate this into concrete actions in or around the actual practice of doing science in the lab (perhaps with the exception of the PhD+ experiment). The robust nature of the institutional context in which they function forces them to return to the core business of doing science (and all that it implies) and view calls for responsible development of nanotechnology (and other changes, e.g. more accountability) as pressures external to the core business. However, the nature of the core business might be changing, together with its institutional contexts (cf. Rip, 2002b, 2011).
Indeed, there is evidence that traditional ways of responding may be changing, although it may be too soon to say what the implications might be. For example, the strategy espoused by the flagship captains, i.e. maintain one's goals or the core business of doing science while accommodating new requirements, constitutes a form of prudential acquiescence but may well over time lead to novel ways of 'organising' responsibilities.

With industrial actors, there were visible openings for change, particularly in the chemical sector, given credibility pressures both in terms of their image as ‘good’ firms and the need to sustain their ‘responsible’ activities in the future. A further indication is the actors’ view of the role of NGOs where some broadening of the enactor perspective occurs in their willingness to differentiate between ‘good’ and ‘bad’ NGOs.

The co-evolutionary perspective adopted in this thesis suggests that productive changes in the processes are more likely to occur when a modulation of the ongoing dynamics is attempted (Rip, 2002a). Following my diagnosis that current responses to the problematic situation are inadequate, entrance points for *modulating* ongoing patterns and dynamics *at* the micro-, meso- and macro- levels and in interactions *between* the levels should be identified. Modulating ongoing patterns and dynamics at different levels is a necessary component because dynamics at one level form the backdrop to problematic situations faced by actors at other levels. Modulation of interactions between levels is necessary because processes at the meso- and macro-levels can affect change at the micro-level and *vice versa.*

5.4 Building blocks for sociologically informed reflective inquiry

The first cluster of building blocks offered in Chapter 6, starts with the ambivalence of promising technology; phrased as an ethical issue it is about whether “to exaggerate or not to exaggerate”. This is a general issue but nanotechnology highlights existing ambivalences as promises which may turn into hype and introduces new ambivalences such as “size matters” and “nano inside”. Ambivalences “imply that there is no simple resolution: an attempt to go for one side of the ambivalence brings out the problems linked with the other side” (Swierstra & Rip, 2007, p. 16). Thus, it forces actors to be somewhat reflective about the situation and to recognise its problematic character. Responses can highlight issues of responsibility but also just fall back on an enactor perspective in which promises have to be pushed to mobilise resources.
I will use further data from interviews with industrialists to map responses; my empirical analysis in the main part of the chapter which was published as an article in *NanoEthics* takes place at the micro-level of individual actors. Due to the importance of multi-level analysis, I include an addendum by discussing the meso-level of the ‘regime of economics of techno-scientific promises’ (Joly, Rip, & Callon, 2010).

The second cluster of building blocks offered in Chapter 7 discusses the limitations of the concept and practices of enhancing ethical reflexivity (of scientists). Instead, one should encourage them to articulate their reflexivity and provide them with tools to do so. Practices can focus on the micro-level and attempt to 'heat up' existing morality (as Swierstra et al., 2009 would phrase it), as in the exercises we developed to stimulate the articulation of reflexivity of scientists. 'Heating up' can also involve modulation of interactions between the meso-level and micro-level by using the requirements of funding agencies at the meso-level as a means of enhancing reflexivity of scientists at the micro-level.

The third cluster of building blocks, addressed in Chapter 8, concerns current divisions of moral labour for science and industry which form a backdrop to problematic situations faced by scientists and industrialists and constitute a problematic situation in themselves (cf.'organized irresponsibility'). I discuss the adequacy of such divisions of moral labour and look at possibilities for opening up divisions of moral labour.

6. The ambivalence of promising technology[34]

6.1 Ambivalences of promising

A traditional individual-based ethics would say that one should not exaggerate but this cannot capture the whole story of ambivalence in promising technology. A technology such as nanotechnology needs promises, including some exaggeration, to persuade target audiences. It is the only way to mobilise resources to actually realise the promise. Thus, actors have to participate in the strategic game of promising (sometimes beyond reason).

Current developments in the world of nanotechnology demonstrate the role of position and context and strategic games in promising technology. There is a back-and-forth pattern of ethical argumentation between proponents and opponents of the technology. The arguments put forward by the actors are indicative of their view of what the ‘responsible development’ of nanotechnology should involve. Some stable distribution of responsibilities (and thus, a division of moral labour) may evolve. This distribution of responsibilities may well be justified and productive but it is primarily the outcome of a struggle, a larger and more distributed version of the struggle that Latour illustrated with the program and anti-program of the hotel manager and the hotel guests in relation to the hotel key (Latour, 1991).
Such positioning and the patterns that are involved have been analysed before; I will offer a brief overview in the next section. What *is* new for nanotechnology is that such discussions and positioning have become pervasive and that actors have to be articulate about them.

Industrial actors are interesting in this respect, because they are closer to actual applications and their repercussions than scientists. We initiated a discussion around responsible development of nanotechnology in interviews with industrial actors. This was part of the ‘Ethics in the Real World’ workpackage in the EU-funded DEEPEN (Deepening Ethical Engagement and Participation in Emerging Nanotechnologies) project. The industrial actors struggled with ambivalences in nanotechnology; their responses to these ambivalences were linked with their position as industrial actors and the particular contexts within which they act. Interestingly, and indicative for the new situation around

[34] The main part of this chapter was originally published in *NanoEthics* (2010) 4 (2): 183-189. The Addendum is included to show the multi-level perspective.

nanotechnology, their interactions with NGOs influenced how they dealt with ambivalence in nanotechnology.
The repertoires that the industrial actors drew on reflect an 'enactor' perspective; the promise of nanotechnology must be pushed and ethics is seen as a brake on progress. However, they can be more nuanced, as our interview data show. By way of a preface, I offer two vignettes demonstrating strategic use of promises. One vignette describes the strategic considerations towards hype followed by biotechnologists in the Netherlands in the 1980s, while the other recapitulates the use of promises about embryo research by opponents of the research.

Proponents of a technology are faced with strategic considerations with regard to whether they want to contribute to hype around a technology or be more reasonable in referring to the promise of a technology; these strategies can be combined with different resource mobilisation strategies. Rip & Nederhof (1986) observed that these two strategies were pursued by scientific researchers in the Netherlands in the 1980s, in the move towards biotechnology-relevant research. Biochemists and molecular biologists made strong claims especially because they were more removed from actual practices of biotechnology than microbiologists and chemical engineers, who were more modest. As biotechnology was not an essential component of their ongoing research, biochemists and molecular biologists were 're-labelling' (Rip & Nederhof, 1986, p. 258) their ongoing research, so that they too could join the biotechnology band-wagon and avail of policy funding opportunities.

The promises of proponents of a technology can be strategically used by opponents to undermine their credibility. Mulkay (1993) examines some of the rhetorical resources used by opponents and proponents of embryo research during a parliamentary debate in the UK House of Commons in 1990. Both rhetorics "look into the future and focus on the expected outcomes of scientific research" (Mulkay, 1993, p. 728). Proponents of the research used the rhetoric of hope to make strong claims about the promise of the research, even though the details of the development were as yet unknown. For opponents, the tangible achievements of embryo research to date were judged to be negligible and the rhetoric of fear was used to challenge opponents' claims, transforming them into a "collection of misleading exaggerations" (Mulkay, 1993, p. 730).

These vignettes demonstrate actors' response to the ambivalence of hype and, in turn, their response to the opportunities of a promising technology (in the first case) and the concerns evoked by a promising technology (in the second case). To continue this discussion, the 'ethics of promising technology' (Swierstra & Rip, 2007) suggests that one should not exaggerate without reason but also that there may well be reasons: "one has to mobilize resources to be able to realize (materialize) the promises, and has to do so in competition with many other claims on such resources" (Swierstra & Rip, 2007, p. 18). Moreover, "one has to claim more than is reasonable, in order to be able to realize what is actually a reasonable claim" (Swierstra & Rip, 2007, p. 18). This ambivalence is widely recognised in promising technology. It leads to two different actor strategies: one can choose to sustain the hype or be more modest in presenting the promise of a technology. While there is an immediate opportunistic argument to pursue the hype strategy, there are two arguments against it. As a result of inflated promises, research investment may be directed into unfeasible areas of research, to the detriment of other research communities that could have benefited more from investment, resulting in wasted resources and missed opportunities. The deontological argument highlights the ethics of exaggeration (Swierstra & Rip, 2007).

There is actually a general pattern in the promises and the responses to them. Sparrow (2007) and Swierstra & Rip (2007) argue that proponents of nanotechnology often try to have it both ways in arguments about the nature and impact of nanotechnologies, describing nanotechnologies as both revolutionary and evolutionary, depending on the discourse surrounding nanotechnologies at the time: "In arguments about their nature and impact we are simultaneously informed that these are revolutionary technologies with the potential to profoundly change the world and that they merely represent the extension of existing technologies" (Sparrow, 2007, p. 57). This ambivalence is visible in patterns of ethical argumentation about new and emerging science and technology described by Swierstra & Rip (2007). The pattern starts with promises voiced by proponents, claiming major changes, all for the good of mankind, that is, the technology is 'revolutionary'. In response, opponents of the technology who are calling for a cautious approach highlight the novelty of the new technology in order to bring attention to the dearth of knowledge about effects of the new technology. The proponents then face a problem; they had initiated the discussion by stressing the novelty of the technology in order to attract allies and mobilise resources. They are now forced to downplay the novelty of the emerging technology and present it as nothing unusual; what was once termed 'revolutionary' is now toned down to 'business as usual' or 'evolutionary'.

This downplaying of novelty by proponents of the new technology is just one move in the strategic game played between proponents and opponents. When the capacity to continue with the development of 'revolutionary' nanotechnology is threatened by opponents' concerns, the proponents are forced to present nanotechnology as 'evolutionary' in order to assuage the concerns and fears of opponents. Given the way in which 'revolutionary' or 'evolutionary' nanotechnology is deployed according to the need to hype up or play down nanotechnology in response to opposing voices, it is clear that this ambivalence depends on the particular context in which nanotechnology is discussed.

This form of context-dependence can also manifest itself in the specific qualification of 'revolutionary' or 'evolutionary'. In an interaction between a prominent representative of industry and a leading NGO representative at a seminar on policy-making in nanotechnology, I observed how the notion of 'revolutionary' nanotechnology was given another qualification. The industry representative began her presentation by saying that nanotechnology should be seen as a *revolution in quality of life* rather than as an industrial revolution. This interpretation of 'revolutionary' differs from the interpretation of 'revolutionary' nanotechnology as 'the next Industrial Revolution' which will profoundly change the world for the better. In correspondence following the meeting, the industry representative told me that the message she wanted to convey was of the great impact of nanotechnology rather than that of an industrial revolution because of the specific view of 'industrial revolution', which is not altogether positive; thus it seemed that the industry representative was cognisant of the need to tailor the notion of 'revolutionary' nanotechnology to suit the particular context. In this context, the opposing discussant was an important factor and the industry representative demonstrated awareness of what kinds of argument might appeal to or even 'win over' the NGO representative. Interestingly, the industry representative had mobilised an argument from 'good life' ethics to argue for the continued development of nanotechnology. This argument is most often used by commentators and critical groups who will sometimes describe a 'good life' and use this as a reference in discussions about a promising technology; on the other hand, proponents of a promising technology often push the promises and fantastic possibilities of a new technology without reflecting on what kind of 'good life' their technology might deliver (Swierstra & Rip, 2007).

The NGO representative then gave a presentation entitled 'There should be a nanotech moratorium' during which he asserted that 'nanotechnology *is* (emphasis added) a major industrial revolution'. In this interaction, it appears that the NGO representative is also aware of the use of qualifying 'revolutionary' by conceptualising it in terms of ‘industrial revolution’.[35] His labelling of ‘revolutionary’ nanotechnology as a ‘major industrial revolution’ enabled him to use the negative connotation of ‘industrial revolution’ in a counter strategy to argue *for* a moratorium on nanotechnology R&D. The ‘game’ of back - and - forth argumentation is visible again.

6.2 Positions of industrialists

These are general considerations. How do industrial actors manage these ambivalences and tensions when faced with strong claims about the promises of nanotechnology emanating from policy makers and being taken up in society, as well as the emerging discourse about responsible development of nanoscience and nanotechnologies and possible restrictions on unfettered development of nanotechnologies?
We mapped the ethical commitments and patterns of moral argumentation of industrial actors whose company had some involvement in nanotechnology. We interviewed respondents from companies involved in the three main domains in nanotechnology – micro/nanoelectronics, materials and surfaces and bionanotechnology. The respondents came from multinational companies including a chemical company, two semiconductor companies, a beverage and foodstuffs company and a big conglomerate including a food company.

In some sectors, nanotechnology is an enabling technology which delivers new materials and components to help create better devices and systems which provide desired functionalities. In other sectors, nanotechnology just improves performance and sometimes allows new functionalities (e.g. surfaces that repel dirt) but the constitutional effects derive from the system and how it is embedded and used. Still, nanotechnology can lead to major differences because certain thresholds may be passed. For example, when RFID (Radio Frequency Identification Devices) become cheaper and smaller, thanks to nanotechnology, and thus more widely usable and easier to implant, all products can be traced individually and an “Internet of Things” becomes possible, leading to a view of the implantable and thus “readable” human. All this is yet to come but it is being discussed already and may lead to measures and arrangements (Rip, 2010a).

[35] The use of ‘industrial revolution’ by both proponent and opponent of nanotechnology is an example of ‘argumentative association’ (Myerson & Rydin, 1996, cited in Burchell, 2007); arguments can be made more or less convincing by associating them, positively or negatively, with other notions, historical practices and so on.

For new materials, it is indicative that chemical firms have developed nanotechnology codes of conduct. They have a good record (cf. Responsible Care program) and think they can meet the credibility pressures. For other domains under the umbrella of nanotechnology, the situation is more complex. Micro-electronics firms have other priorities than responsible development of nanotechnology. In bionanotechnology, companies' first concern is to survive.

The industrial actors we interviewed did not switch from 'revolutionary' to 'evolutionary' but the other way around, from 'evolutionary' to 'revolutionary'. We began the interviews by asking the respondents about their company's involvement in nanotechnology and their stance towards responsible innovation in nanotechnology.[36] They described nanotechnology as an 'evolution' in their development and responsible innovation in nanotechnology as a normal part of their corporate social responsibility, thus 'business as usual'.

This description of development in nanotechnology as 'business as usual' was evident in the bemused response of a respondent from a chemical company when asked how his company came to be involved in nanotechnology. He replied "We are a chemical company, so why the question?" He went on to describe nanotechnology as a "natural step in development" when nanotechnologies are defined as "the next step to control materials at an ever smaller scale."

In another version of 'business as usual', the respondent from the beverage and foodstuffs company explained that there is *already* nanotechnology – which is not new – in the food chain.

Nanotechnology was viewed as evolutionary by respondents from both semiconductor companies. One respondent explained that nanotechnology simply represents a solution to a technical problem. In the semiconductor sector, micro-electronics includes more and more nanotechnology in its miniaturisation drive. Thus, for this sector, nanotechnology is not revolutionary; it is the continuation of microtechnology.

The industrialists' use of the 'nothing unusual' argument is general but is articulated differently. The response of the respondents from the

[36] We asked the respondents whether their company's stance was part of their overall corporate social responsibility or additional to corporate responsibility; we wanted to find out if the industrial actors considered nanotechnology to be 'ethically special'.

chemical company and the beverage and foodstuffs company highlights that there is nothing yet at stake for the companies in terms of having to deal with specific nanotechnology-related issues such as ethical, environmental and health and safety issues. Their response emphasised downplaying the promise of nanotechnology; these sectors of industry are aware that nanotechnology evokes certain fears and concerns so they are careful to stress that nanotechnology is nothing new and thus not cause for concern. The semiconductor sector, on the other hand, does not see these concerns as relevant for them, if they are aware of them at all.

When we asked the respondents for their view on calls for a ban on nanotechnology development[37] nanotechnology became 'revolutionary' - with the exception of the respondents from the semiconductor companies - and could contribute to efforts towards climate protection or to the fight against cancer. This was then linked to an ethical argument against a moratorium on nanotechnology development. [38]

I offer a few quotes to support this diagnosis:

> Nanotechnology would be good for the environment, for energy use, etc. and if you look at nanomedicine - what they talk about - nobody can be against it… if you design a medicine in such a way that it finds the right place to be released in the body without any additional side-effect.
>
> (respondent from the chemical company)

The benefits of nanotechnology in the push towards climate protection were noted by the respondent from a big conglomerate including a food company who felt that a moratorium on nanotechnology R&D would slow down the development of solar cells "…when everybody outside is saying, the single biggest threat to our human species is climate change…". He added "[The] same applies for preservation of foods in hunger stricken areas". This respondent continued by making claims of "ethically responsible" action and said that he considered a moratorium on commercial development of nanotechnology to be "ethically questionable".

In the last quotes, the 'nothing unusual' argument is inverted; the proponents of the new technology *stress* the *novelty* of nanotechnology

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[37] In 2003, the ETC Group, a non-governmental environmental organisation, called for a moratorium on the commercial production of new nanomaterials.

[38] Rip (2007b) argues that proponents of a technology often invoke ethical arguments about their mandate to work towards progress and failure to harness the potential of a new technology is seen as unethical.

when defending continuation of its development. This differs from the pattern of moral argumentation described by Swierstra & Rip. In this case proponents of nanotechnology adopt the strategies of opponents – to highlight the novelty of nanotechnology – but for a different cause than that pushed by opponents. Here the novelty argument or revolutionary argument is used in order to *defend* development of nanotechnology. Thus the respondents use the revolutionary argument when there is something at stake for them as proponents of nanotechnology; in this case it is their right to continue to work on nanotechnology development. There was a clear shift in focus from the *technical* or the performance aspect - when referring to the evolutionary nature of nanotechnology - to the *social* problem/solution dichotomy - when pronouncing on the revolutionary potential of nanotechnology. When respondents referred to social issues such as medical treatments and climate change, which are both high on the agenda in discussions in the social sphere, nanotechnology became revolutionary. Positioning nanotechnology as a potential solution to social problems facilitated the call for ongoing development of nanotechnology.

The industrial actors have a prudent approach to the promise of nanotechnology. They realise that it is in their interest to present nanotechnology as 'business as usual' or 'evolutionary' in order to render nanotechnology familiar and therefore harmless. On the other hand, they offer the promise of 'revolutionary' nanotechnology as an argument to let them continue. Such an argument assumes that their audience will want progress (through nanotechnology) and so will be receptive to their claim. NGOs and civil society organisations may, or may not, go along with this. An example is the Friends of the Earth report on agricultural and food applications[39]; while FoE wants improvement of agriculture, the nano route will prejudice precision agriculture as an alternative to the biological/ecological route favoured by FoE.

[39] See http://action.foe.org/content.jsp?content_KEY=3965

6.3 A division of moral labour

The ethical arguments of the industrial actors referred to their notion of progress through the development of nanotechnology. Indeed their response to the ambivalence of the nature and impact of nanotechnology was predicated on their need to be allowed to continue with the development of nanotechnology. However, they did not make this kind of argument upfront. This argument emerged when they made claims of 'ethically responsible' action, for instance, the development of organic solar cells to be deployed in the fight against climate change. Thus responsibility was explicitly framed in terms of the development of nanotechnology to meet societal challenges. This then allowed them to turn the stance of NGOs that industry is ethically questionable in its pursuit of nanotechnology back onto the NGOs; if NGOs stop development in nanotechnology, then *they* are the ones who are unethical.

The ethical arguments which the industrial actors used to justify development in nanotechnology reflect standard repertoires in which scenarios of promise are pushed and ethics is viewed as a brake on progress. These standard repertoires build on the present division of moral labour. Division of moral labour refers to a division of obligations and commitments, as well as to notions regarding who is eligible to be praised or blamed (Rip & Shelley-Egan, 2010). The present division of moral labour creates a space in which scientists and other technology developers, such as industrial actors, can focus on the progress of science and technology, while other actors (government agencies, NGOs) are expected to look after other considerations, including ethical and social ones.

Indeed the industrial actors' view of the role of NGOs in the responsible development of nanotechnology referred to a division of moral labour. The industrial actors felt that NGOs had the right to ask critical questions and indeed, that somebody *should* ask questions on behalf of the public. This was reflected in one respondent's view that NGOs are "entitled to their position" even when they call for a moratorium on nanotechnology development.

Another respondent felt that NGOs' concern about nanotechnology is

> …a very good thing, in the sense that there are groups of people who watch the developments and look critically at them, ask questions to make sure that everybody is keen on the balance between opportunities and the potential risks. Well, that's the impression I have. Also, I believe that even the groups that are sort of aware and ask critical questions, my

> personal impression is that they are also looking for the balance about what is really the issue and only the ones who are very political will make a firm statement like there should be a ban before we know enough.

Here the respondent introduces a distinction between 'good' NGOs and 'bad' NGOs. This is an enlightened view; there are also industrial actors who are furious over the activities of NGOs. In our interviews, we heard respondents accuse NGOs of being agitators, failing to act in good faith, using misleading information to further their cause and painting different nanotechnologies with the same brush.

6.4 In Conclusion

A division of moral labour is effective when it is accepted and implemented, that is, when it is 'solid'. However, in changing circumstances (which might include changing values, e.g. about precaution or about participation), where responsibilities may have to be redefined, the solidity of the division of labour will become a hindrance rather than a help. It has to be opened up or 'melted' down to allow space for new configurations (Rip & Shelley-Egan, 2010). While the industrial actors' views about NGOs reinforced this division of labour, new configurations in the world of nanotechnology, such as the collaboration between the chemical manufacturing company DuPont and the non-profit group Environmental Defense, suggest that there is already a move towards redefining responsibilities in the world of nanotechnology.

In 2005, DuPont and Environmental Defense (who could be viewed as adversarial stakeholders) formed a partnership to work together to produce a nano risk framework,[40] aimed at evaluating and addressing potential environmental, health and safety risks of nanomaterials across the entire life cycle of the materials. DuPont evaluated the framework – deemed appropriate by both organisations – using three case studies and published the results in early 2007. Both organisations have issued a call for feedback on the framework and have encouraged companies to adopt the framework. Interestingly, there was a response from a 'civil society labour coalition',[41] which issued a statement condemning what they called the "public relations campaign" of DuPont and Environmental

[40] See http://nanoriskframework.com/page.cfm?tagID=1095
[41] See http://www.etcgroup.org/upload/publication/610/01/coalition_letter_april07.pdf

Defense. The corporate partnership between DuPont and Environmental Defense may set a precedent for a new kind of interaction between industry and NGOs. On the other hand, the strong response from the civil-society labour coalition reasserted the traditional boundaries and division of moral labour which exist between industry and civil society organisations. At this stage, it is impossible to decide whether the civil-society labour coalition's reaction is conservative in the face of ongoing overall changes, or an indication that such changes are not occurring, and the DuPont-Environmental Defense collaboration is a passing occurrence.

This case shows that operationalisation of 'responsible development' can, and will, be contested because changes in division of moral labour are about politics just as much as they are about ethics. This is visible in my interview data as well, even while there is no action involved. The ambivalences of nanotechnology, and of promising technologies more generally, are not just an intellectual challenge; the evolving strategic games that are played are for real, even if the discourse of responsible development may start as a new 'language game'.

Addendum

The ambivalences of promising technology are played out against a backdrop of what Joly, Rip & Callon (2010) call a 'regime of economics of techno-scientific promises' (ETP regime). This regime is fuelled by ideas about global competition and strategic games in which "being first is more important than going in the right direction" (Rip, 2009, p. 669). At the policy level, an overall sense of urgency is created, as is clear in these quotes from the recommendations of the so-called Aho Report (Aho, Cornu, Georghiou, & Subirá, 2006): "The need for Europe to provide an innovation-friendly market for its business (…). This needs actions on regulation, standards, public procurement, IPR and fostering a culture which celebrates innovation" (p. vii). [42]

On the ground, the situation is more complex, as is clear in my analysis above (in the published article). Even so, there is a pervasive governance assumption - a division of labour between technology promoters and enactors on the one hand and civil society on the other hand: "Let us (= promoters) work on the promises without too much interference from civil society, so that you can be happy customers as well as citizens

[42] The Aho Report reinforces this message by saying, rather ominously: "Europe and its citizens should realize that their way of life is under threat but also that the path to prosperity through research and innovation is open if large scale action is taken now by their leaders before it is too late" (p. vii).

profiting from the European social model" (Joly et al., 2010, p. 25). Technoscientific promises begin to function as a hegemonic political order "with a tyranny of urgency and naturalization of technological progress" (Joly et al., 2010, p. 26) to the detriment of the participation of civil society.

These meso-level dynamics depend on a short-circuiting of an essential ambiguity: "promises are by their very nature uncertain, requiring support by believing in them before they exist; but they should not be accepted at face value either" (Joly et al., 2010, p. 24):

> The creation of a fiction in order to attract resources – financial, human, political, etc. – namely, that the emerging technology … 'will solve human problems'… through a wide range of applications. The credibility of this cornucopian conception of technoscience is partly based on the 'naturalization' of technological advance, which is seen as almost a self-fulfilling prophecy (if enough resources are provided and an effort is made) (p. 24).

While the regime of ETP is hegemonic at the meso-level, it is not the only regime. Joly et al. (2010) argue that there is also a regime of collective experimentation. Whether it is a fully-fledged regime is not clear yet but there are interesting examples, like electric vehicles (cf. Hoogma, Kemp, Schot, & Truffer, 2002). Electric vehicles are surrounded by promises (in relation to their being an alternative to the dominant regime of internal combustion engines) and constitute a subject for collective experimentation. Experimentation "… does not derive from promoting a particular technological promise, but from goals constructed around matters of concern that may be achieved at the collective level" (Joly et al., 2010, p. 27).

The European Expert Group on Converging Technologies (Nordmann, 2004) proposed to develop the visions which inform enabling technologies like nanotechnology in spaces in which a variety of stakeholders are involved. This appears to be happening already to some extent but in an *ad hoc* manner. The discourses and dynamics at the macro-, meso- and micro-levels should be recognised and taken into account so as to make ongoing practices more productive.

7. From enhancing ethical reflexivity to stimulating articulation of reflexivity

7.1 Introduction

Scientists are regularly called upon to take up broader social and ethical aspects of their research in order that research choices can be made which bring to bear these broader considerations on their work. Such an emphasis on the need for consideration of broader aspects of nanoscience and nanotechnology research is visible in nanotechnology policies in many countries, in particular in the Netherlands, the US and the UK.

There is an assumption that, by enhancing enactors' reflexivity in relation to broader issues and the (possible) need to do something about them, actors will be able to make decisions which can contribute to research and networking that better meets society's needs. Studies relating to the broader aspects of research have been run in parallel with funding programmes of new and emerging science and technology, including nanotechnology. Constructive Technology Assessment projects - which can contribute to enhancing the reflexivity of actors in relation to broader issues by feeding back CTA insights into ongoing discussions and choices - have also been established. [43]

Enhancing the ethical reflexivity of actors can be a goal in its own right. Examples include the provision of ethics courses for science students, provisions in Codes of Conduct and attempts to safeguard the integrity of scientists. I have already referred, in Chapter 3, to the VSNU Code of Conduct for Scientific Practice. There is one further noteworthy observation about this Code – the VSNU has requested that universities refer to the Code when awarding PhD degrees, thereby creating visibility for integrity in research. Other institutional arrangements include the establishment of the US Office of Research Integrity (ORI). However, there are reasons to be sceptical about how effective such arrangements can be. For instance, the ORI has system responsibility but depends for its functioning on cases of scientific misconduct being brought to its notice.[44]

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[43] Constructive Technology Assessment aims to contribute to the construction of new technologies and the manner in which new technologies become embedded in society by including additional aspects and perspectives in developments at an early stage (cf. Schot & Rip, 1996).
[44] See Rip (2007a).

Explicit in some of these activities such as ethics courses and codes of conduct and implicit in many, is an 'ethical deficit model'.[45] The terminology of 'enhancing', independent of a diagnosis regarding the *actual* deficiencies of scientists in this respect, is telling. An additional feature of the 'ethical deficit model' is that social scientists, ethicists and humanists are positioned as knowing 'better' than scientists and industrialists; experts in the social sciences and humanities can use their expertise to help these actors overcome their shortcomings by enhancing their ethical reflexivity.

I[46] argue that enhancing ethical reflexivity can be pursued without the deficit model by stimulating the articulation of reflexivity as a basic human competence. I offer two arguments against this 'ethical deficit model'.

First, exercises in enhancing ethical reflexivity of actors create an asymmetry between natural scientists and social scientists where social scientists and ethicists are positioned as having some "superior insight" which natural scientists and industrialists supposedly lack. Of course, if there is a problem that needs to be addressed or redressed this may require some help from the outside. Social scientists have different professional knowledge and can bring this knowledge to the table. This can be part of 'moving about' (Robinson, 2010, p. 29) in the world of nanotechnology; social scientists can gain an overview of nanotechnology developments and contribute to the broadening of the enactor perspective.[47]

Indeed, for newly emerging science and technology there is a problematic situation to which scientists and industrialists must respond one way or another. They find themselves in a situation where they are co-

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[45] I introduce 'ethical deficit model' in analogy to the well-known "deficit model" of public understanding of science. The latter deficit model conceptualises the lay mind as an empty vessel to be filled with understanding of science and locates knowledge and expertise solely with scientists.

[46] I use the pronoun "I" here but wish to acknowledge that, in writing this chapter, I have built on the joint efforts and texts of deliverables with Prof. Arie Rip as part of our work on the DEEPEN project. Moreover, I acknowledge productive interactions with the entire DEEPEN project team and their input into this work. I assume responsibility for the work presented in this chapter.

[47] Social scientists also have their limitations. Lindblom's (1990) perspective on inquiry emphasises probing as a kind of inquiry which can facilitate change. Lindblom argues that there is no epistemological difference between probing by citizens, by government functionaries and by social scientists; social scientists, however, may have more honed and articulated probing skills (Lindblom, 1990 cited in Robinson, 2010).

constructing the novelty of nanotechnology but it is unclear who can be held accountable for the consequences of the novelties they introduce (see Chapter 1, organized irresponsibility). A social scientist can contribute insights about patterns and possibilities in processes at the collective level which are not easy for enactors "on location" to obtain.

Thus, there are functional asymmetries. The ethical deficit model leads to dysfunctional asymmetry when a kind of 'teacher/student' relationship forms in interactions between the social scientist/ethicist and the natural scientist. Scientists can maintain this relationship by delegating reflexivity to the expert who can guide them.

However, there is no need to delegate because of a supposed lack or basic deficit. This observation links up with my second argument against the deficit model: enactors already have competence for ethical reflexivity - it is the performance that may be lacking. My findings can be read as demonstrating that problems occur in the articulation of reflexivity. This competence/performance distinction can be understood as similar to the distinction between linguistic competence and performance. There is the basic competence to speak a language at all. A first round of performance involves learning to speak a particular language; this ability is a competence in its own right. In linguistics, performance of a language relates to actually speaking a (particular) language. I argue that, with regard to reflexivity of actors, they are not lacking competence in reflexivity but are lacking the skills to perform the *articulation of reflexivity*. This particular limitation derives from actors' limiting their reflexivity by recourse to roles and mandates. Consequently, justifications are made, not in terms of ethics but in terms of their role, work, institutional context and so on. While these are legitimate justifications for these actors, they are offered without reflective inquiry and thus allow short-circuiting of problematic situations.

Enhancing the ethical reflexivity of actors from a non-deficit perspective is to encourage them to articulate their reflexivity. Actors do not need help to be ethically reflexive; they have the capacity to be reflexive but may require help in order to *perform* their reflexivity. Scientists and industrialists can profit from tools and incentives to enable them to *see* that they are making shortcuts.

Before I discuss tools and incentives, I will discuss basic perspectives on ethics and reflexivity, distinguishing a perspective linked to the ethical deficit model and a perspective on 'ethicality'. Next, I discuss practical approaches to enhancing ethical reflexivity and evaluate their contribution to 'heating up' the moral perspectives of actors. This allows me to identify certain requirements necessary for ‘heating up’. Following on from this, I describe and evaluate the use of a tool to stimulate the articulation of ethical reflexivity in a focus group exercise. In the concluding section, I reflect on a larger process of reflexiveness and look at possibilities for the integration of tools at meso-level to enhance ethical reflexivity of actors at the micro-level.

7.2 General issues of morality and ethicality

Approaches to enhancing ethical reflexivity imply a basic perspective on ethics and reflexivity. One perspective which can be identified (and which often goes together with a deficit model) emphasises the training component of enhancing ethical reflexivity, in relation to the competencies necessary to ‘do’ ethics and to progress in moral development. This perspective on ethics and reflexivity also includes a conception of morality as linked to persons being ‘responsible’. A second perspective, which is the one I use, comprises an approach to enhancing reflexivity which centres on working with the capacity for reflexivity which actors already have. The first perspective often focuses on individuals as somewhat independent of context. In the second perspective, roles and positions of actors are taken into account as well, up to overall changes in the social and moral landscape of our societies (a multi-level perspective).

To start with an example: An emphasis on training is visible in Coeckelbergh’s (2006) otherwise interesting argument that in order for engineers to be able to discern the moral relevance of design problems and to envisage the possible outcomes of their designs, there is a need for them to develop the capacity for “moral imagination”. Competency in moral imagination is necessary because ethics and social considerations are “not naturally part of their self-image as a professional” (p. 254). Thus if engineers are unable to articulate or even recognise the ethical dimension of their design activities, they will be unable to reason about ethics. Coeckelbergh argues that there is thus a requirement for “training that stimulates moral imagination” (p. 256).

With the reference to ‘enhancement’ or ‘training’, the literature on moral development and psychological studies of moral reasoning becomes relevant. The classical approach of Kohlberg (1981) distinguishes six stages in the process of moral development, each with its own type of moral reasoning. In the highest stage (stage six), moral reasoning is based on abstract reasoning using universal ethical principles. Gilligan (1981) - who collaborated with Kohlberg - criticises both the focus on the ethics of justice and the idea of necessary stages. Her criticism of the idea of necessary stages stems from her observation that Kohlberg's theory is too androcentric, i.e. the idea of necessary stages implies an interpretation of the empirical findings as demonstrating that women would often not reach the highest stage.[48] Gilligan's alternative is an ethics of care and the study of different moralities "in their own right"; she describes her approach as follows:

> In [my] conception, the moral problem arises from conflicting responsibilities rather than from competing rights and requires for its resolution a mode of thinking that is contextual and narrative rather than formal and abstract. This conception of morality as concerned with the activity of care centers moral development around the understanding of responsibilities and relationships, just as the conception of morality as fairness ties moral development to the understanding of rights and rules (p. 19).

A discourse of responsibilities is currently on the agenda with the move towards 'responsible development' of nanoscience and nanotechnology. The discourse of evolving responsibilities is not just an ethical discourse. It draws on the "language" of responsibilities as a means of addressing ordering of our society (Rip, 1981). Indeed, if one looks at the history of this discourse, one sees this language of ordering society at work.

Rip (1981) has emphasised that the concept of 'responsibility' is more recent in origin than the adjective 'responsible' which first appeared in the 17th century. The Oxford English Dictionary lists 1787 as the oldest known occurrence of the word 'responsibility'; in France this is 1782. The Woordenboek Nederlandse Taal (1959, p. 137) notes how in the late 18th century, the concept '*verantwoordelijkheid*' entered the Dutch discourse as the translation of the then recently coined French term '*responsabilité*', which represented part of the emergence of bourgeois society. Old ideas about hierarchy and tradition succumbed to new Enlightenment principles of citizenship, whereby citizens had to collectively create and maintain a political order. Along with freedom and equality, responsibility constituted the cornerstone for the functioning of the new political institutions.

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[48] Gilligan uses a discussion (which was part of the studies she and Kohlberg carried out) between two 11 year-olds, Jake and Amy, as a commentary. They had to discuss an ethical dilemma and Jake considered the conflicting principles and their possible hierarchy, saying "[It is] sort of like a math-problem with humans".

On this basis, further meanings of 'responsibility' developed during the 19th and early 20th century which included organisational responsibility. 'Responsibility' was also used to reformulate the classical debate about attribution and guilt (McKeon, 1957). A key item was the notion of 'diminished responsibility' because of which a person could not be held accountable for his (wrong) deeds. Further developments included reference to the 'fully responsible' person, *compos mentis* and ethically mature; in American English, in particular, phrases like "a totally responsible individual" can be used (Howard & Tracz, 1970, p. 67). 'Responsible' now characterises a person rather than a relationship and then also a feature of action. Being 'responsible' relates to a new virtuousness and one which need not be specified other than by reference to what is expected in our society, up to being a responsible citizen.

There is a tendency in the literature (not just with Kohlberg) to emphasise stages towards becoming morally mature. Application of the insights from this literature to the task of enhancing the ethical reflexivity of actors perpetuates one assumption of the 'ethical deficit model' that actors are not morally mature and require 'enhancing' or training in ethical reflexivity. This is not to say that there are no deficits. Indeed, part of the language of responsibilities is about diminished responsibilities of children and of mentally deficient people.

In order to develop the second perspective on the task of enhancing ethical reflexivity, I start from the side of anthropology/sociology. The notion of 'sociality' captures the irreducibly social nature of man, while also including the fact that people are 'knowledgeable actors' (Giddens, 1979) and will anticipate and reflect on ongoing structuration, thus making it a reflexive process. The level of reflexiveness of the process will vary and this is partly dependent on the level of reflexivity of the knowledgeable actors (at the micro-level). [49]

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[49] This brief statement can be developed further. Reflexiveness (at the macro-level) is central to the process of 'reflexive modernization' as discussed by Beck, Giddens, & Lash (1994). Reflexive modernization is a process of modernization of modern society in which the key social institutions of first modern society (e.g. the nation-state, the nuclear family) have lost their taken-for-granted character and are under continual pressure to justify themselves in second modernity, which is characterised by globalization and the intensification of individualization (Beck, Bonss, & Lau, 2003). The reflexiveness of the process may be enhanced when the reflexivity of actors leads them to act in such a way that change in institutions is required. The reflexiveness of the process will also depend on interactions; an example is the occurrence of informal technology assessment in and through controversies, even when the contesting actors pursue their own interests without much reflexivity. Reflexiveness can have

Enhancing ethical reflexivity is thus not necessarily linked to the 'ethical deficit' model. Although enhancing ethical reflexivity can have a training component, it essentially offers opportunities to actors to build on the capacity for ethicality which they already have. This does not imply that everything that actors say and do should be embraced, however. There are differences in quality with regard to the ability to articulate ethical perspectives in action and that is why one speaks of knowledgeable actors and here of "ethicable" actors. However, there cannot be *a priori* differences between who is knowledgeable or ethicable and who is not (and thus cannot get a hearing). My interest in 'lay' ethics is also driven by this conviction and it applies to people who are 'lay' with respect to nanotechnology just as much to nano-enactors who are lacking some ethical competence (see Chapter 2, Section 2.4.1). In both cases, quality can (and should) be enhanced.

Enhancing ethical reflexivity has to build on the basic premise of "ethicable" actors. The articulation of ethical reflexivity is based on the overall competence of ethicality. Enhancing ethical reflexivity is not only a matter of enhancing individual capacities, however important that may be. Interactions and outcomes at the collective level are just as important. Thus roles and positions of actors have to be taken into account when enhancing their reflexivity, just as much as their ethical competencies or capacity for moral reasoning. Roles and positions of actors are then not a way of by - passing a 'problematic situation' but part of overall changes with their own dynamics which enable and constrain actors.

7.3 Enhancing reflexivity and agency

Enhancement of their ethical reflexivity is not a priority for scientists and industrialists, for two reasons. One, actors are more interested in advice about what should be done and what should not be done than in being reflexive. Two, the specific stance of enactors in which they work in 'enactment cycles' by constructing scenarios of progress to be made and identifying obstacles to be overcome, avoids reflexivity. This is clear in how enactors tend to dismiss opposition as irrational or misguided or as a result of other actors simply following their own agendas. They get frustrated because they feel that a simple description of the promise of their technological option should be sufficient to convince consumers/citizens. In a more enlightened approach, enactors may be

different forms, meaning that it can be reactive or proactive; for example, environmental issues can overcome actors or can be actively pursued.

prudent and discuss the emergence of negative attitudes, cf. Vicky Colvin's (Director of the Center for Biological and Environmental Nanotechnology at Rice University, Texas) anticipation of the 'wow-yuck' pattern in nanotechnology, similar to that which occurred in biotechnology (Rip, 2006a).

When enactors *are* willing to be reflexive, they may still feel helpless as to how to go about it. Rip (2007b) has argued that scientists may not have the necessary tools to be reflexive. This suggests a need to build capacity in terms of furnishing scientists with the necessary skills and competencies to identify issues, to be productive about them and at times, to be proactive about them.

7.3.1 Current approaches

There are already a number of practical approaches to articulating reflexivity.

A basic requirement for reflexivity is competence in *moral reasoning*. The approach of Stephen Toulmin (1958) is particularly valuable in articulating the warrants for an ethical claim or stance and can be readily applied to concrete situations (cf. Rip et al., 1995; Schellens, 1985).

A further step, which might be necessary from time to time, particularly when wholly new challenges have to be addressed, involves working towards (narrow and perhaps broad) reflective equilibrium, as proposed by Thagard (1988) (inspired by John Rawls and Norman Daniels). At the level of R&D networks, Van de Poel & Zwart (2010) have developed an approach for the moral assessment of such networks on the basis of wide reflective equilibrium. The wide reflective equilibrium approach aims at coherence between moral judgements, principles and background theories. This approach takes seriously the moral judgement of actors, while also leaving room for critical reflection about these judgements.

Ethical reflexivity can be stimulated and required competencies enhanced in a number of ways. One way is the inclusion of ELSA (and insights of ELSA studies) in training at Masters and PhD level and in nanotechnology research programs and nanotechnology research institutes. In a similar vein, the research programme established by the Netherlands Organization for Scientific Research (NWO) on Responsible Innovation (abbreviated to MVI: Maatschappelijk Verantwoord Innoveren)[50] emphasises interaction with social scientists.

There are also system-level or 'soft structure' changes which allow ELSA to be put on the agenda more easily and/or imply that neglecting ELSA might lead to loss of credibility. These kinds of 'soft structure' effects are visible in nanoscience and nanotechnology funding research programs which now require an ELSA component. Another means of stimulating and enhancing competencies in ethical reflexivity comes from the side of funding agencies which would require consideration of ethical and social aspects in all research proposals, over and above the usual requirements concerning the ethics of experiments. Some funding agencies are already considering the inclusion of this requirement in proposals. The Technology Foundation STW, a division of the Dutch funding agency NWO, is running some pilot projects.[51] The European Commission already has a requirement for extended impact assessments in research proposals.[52] This requirement has the same weight as the regular requirements of scientific quality and management of the proposed project.
There are also Codes of Conduct, which are widely used as detailed guidelines for the behaviour of various professional communities. In relation to the task of enhancing ethical reflexivity, Codes of Conduct can be used as a reference - this is how one must behave (indeed, they can have some legal status) - rather than providing incentives for discussion. However, codes of conduct can be important for enhancing ethical reflexivity if one looks not only at behaviour but at the discussion and reflection which might follow. Indeed Schuurbiers (2010) argues that the implementation phase of codes of conduct is just as important as their establishment as it addresses questions relating to how the code is adopted and how it can be implemented in ongoing practices; such questions may lead to enhancing of the ethical reflexivity of actors.

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[50] http://www.nwo.nl/mvi

[51] Similar ideas had already been proposed in the 1970s by the science, technology and society movement (cf. Rip & Goeman, 1978). These ideas are only now entering the science system; these ideas are linked to the reflexiveness of the process and are an important factor in the reflexivity of actors in the process.

[52] Extended impact assessments have three criteria: 1) contribution to expected impacts as listed in the call; 2) appropriateness of measures (for dissemination, engagement, etc.) as formulated in the proposal; and 3) "expected extended impact"- this is a specific impact which needs to be accounted for, independent of the broader impact research may have on relevant actors or on society at large.

Reflexivity should hopefully lead to improved *action,* if that is required. In the short term, marginal changes may be the most that can be expected. However, such changes may accumulate over time and lead to changing role expectations. For example, environmentally friendly behaviour, in particular in the chemical industry, evolved from an exception (in the late 1960s) to the rule (in the 1990s, cf. the Responsible Care® program).

Related to the issue of improved action is the question of agency and responsibility. Can researchers – and individual actors generally – make much of a difference? There are a few interesting practical approaches which contribute to creating more agency.
Fisher et al. (2006) discuss the possibility of "midstream modulation" as a means of evaluating and modulating research decisions in light of social considerations during the research process. Midstream modulation takes the form of a 'lab-scale intervention' (Schuurbiers & Fisher, 2009).

'Fictive script' (De Laat, 1996, 2000) can be used as a tool to create greater agency for actors. The notion refers to the conditions necessary for an envisaged innovation to take place and to be successful. Actors can be confronted with a fictive script and be asked to fill in the gaps required for the implementation of a successful innovation; such an exercise stimulates greater agency for actors because they can now see what has to be done and how.
Den Boer et al. (2009) have used the idea of 'fictive scripts' in a mapping methodology aimed at turning open-ended promises of nano-researchers into concrete challenges. The authors specify 'future scripts' as a possible future innovation chain that could take up and realise the potential of some nanoscience research. By comparing current innovation value chains (including external contexts and structures or 'framework conditions') with future innovation chains, gaps and barriers in present networks can be identified. This kind of scripting exercise can be carried out in considerable detail, with checks and counterchecks with various relevant and knowledgeable actors. The primary aim of the study of Den Boer et al. (2009) was to develop a methodology to enhance the ethical reflexivity of (nano)scientists, in particular junior scientists, in relation to present and future societal contexts of their work, by exploring potential research connections even when they are not (yet) linked to applications. Again, stimulating agency is an important aspect of this 'reflexivity-in-action'.

Socio-technical scenarios (cf. Rip & Te Kulve, 2008) can be used to draw out ethical issues and arguments and can be used interactively in workshops (or made available for broader use). Van Rijswoud et al. (2008) have used an interactive scenario study in the field of community genetics in order to articulate the 'endogenous futures' of community genetics and stimulate debate among various stakeholders. This method has been taken further by Swierstra et al. (2009) and Stemerding et al. (2010) in their 'techno-ethical' scenario approach. The construction of techno-ethical scenarios facilitates the exploration of potential controversies around new and emerging science and technology beforehand by applying the 'grammar' of ethics of new and emerging science and technology (for a discussion of NEST-ethics, see Chapter 2, Section 2.4.2). This approach can help stakeholders to recognise, understand and manage potential controversies and contribute to public debate about the desirability of the NEST in question. Techno-ethical scenarios generate informed agency. Moreover, they create another position for scientists, as both 'techno' and 'ethical'. The 'techno' component acknowledges and requires the competence of scientists, while the 'ethics' component addresses their lack of articulation.

In the field of nanotechnology, Robinson (2010) has used socio-technical scenarios in CTA workshops as a platform for the exploration of issues around emerging nanotechnologies and to facilitate the 'probing' of the worlds of the various participants. The scenarios also offered entrance points for ethical discussion but these were rarely taken up in the workshops; other issues such as start-up firms and regulation dominated. In the Nanodialogue project, 'nano-scenarios' were developed as a tool for public engagement exercises (cf. Türk, 2008).

7.3.2 Evaluation of approaches to enhancing ethical reflexivity

This overview shows that there is already much ongoing activity around enhancing ethical reflexivity of actors. The quality of these approaches can be evaluated with regard to their contribution to 'heating up' the moral perspectives of scientists and their enabling scientists to see where and how they are making shortcuts.

There are two 'culprits' – in the shape of ELSA studies and training courses in ethics for scientists – which do not contribute to 'heating up' the moral perspectives of scientists because of lack of involvement and thus limited opportunity for scientists to articulate their reflexivity.

In contrast, the wide reflexive equilibrium approach to moral issues in R&D networks offered by Van de Poel & Zwart (2010) not only works with the competence of actors to make moral judgements - thus rejecting the ethical deficit model - but also requires a person to reflect on his or her value system in order to achieve wide reflective equilibrium.

Most of the remaining approaches discussed in the previous subsection encourage scientists to engage in ethical reflection but they also leave room for sidestepping reflexive inquiry. The requirement for consideration of ethical and social aspects of research in research funding proposals goes some way towards 'heating up' the moral perspectives of scientists by requiring them to think in broader terms than the ethics of experiments, for which they can have 'recourse to the procedural'. However, over time, practical considerations may gain the upper hand, for example, when scientists comply with the requirement by 'copying and pasting' from earlier proposals.

Codes of Conduct create space for avoiding engaging in ethical reflexivity by allowing scientists to use them as simple guidelines for behaviour. However, as I have discussed already, discussion and reflection on Codes can lead to some articulation of reflexivity. Indeed, the ethics of collective co-responsibility which the EC Code of Conduct for Responsible Nanoscience and Nanotechnologies Research advocates, invites scientists to reflect on their role in this new collective co-responsibility. Such reflection involves some 'heating up' of morality as actors can no longer fall back on their roles and mandates.

Techno-ethical scenarios facilitate opening up of moral perspectives of actors but not in a straightforward way. The development of such scenarios replaces actors' own anticipation of potential ethical issues and arguments. However, it is the use of scenarios in *interaction* with other stakeholders which may lead to opening up, for example through the occasion of justifying their own perspectives to others.

Interaction is an important component of laboratory engagement studies and methodologies aimed at "reflexivity-in-action". The risk of falling back on the ethical deficit model is mitigated in practice by encouraging actors to articulate their reflexivity and by indicating to actors when they are making shortcuts.

CTA workshops "act as a microcosm of the real world and allow the mingling of actor-roles and experiences of those participating" (Robinson, 2010, p. 206). Moreover, such workshops introduce elements that would normally be quite distant or invisible to participants' traditional activities in the real world (Robinson, 2010). These particular features of CTA workshops facilitate the performance of the articulation of reflexivity of actors.

Looking back on the advantages and disadvantages of the various approaches for enhancing ethical reflexivity from a non-ethical-deficit perspective, one can posit certain requirements which are necessary for opening up the moral perspectives of scientists. Heterogeneity appears to be particularly important.

Heterogeneity circumvents a situation where “experts” (scientists) can just repeat their own preconceptions (Robinson, 2010). In terms of ‘heating up’ moral perspectives, heterogeneity in a protected space such as a focus group enables actors to see that there is a ‘problematic situation’ and allows them to develop their ethical perspectives and the justifications for these perspectives in interaction with others with possibly quite different perspectives.

I have added to the tool kit by developing and implementing a tool, in the form of argumentation scenarios, aimed at facilitating the articulation of reflexivity in a focus group exercise in which ‘design for difference’ (heterogeneity) was an important requirement. I used the Toulmin Model of Argumentation and its emphasis on justification for a claim (cf. Toulmin, 1958) as background structuring of the moral reasoning in the argumentation scenarios.

7.4 Design and implementation of an exercise to stimulate the articulation of reflexivity

As part of the DEEPEN project, we developed two overlapping exercises to stimulate the articulation of reflexivity**.** A focus group exercise[53] was implemented in order to facilitate discussion of the arguments and justifications behind the increased call for accountability/responsibility of scientists. The second exercise involved the development and use of argumentation scenarios as a tool with which to identify links between arguments in the focus group discussion and as a means of identifying where further justification is necessary. Such a tool can be used to stimulate the articulation of reflexivity.
As a tool, the argumentation scenarios can be discussed without providing details of the focus group in which they were used; however, it is useful to discuss the context of the focus group as a means of understanding their role in stimulating the articulation of reflexivity**.**

[53] I presented the findings of this focus group exercise in Chapter 3.

The focus group exercise

The level of reflexivity which is already present in the world of nanotechnology is not high. My empirical findings demonstrated that there *is* reflexivity in the nano-world but it is not adequate to respond to problematic situations related to the 'responsible development' of nanotechnology. The focus group participants were offered opportunities to build on their reflexivity using accountability/responsibility as the main topic. This particular topic was chosen because the current emphasis on the 'responsible development' of nanotechnology necessitates some attention to issues of accountability/responsibility. We began the focus group exercise by exploring ethical dilemmas faced by scientists, both as a probe and in order to provide participants with an opportunity to reflect on their own experiences with issues of accountability/responsibility.

The participants generally experienced some difficulty in putting forward considered arguments linking issues of accountability/responsibility with their own research. There was general discussion around the EC Code of Conduct and responsible development of nanotechnology which enabled the identification of ethical issues, including distributed responsibility and ethics of scientific promising.

Argumentation scenarios

Following a first round of discussion, the participants were provided with argumentation scenarios (see Appendix) as tools with which to develop their ethical perspectives in a more structured manner and to enable them to be able to provide justifications.
Argumentation scenarios identify links between arguments and help to identify where further justification is necessary. Toulmin's Model of Argumentation is particularly useful for ethical argumentation. It includes three main parts in addition to relevant data – *claim*, *warrant* and *reservation*. In Figure 1, I show the three main parts.

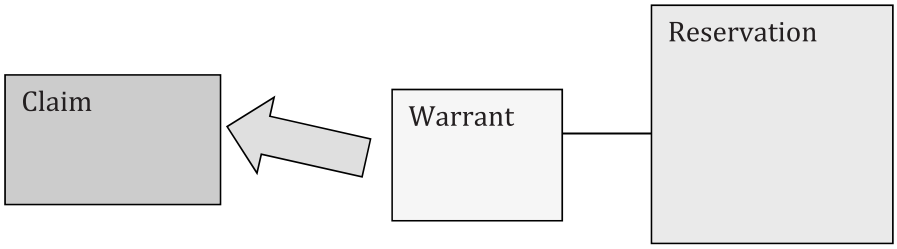

Figure 1: Claim, warrant and reservation in Toulmin's Model of Argumentation

Claim: the statement which the "arguer" puts forward and wants to have accepted. In the case of a scientific argument, the claim will often be about empirical data. In the case of ethics, there might be relevant data but the claim has a normative character.

Warrant: the important part in an ethical argument. It offers a general ethical justification. Such a warrant can have a consequentialist, deontological or good-life character. A deontological argument is concerned with *duties* and *principles* which require people to behave in specific ways, regardless of the consequences. "Thou shalt not kill" is a deontological argument.

Reservation: possible limitations to the warrant, up to an argument against the warrant. For example, if the warrant is a deontological argument, there might be an argument against deontological ethics, from a consequentialist ethics perspective.

Any argumentation can be structured and checked for quality in this way.

Design of the argumentation scenarios

The present discourse of responsible development of nanoscience and nanotechnologies and the credibility pressures that may be felt formed the "backbone" of the scenarios. The overarching argument or claim was one of 'non-accountability'. The purpose of using this claim was to facilitate general discussion around the accountability of scientists and to highlight our argument that scientists should at least *consider* the issue of accountability, rather than dismiss it outright.

In preparation for the workshop, we collected and arranged the various arguments on accountability/responsibility in scenarios. We found at least four, which were, to some extent, linked. The focus in the Toulmin analysis was on the claims and warrants which we expected the scientists to offer and reservations to the warrants, introduced by us. The scenarios were not prescriptive but created as a guide to possible links between arguments we expected the scientists to put forward.
The Toulmin Model of Argumentation does not offer guidance as to the different roles which the claim and warrant can assume and which should be put up front. This is important because in a discussion, the *sequence* of the argument makes a difference to the outcome. For example, if one starts with the need for a firm to survive in a market context and then adds Corporate Social Responsibility, the result is different than when one begins with social responsibility of different actors and zooms in on a situation of market competition. Thus, it is important to construct different scenarios of argumentation.

Use of the scenarios

Our focus was on the process which unfolds during the exercise rather than the outcome (e.g. measuring the level of reflexivity achieved, if that were possible). The argumentation scenarios were introduced over half way through the discussion in order to map arguments in the discussion and to demonstrate the structure of the arguments, in terms of claim, warrant and reservation. Some arguments had already been explored in the preceding discussion. The scenarios were recognised as being valuable by the participants. The participants commented that the idea was clear as a means of sketching out the various paths for reasoning. They were interested in understanding the link between claim, warrant and reservation and could recognise the link between different scenarios. Interestingly, the participants showed their interest, even excitement, about the scenarios in the same manner as Jake in Kohlberg and Gilligan's study: a sort of math problem with humans (see footnote 6).

There is a danger that such argumentation scenarios could be used in a calculative manner, such that the emphasis would be on solving the 'problem' of the argument, rather than on providing justifications for the arguments. For this reason, articulation of arguments in action and interaction is important. These argumentation scenarios are also complementary to the wide reflective equilibrium approach of Van de Poel & Zwart (2010) and Rip et al. (1995).

This exercise did not transpire to be a good example of the role/importance of heterogeneity for supporting the articulation of reflexivity. Although we tried to select the participants on the basis of the fields in which they were involved, the fact that they were scientists was more important than the fact that they were physicists, chemists, etc., with potentially different perspectives. Even though there were some differences in ethical stances and willingness to be ethically reflexive which did lead to some further articulation of reflexivity (see Chapter 3), the homogenous nature of the group did not allow for any significant opening up of perspectives.

With regard to the quality of argumentation scenarios as a tool for supporting the articulation of reflexivity, the emphasis on moral reasoning is important for addressing and enhancing the competence of actors. As noted, ways must be found to avoid the use of such scenarios in a calculative manner only; interaction between heterogeneous actors offers one way.

7.5 Conclusions and Discussion

I began this chapter by characterising some current efforts in enhancing ethical reflexivity as belonging to an ethical deficit model and arguing for the need to develop tools and incentives aimed at stimulating the *articulation* of reflexivity. I offered an analysis of present approaches – both in the literature and in practice – to enhancing ethical reflexivity. The next step involved evaluating the quality of the approaches, including our own, in relation to their effectiveness in stimulating the articulation of reflexivity from a non-ethical-deficit perspective.

These approaches, including our own, go some way to overcoming the ethical deficit model. In order to circumvent - to some extent - the ethical deficit model, recognition of the competence of actors and articulation of reflexivity in action and interaction are important.

One argument I make against the ethical deficit model centres on the need to work with the capacity for reflexivity which individual actors already have. While individual reflexivity of scientists is clearly important for their ability to respond to problematic situations, the “organized irresponsibility” in relation to newly emerging science and technology of which they are part cannot be addressed by such individual reflexivity alone. It is necessary to broaden the perspective to reflexiveness in the overall process at the meso- and macro-levels. This is a larger question than I can address in this chapter, which is about tools and activities to enhance reflexivity. However, I will conclude by offering a brief discussion as to how tools for reflexiveness of the process might function.

There are already indications of reflexiveness at the meso-level, visible in mechanisms such as Codes of Conduct and in initiatives taken by funding agencies. Initiatives at this level can influence dynamics at the level of actors' practices and potentially, at the macro-level of the division of moral labour regarding science in society. The question now is whether these initiatives can be operationalised with the help of the tools/practical approaches described already in order to affect changes in the practice of doing science.
I will focus on initiatives taken by funding agencies because of their pivotal role in providing resources for doing science. For Codes of Conduct, there is no such 'peg' on which to 'hang' tools. Codes of Conduct may be quite open-ended without sanctions and will depend on individual initiative or will be very specific, e.g. Codes of Conduct for engineers.

Funding agencies' interest in extended social impact assessment can be operationalised by requiring 'fictive script' to be part of the proposal. The requirement of a 'fictive script' would imply that scientists would no longer be able to 'pimp' their proposals (see Chapter 3, Section 3.2.3) in a sort of reality vacuum but would be required to translate open-ended promises into potential research connections and reflect on what would be required in order to make these connections successful. Moreover, scientists would be required to think about the current and future societal contexts of their work. As Den Boer et al.'s (2009) exercise shows, the requirement to carry out such research would induce/enhance reflexivity.

Argumentation scenarios used with a version of Toulmin's Model of Argumentation (i.e. only with claim, warrant and reservation, as in our approach) might also be usefully employed as a tool in funding proposals. Applicants could be provided with an example of how to develop such scenarios. Argumentation scenarios, combined with a Toulmin analysis, would work similarly to 'fictive scripts' by enabling a reality check on promises. Providing a warrant for the promise of a particular kind of research would be an important step as it would allow a chain of reasoning from the grounds for the argument (i.e. the promising research) to the conclusion of the argument or the claim (this research should be funded). By filling in this chain of reasoning, actors would be required to articulate their reflexivity. The reservation step would also be important as a means of inducing reflexivity. Researchers would have to step outside their enactor perspective to at least *think* about why their claim might be rejected, e.g. society does not need or want this research. This step should not necessarily imply punitive action by the funding agency; rather it should be seen as a means of broadening the enactor perspective.

If scientists were required to provide extended social impact assessments, they might well be pragmatic about it and outsource these new tasks to social scientists and ethicists. This would lead to a division of moral labour in which ethical reflection is delegated to 'socio-humanistic consultants' (Rip, 2009) or 'convergence workers' (who are able to traverse intellectual and other boundaries between the natural and the social sciences) (Stegmaier, 2009). This is one possible 'future of ELSA' outlined by Rip (2009). In another future scenario, social scientists and ethicists would work to actively contribute to the articulation of directions in which to proceed. While their expertise would continue to be 'a form of reflexive mediation' (Rip, 2009, p. 668), it would require active involvement of scientists and other actors and at various levels/institutions. Moreover, it would be part of a larger attempt to modulate ongoing co-evolution of technology and society and make it more reflexive.

8. Division of moral labour

8.1 Introduction

Individual actors are embedded in institutions and repertoires which enable and constrain their responses to 'problematic situations' in and around nanotechnology. It is therefore necessary to consider meso- and macro-level patterns and dynamics as well. Some of the effects are obvious, as when scientists and industrialists identify with their respective institutional interests and/or find it difficult to deviate from these immediate interests. Less obvious perhaps, is the background question as to why it is considered legitimate, in our societies, to have such institutional interests, to have markets which function in particular ways, et cetera. One could speak of a *de facto* constitution of our societies which is visible in how legitimacy is conferred on institutions and thus to individual actions referring to institutional goals and interests.

A Constitution, with a capital C to indicate its formal status, refers to a set of fundamental principles according to which a state (or an organisation) is organised and governed; these rules constitute what the entity (e.g. society) is and should be. Constituting occurs anyway and one can try to reconstruct a *de facto* constitution and perhaps comment on it. Historians and social scientists, as well as intellectuals and other commentators, can and do make such reconstructions. Scholarly work addresses *de facto* constitution when it includes the normative thrust of institutions and social order, for example in structural–functionalist theories of social order or in political science analysis of trends towards neo-corporatism.

An aspect of this *de facto* constitution which is important for my theme (but not regularly addressed as such in the scholarly literature) is the division of moral labour. As I noted in Chapter 6, it refers to a division of obligations and commitments, as well as to notions regarding who is eligible to be praised or blamed. This occurs in the small, as with roles in a group or an organisation, as well as in the large, at the level of society and its institutions. It is the latter in which I am interested here, for two reasons. First, division of moral labour is an important pattern at meso- and macro-levels. The second reason centres on how it functions in ethical stances and justifications of actors and institutions.

While part of the *de facto* constitution (and to some extent taken up in the Constitution), division of moral labour can be analysed and diagnosed in its own right. This is particularly important for science (and science-linked technology), given the reference to its mandate to work towards progress. In this chapter, I begin by discussing how this mandate and the attendant division of moral labour emerged and stabilised and continues to be the basis for discussion of legitimacy and the allocation of praise and blame. Moreover, I discuss how it may evolve further.

A key question therefore is whether such a division of moral labour is still adequate. Division of moral labour can be approached descriptively (what is the case?), instrumentally (does it deliver in terms of accepted goals?) or normatively (is it a "good" division of labour?). The latter two approaches imply an evaluation of the current situation and I will offer some evaluation in the later sections of this chapter. There is an additional aspect of the quality of a division of moral labour, which is processual: can the division of moral labour open up and evolve (and close down again, in the sense of becoming solid)?[54] From a pragmatist ethics perspective, this is an important question, even if the macro-level pattern and dynamics is not often addressed in pragmatist ethics.

I can turn this view on the processual quality of a division of moral labour into a means of addressing the question of adequacy. In line with my overall pragmatist ethics approach, I argue that the first step is the need to open up the taken-for-granted nature of the existing division of moral labour. The ensuing deliberations and interactions can then lead to different outcomes, ranging from a reconfirmation of the earlier division of moral labour, to modifications, or to a complete overhaul.

I will consider the first step in this chapter and inquire whether openings occur and of what kind. These openings must be located against a backdrop of longer-term changes, along with possibilities to "modulate" developments.

8.2 Division of moral labour for science in society[55]

I will start by briefly characterising how the particular division of moral labour for science (and science-based technology) in our societies emerged and stabilised. Its current form has emerged following successive settlements between science and society throughout the

[54] The terminology of 'opening up' and 'closing down' has also been used in Stirling (2008) but for processes of appraisal of technology at the meso-level. There is definitely overlap between his approach (and his normative concerns) and mine.

[55] This section draws on Rip & Shelley-Egan (2009).

centuries. These settlements can be conceptualised in terms of a 'social contract' between science and society.[56]

The 17th century heralded the beginning of science as we know it. "Natural philosophers" received royal charters in which agreements regarding the boundaries between their studies and the social affairs of the monarch or society were laid out (Elzinga, 1997). Science was legitimised by the claim that it was neutral, in the sense that it would not interfere with society and was afforded protection by kings (in Great Britain and France). This is very clear in the implicit social contract of the Royal Society – we can do science if we do not interfere in society – and is reflected in Robert Hooke's draft charter:

> The Business and Design of the Royal Society is: To improve the knowledge of natural things, and all useful Arts, Manufactures, Mechanick Practices, Engynes and Inventions by Experiments – (not meddling with Divinity, Metaphysics, Moralls, Polliticks, Grammer, Rhetorick or Logick) (quoted after Van den Daele, 1977, p. 31).

By not interfering with "Grammer, Rhetorick or Logick", the three basic disciplines of a university education, the Royal Society also kept a distance between their "Business" and that of the universities.

The first half of the 19th century saw the emergence of a further settlement, or a second, additional social contract between science and society in which professionalised and specialised science was an integral part of the new bourgeois-industrial society (Rip, 2011). The late 19th century witnessed further professionalisation of science and the creation of a protected space for doing science, characterised by relative autonomy and disciplinary authority (Rip, 2011). At the same time, there was a mandate to develop new technologies (like electricity) and to introduce them to society, as long as this represented 'progress' (Van Lente, 1993). This era also marked the beginning of an "entitlement" attitude of scientists (Rip, 2011), reflected in the view that science had a "right" to sponsorship by the nation state.

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[56] The notion of a 'contract' has been used as a means of studying changing relations between science and society (Guston & Keniston, 1994). The contract prescribes the kind of knowledge science is expected to deliver, the rationale for why academic science deserves support and the necessary conditions under which academic researchers should work (Hessels, Van Lente, & Smits, 2009). While the contract is not a formal one and the partners of the contract are ill-defined (Rip, 2011), there are nonetheless a number of fundamental notions integral to the contract which both science and society do not question (Hessels et al., 2009).

This "entitlement" attitude continued to be visible and was further strengthened in the 1950s in the regime of 'Science, the Endless Frontier'. Once more, there was a protected space for doing science, in this case at the macro-level of the overall institution of science (Rip, 2011). This 'Golden Age' saw a contract between science and society in which "… government provided the money (and) science provided the discoveries and kept its own house in order" (Guston & Keniston, 1994, p. 13). In terms of a division of moral labour, scientists had a mandate to work towards scientific progress, without having to be concerned about relevance. By the 1970s, this contract became increasingly difficult to legitimate in the face of new challenges concerning sustainability, innovation and economic growth (Rip, 2007b). The protected space for doing science could no longer be taken for granted: "The boundaries of the macro-protected space became porous, there was recontextualisation of science in society, up to political concern about quality and integrity of science" (Rip, 2007b, p. 39).

In the new era of 'Strategic Science' (Rip, 2004), the promises of high science and high technology are emphasised from outside science as well as from inside science and are linked to the relevance of science or the potential societal benefits of scientific research:

> The substantial investments societies make in science today are only regarded as legitimate thanks to the great promises of modern science in terms of economic competitiveness, cultural enrichment or progress. In other words, the 'relevance' of science has become crucial for its public support (Hessels et al., 2009, p. 388).

The importance of the relevance of science implies the need for further recontextualisation of science in society. However, the relative protection of the lab remains (and remains functional for doing good science) (see Chapter 2, Section 2.2.1). There is a 'problematic situation' at the macro-level (with repercussions for institutions and individual actors) induced by the need for 'recontextualisation of science in society' and 'struggles' for relevance. One challenge is to balance the need for relative protection of knowledge production with the requirement of opening up to societal voices and inputs.

Thus, successive contracts between science and society have cumulated in a division of moral labour which is visible in science today. Scientists have a (partly self-defined) mandate to work towards progress and that is how they fulfill their duties and responsibilities to society. Such a view comprises part of the scientific ethos and informs the justifications which scientists and other inhabitants of the world of science put forward to

uphold these norms and observe them (cf. Chapter 2, Section 2.2.1); in a sense they work to protect the scientific endeavour from undue interference. Society will accept the scientific endeavour in these terms as long as scientists deliver, both in terms of producing what was promised (the cornucopian side of science) and in adhering to the normative structure of science (integrity of science). This mandate thus justifies the relative autonomy of science and facilitates a sort of macro-protected space.
The mandate rests on a notion of progress in which scientists argue that it is their 'business' to work towards the production and delivery of scientific knowledge, while other actors, who may be better qualified, or more responsible, or more at risk, should deal with social, ethical and political issues. Such a notion of progress generates a division of moral labour in science in which scientists take on certain responsibilities while rejecting others. This can then also lead to scientists playing a double game of attribution of praise and blame or showing 'elasticity of moral thinking' in which they cash in on the good things while refusing to take responsibility for bad things. [57]

8.3 Division of moral labour for industry

The development of nanotechnologies in industry is visible in product and process development (which has its own dynamics), with a strong R&D component. The question of a division of moral labour for industry, in relation to nanotechnology development, must address the combination of the division of moral labour around new science and technology and the broader (and long standing) division of moral labour which is linked to market actors. I can build on my discussion in Chapter 2, Section 2.3.

For industry, the most visible division of moral labour rests on an ethics of self-interest whereby industrialists argue that that they are responsible for profit-making and survival of the firm, while other actors should be responsible for potential negative effects of industrial development. This division of moral labour is supported with reference to market mechanisms which create the greater good at the collective level because of the competitive environment (see Chapter 2, Section 2.3.1).

[57] In Chapters 2 and 3, I used Ravetz's aphorism to illustrate this: "Scientists take credit for penicillin, but society takes the blame for the Bomb" (Ravetz, 1975, p. 46).

Historically, one can see an evolution from 19th century 'robber barons' and an emphasis on self-interest and profit-maximisation to the importance of being a "good firm" in the late 20th century. The term 'robber baron' was used to characterise powerful 19th century American businessmen and bankers as unscrupulous industrialists.[58] Robber barons "justified and legitimated their individual thirst for ever greater personal wealth and power as being part of a progressive collective scheme – where survival indicated superiority ('fit') and superiority ('fit') was measured by survival" (Djelic, 2005, p. 60). From the 1930s on, the neo-classical economics argument about the value of the profit motive, in combination with consideration of longer-term survival of the firm, became widely accepted; this was what a 'good' firm should do, while leaving other concerns and issues to others.

Later in the 20th century, firms (at least some firms) were willing to take up broader responsibilities. A clear case is the movement towards Corporate Social Responsibility (CSR) (see Chapter 2, Sections 2.3.1 and 2.3.2 for examples). It justified companies assuming broader responsibilities that extend beyond profit-making and adherence to the law and their being expected to do so. Independent of the label CSR, one sees local activities ("being a good neighbour"), e.g. community partnerships which bring together communities and corporate organisations, as opposed to nomadic behaviour on markets. More recently, firms also justify their actions with reference to larger concerns in the outside world such as "sustainability" and play on this in their public relations. While regular market incentives play a role, credibility pressures and strategic games are also important factors (Rip & Groen, 2001).

It is important to be and to be seen as a "good firm"; the scope of what counts as a "good firm" has broadened. "Good firms" behave well and can be praised for their "good faith" efforts, even if outcomes are not always ideal. On the other hand, there are also nomads, "cowboy firms", which transgress and are unconcerned about the rules. They must therefore be condemned, especially because they endanger the credibility of the "good firms" in the sector. [59]

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[58] The term 'robber baron' was a name initially given to unscrupulous nobility in medieval Europe who violated rules for collecting tolls on the river Rhine, either by charging higher tolls than the standard or by collecting tolls without authority from the Holy Roman Emperor.

[59] Interestingly, discussions about integrity of science and the occurrence of fraud have the same structure. Fraud is positioned as deviation from a general good practice and is conducted by "rogue scientists".

Industrialists can play games of praise and blame, for example when they put sole responsibility on consumers who buy (or do not buy) products or, more abstractly, refer to market forces which are outside of their control. However, there is also acceptance of responsibility, also in the world of nanotechnology. In particular, chemical companies, with their experience of the Responsible Care® program (see Chapter 4, Section 4.3.1), which commits companies to working in an environmentally friendly way, were willing to take up notions of responsible development. In practice, this means paying attention to safety and health issues of employees and transparency to the outside world.

For broader issues, such as the debate on precaution and a possible (partial) moratorium – for example, on nanoparticles, as called for by NGOs like the ETC group and Friends of the Earth – broader views were offered which fit with the enactor perspective on a division of moral labour. For example, there was a unified negative response to the call for a moratorium and recourse to ethical arguments regarding industrialists' mandate to work towards progress.

The industrialists' view of the role of NGOs sometimes explicitly referred to a division of moral labour. One respondent saw the call for a moratorium as "a bit of a knee-jerk reaction" but conceded that "they're right in one sense, I guess, there's always a chance that we don't understand [the risks]." A further division within this division of moral labour was visible when the industrialists introduced a distinction between 'good' and 'bad' NGOs.

Even if the approach of industry (and the chemical sector in particular) to the 'responsible development' of nanotechnology is driven by prudence and concern about credibility, it can nonetheless lead to a 'good' division of moral labour. Companies may not be interested in morality but through the efforts to survive and protect themselves, they work to protect others, leading to positive effects at the collective level.

8.4 Diagnosing the existing/evolving division of moral labour

To be effective, a division of moral labour must be solid, i.e. stabilised and accepted. Consequently, from a pragmatist-ethical perspective, an effective division of moral labour (and in particular around new science and technology) is essentially ambivalent. On the one hand, it allows and even stimulates delegation of responsibility and a passive attitude that contributes to "organized irresponsibility" in relation to new challenges

(Beck, 1995). On the other hand, as a way of dividing moral labour, it facilitates (hopefully) being able to do better overall.

This observation implies that evaluating the division of moral labour in terms of whether it is functioning well and/or is a good division of moral labour will not be a simple matter and the perspective of the evaluator will be an integral element; that is why I use the term 'diagnosing'. It is not immediately apparent as to how to do such a diagnosis. One entrance point is the notion of second-order ethics; second-order ethics refers to the ethical (and more broadly, normative) aspects that come into view when one inquires into the justification of present arrangements, rather than taking them for granted and focuses on first-order ethics of actions and interactions playing out within these arrangements. Such second-order ethics call for an ethics of order and change at the level of institutions and society, a topic which is not part of regular ethics. It is part of political theory, especially when the *de facto* constitution of society which I discussed in the introduction to this chapter is considered. To go in that direction would take me too far away from my theme of responsibilities and irresponsibilities around newly emerging science and technology, particularly around nanotechnology. I will briefly touch upon political theory, e.g. about neo-corporatism, in the conclusion.

The other entrance point focuses on the process. The evolution of the division of moral labour will be a mixture of global changes (like the call for responsible development of nanotechnology), reference to mandates and earlier divisions of moral labour, typical moves such as delegation to the technical and the procedural and individual activities which may have larger effects. The reflexiveness of the process is important, as I noted in the introduction and I will discuss indications of opening up in the next section. First, I consider what is happening in the world of nanotechnology.

Delegation to the future is an important aspect of the division of moral labour. Enactors of nanotechnology project a wonderful future which justifies present activities; thus there is no other argument necessary for the present effort.[60] This delegation to the future is linked to *justification through the promise of progress.* If this promise is contested, a further argument - *justification through a deficit model* - comes into play; members of the public are seen as empty vessels, merely requiring

[60] The promises of enactors about new options tend to short-circuit the question regarding what kind of 'good life' can be brought about as a result of nanotechnology (Swierstra & Rip, 2007).

understanding or just 'information' in order for them to accept the promise of nanotechnology (cf. Rip, 2006a).

In Chapter 6, I showed how discourse on the responsible development of nanoscience and nanotechnologies begins with the promise of nanoscience and nanotechnology but then centres on ambivalences in nanotechnology such as the notion that "size matters" – for better or for worse. This particular ambivalence in nanotechnology has led to the framing of responsibility about the development of nanotechnology to meet societal challenges. In pursuing this, the industrial actors will still focus on the 'revolutionary' and cornucopian character of nanotechnology, while NGOs will be expected to look after broader considerations, including ethical and social considerations.

The main division of moral labour we see in the world of nanotechnology is solidly embedded in the regime of techno-scientific promises (see Addendum in Chapter 6) and it functions well in terms of delivering on the 'enactor' perspective and producing workable solutions in the short-term. However, in changing circumstances, such as the move towards responsible development of nanotechnology, in which new ways of 'organising' responsibilities are being sought, the solidity of this division of moral labour will not be enabling. It will be constraining for those who do not view the development of nanotechnology from an enactor perspective (e.g. NGOs)[61] and for those who are seeking to renegotiate the current division of moral labour, e.g. the European Commission with its proposed Code of Conduct.

In this diagnosis, I am prepared to take sides, not necessarily for NGOs or the European Commission and its Code of Conduct but against the solidity of the division of moral labour embedded in the regime of techno-scientific promises. There should be space for co-evolution - this might lead to some reconfiguring of the division of moral labour.

8.5 Opening up of the taken-for-granted nature of existing divisions of moral labour

There is opening up of existing divisions of moral labour, intentionally or unintentionally. There might be resistance to specific attempts to open up but the point is that the existing division of moral labour cannot be taken

[61] Cf. the division of labour between enactors who promote the new technology and critical (comparative) selectors who are interested in articulating the control of the technology.

for granted anymore. When that is accepted, the processual quality of the division of moral labour is high: it will not be a prisoner of its own solidity.

At the policy level, efforts are being made to devise responses to newly emerging science and technology like nanotechnology. The EC Code of Conduct for responsible research is a clear example. However, such efforts are mainly taking place at a discursive level and may not be taken up in the worlds of science and industry. Nevertheless, there is receptivity to these initiatives, at least in terms of willingness to discuss such codes seriously.
Codes of Conduct can be viewed as so-called 'soft' (non-binding) governance structures. Soft governance structures or soft law approaches have been discussed in relation to their role and effectiveness in the regulation and governance of nanotechnology (cf. Bowman & Hodge, 2008; Dorbeck-Jung, 2007). For my argument here, the importance of such soft governance structures relates to how they may stimulate critical reflection on background issues and thus provide openings for longer-term changes.

Another opening-up derives from the intervention of third parties. Third parties such as funding agencies and insurance companies do not develop nanotechnology themselves but exert leverage on developments through their actions. It can be easier for third parties than it is for immediate parties to take initiatives which might lead to change. [62] An example of such an intervention is that of the re-insurance company SwissRe which, through its 2004 Report and follow-up activities - driven by its own concerns about possible financial losses - transformed the question of the risks of nanoparticles from a fringe concern voiced by some critical NGOs, to a legitimate topic high on the agenda of national and international authorities (Rip & Van Amerom, 2009).

Third parties such as funding agencies (for science) and business sponsors (for industry) may require anticipation of adequate societal embedding of the nanotechnological research and development they are asked to fund. In Chapter 7, I discussed tools and approaches for such anticipation. Here, I note that such anticipations may follow existing divisions of moral labour but can also, intentionally or unintentionally, question them when these appear to go against promises and their envisaged societal embedding.

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[62] Analytically, the importance of third party initiatives relates to their ability to break through waiting games (cf. Te Kulve, 2010) and other impasses that occur in two-party games (Rip, 2010a).

Another kind of third party is the self-styled 'socio-humanistic consultants' or 'convergence workers' (Stegmaier, 2009) who engage with scientists in the lab, at the coal - face of research. I discussed their role in enhancing/articulating ethical reflexivity in Chapter 7 but the fact of their being there already constitutes some opening up of a traditional division of moral labour. The same applies to Den Boer's exercise involving a fictive script of applications of scanning tunneling microscopy (Den Boer et al., 2009).

There are openings, that much is clear. Will they add up to a reconsideration and perhaps reconfiguration of the present divisions of moral labour? This is not just a matter of the force of the various actions but also depends on overall, landscape-level changes. This is where the Beck et al. (1994) diagnosis of reflexive modernization can be brought in. Delvenne & Rip (2011) developed Beck's diagnosis into an empirical study of science-related institutions, showing how blurring of boundaries and openness to plurality occurs (to some extent) and is recognised as a challenge. They mapped different responses to this 'problematic situation' at the level of institutions.[63]

The point here is that the 'problematic situation' of novelty and uncertainty of nanotechnology and the specific openings it creates is embedded in wider landscape-level changes which occur independently of newly emerging science and technology. However the two dynamics reinforce each other in how they shape the evolution of divisions of moral labour.

8.6 In Conclusion

My analysis of division of moral labour, in general for science and for industry and in particular for the newly emerging nanoscience and nanotechnologies, can be pursued in two directions. One is the cluster of issues around ethical reflexivity, a key topic in my research, especially in Chapter 7. The other cluster of issues is about the politics of the division of moral labour, as it is linked to the *de facto* constitution of our societies.

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[63] Reflexive responses and their further evolution can range from 'enlightened modernist', which can involve taking up elements of reflexivity in order to survive under conditions of reflexive modernization to 'ecological modernist', in which a goal such as 'sustainability' is specified and measures are developed to achieve this goal without giving up on the main thrust of modernity. The 'reflexivity' pathway embraces the blurring of boundaries and openness to plurality.

In the interactions and attempts to solidify elements of a new and better division of moral labour, much more is at stake than ethical reflexivity at the individual level (see Chapter 7). Ethical reflexivity of actors is caught between individual agency and institutional role. Individual ethical reflection runs up against institutional and moral divisions of labour. In other words, in order for change to occur, there have to be openings at the institutional level. These may occur anyway, independent of the specific challenges of nanotechnology. This is where the Beck et al. (1994) diagnosis of reflexive modernization comes in, as I noted already.

Thus, there is the need for a productive combination of individual and institutional reflexivity. Institutional arrangements may be put in place in order to stimulate reflexivity at the individual level. One such measure is the implementation of reflection on broader issues of research as a Key Performance Indicator. The institutions themselves might become reflexive as well, as Delvenne & Rip (2011) suggested and attempted to map.

In addition, there are the politics of responsible development. There are immediate politics in the sense of struggles and negotiations about directions in which to proceed and arrangements to be made. There are also ‘deep’ politics, in the sense that divisions of moral labour and in the end, the constitution of late industrial society, may shift.

Initiatives such as the DuPont and Environmental Defense collaboration on a risk framework for nanotechnology (see Chapter 2, Section 2.3.3) are one example of governance attempts below the decision making of representative democracy and government agencies. Beck (1992) introduced the evocative term “sub-politics” to characterise such phenomena - a form of politics and action at a level below representative democracy decision-making. If such “sub-politics” become institutionalised, it amounts to a neo-corporatist approach (cf. Rip, 2010a). The calls for midstream modulation (Fisher et al., 2006) and midstream public engagement (Joly & Rip, 2007) reinforce this move towards neo-corporatism. Similarly, Constructive Technology Assessment exercises (Robinson, 2010) bring stakeholders and other actors together to articulate strategies for technology development and its embedding in society, independent of representative democracy decision making.

These brief considerations indicate possible multi-level co-evolutionary developments. At first, there are only minor modifications in divisions of moral labour. After all, ‘problematic situations’ are difficult to resolve. However, in the longer term, the net effect of a variety of outcomes stemming from interactions and deliberations could be an overhaul of the current division of moral labour.

9. Conclusion and Discussion

9.1 Introduction

In the first part of this chapter, I look back on the story so far and discuss the sociological extension of Dewey's pragmatist ethics. In the second part, I develop a forward look in relation to how current efforts and activities around the 'responsible development' of nanotechnology might play out in the future.

My starting point as analyst was the problematic situation of 'organized irresponsibility' with regard to newly emerging science and technology, in particular nanotechnology. This raises questions about the way in which actors, in particular enactors of nanotechnology, respond to the novelty and uncertainty of nanotechnology and to attempts to address the 'organized irresponsibility' that goes with it (as in the call for responsible development of nanotechnology). While this can be taken up as a straightforward sociological undertaking of mapping responses and trying to understand them, there is an ethical concern as well: how can a social scientist contribute to better responses to the problematic situation he or she perceives? In this introduction, I conduct (to speak with Dewey) a brief reflective inquiry into the contribution of sociology. This also indicates elements of what a sociological extension of Dewey's pragmatist ethics amounts to.

In order to understand the responses of individual actors to novelty and uncertainty of nanotechnology, one has to understand both the particular context in which the actors are embedded, along with co-evolution at the collective level. Co-evolution at the collective level adds greater complexity to the 'problematic situations' in which actors can find themselves. Dewey's focus on the individual is no longer sufficient. Moreover, actors' responses at the micro-level to novelty and uncertainty will be shaped by their particular context and position, while they are also influenced by (and influence) behaviour and interactions at the collective level of institutions and sectors.

Clearly, a multi-level perspective is necessary. It is important for understanding overall dynamics and for understanding how morality can co-evolve with socio-technical change. My analysis, in Chapter 8, of evolving divisions of moral labour is an example. However, it is not only a matter of understanding what happens. There is also diagnosis involved and consideration of how things might go better. This is already visible between the lines of the empirical chapters, for example in the discussion of 'wicked problems' in Chapter 4. Sociological understanding of the problematic situation of 'organized irresponsibility', with the help of the multi-level approach, also allows identification of building blocks (in Chapters 6-8) for a more adequate and longer-term response to problematic situations, which takes into account overall dynamics and the possibilities of modulating dynamics (at different levels).

Reflective inquiry, in Dewey's sense, can now become sociologically informed reflective inquiry. In addition, the multi-level dynamics of co-evolution of technology and society imply that reflective inquiry is located at different levels and with different actors. Interactions between levels and between actors then become important. One could speak of a multi-level form of reflective inquiry as a means of identifying openings for change.

This sociological extension to pragmatist ethics for NEST is not just a conceptual matter. It allows contributions to actors' perception of the problematic situation (e.g. recognition of multi-level dynamics) and actors' reflective inquiry (e.g. enabling actors to see themselves as part of the problematic situation). Swierstra & Rip (2007) and Swierstra, Stemerding, & Boenink (2009) extended pragmatist ethics for NEST by offering ethical support to discussions and interactions around emerging technologies; I envisage productive collaboration (rather than the traditional division of labour between sociologists and ethicists where the latter speak about the normative and the former only about the empirical-descriptive). It is the combination of ethical and sociological support that is important.

In Dewey's view, actors are expected to recognise themselves that they are in a 'problematic situation'; if they do not, they miss an opportunity for reflective inquiry. Dewey did not preclude sociologists (or ethicists, for that matter) from intervening and contributing (cf. Lindblom, 1990). My identification of building blocks for sociologically informed reflective inquiry is intended as such a contribution and will be one when taken up by scientists and industrialists. In my interviews and focus group exercise, I referred (implicitly or explicitly) to problematic situations and explored possible diagnoses. Thus, I put a problematic situation on actors' agendas. My probing of their responses was also an 'anticipatory intervention' (Te Kulve, 2011). My choice of what to probe was based on a diagnosis that while actors may recognise that they are in a problematic situation, they may still respond in traditional ways which may not be conducive to reflective inquiry. My intervention was a 'soft' intervention (Rip & Te Kulve, 2008) but still an intervention. As interventions, they can be positioned as an attempt to 'heat up' responses to the problematic situation (i.e. query their 'naturalness') and perhaps identify openings for change by challenging the worldview of actors and providing them with tools to facilitate the articulation of their reflexivity. My primary goal was probing but I did not mind influencing their reflective inquiry and perhaps actions.

9.2 The story so far

My first research question addressed the micro level of responses to the problematic situation:

> What are the ethical stances, ethical choices and justification of interests and positions of scientists and industrial actors who have a stake in the development of nanotechnology? What kinds of responses to the novelty of nanotechnology do they have? What is the current role of ethical stances and choices of actors in the development of nanotechnology?

The scientists I studied (Chapter 3) recognised the problematic situation brought about by the increased call for accountability/responsibility, however their responses were largely traditional, in the sense that they drew on standard repertoires. Recourse to standard repertoires allowed the scientists to justify their accountability/responsibility in terms of the primary responsibility of scientists to work towards progress in science and to exclude those (broader) responsibilities which would interfere with the advancement of science. Thus standard repertoires in science function well in allowing scientists to get on with the core business of doing science.

However, standard repertoires and the institutional context of science are constraining in that they make it difficult for scientists to find ways of adequately responding to the problematic situation. The recurrent problem definition by scientists emphasises external pressures on the ongoing work of doing science. This particular problem definition, in turn, leads to responses - in terms of strategies of action to deal with the pressures - which have been 'tried and tested' in the past. Such responses to the novelty and uncertainty of nanotechnology may be sufficient as a first and tentative move. However, as the call for responsible development of nanotechnology is something new in these actors' situation, this response may not be adequate. There was some reflexivity, however, when, for example, the flagship captains spoke about the need for institutional incentives in order for real change to occur. Clearly, scientists may recognise that they are part of the dynamics of "organized irresponsibility" but still feel unable to change that dynamic.

In contrast, the situation for industrial actors is more heterogeneous and thus more open. Industrial actors (Chapter 4) recognised 'wicked' problems related to the responsible development of nanotechnology. While they had some recourse to position and mandate, they realised (chemical companies, in particular) that traditional responses to the development and use of new technologies are no longer sufficient in light of the technical, commercial and social uncertainties of nanotechnologies. There are thus signs of novel responses in chemical companies' linking up with the notion of responsible development. The activities highlight a shift from accountability to responsibility and a focus on the *process* of (responsible) development rather than on the *outcomes* of the development of nanotechnology, suggesting some broadening of the enactor perspective.

In order to achieve their own goals, companies need to find a balance between their self-interest and the efforts necessary to contribute to responsible development of nanotechnology. Thus at the same time as they are using standard repertoires of justification of nanotechnological development (see Chapter 6), chemical companies are opening up to the outside world, even if this does not always lead to positive results for companies. However, a traditional division of moral labour is still largely in place; industrial actors continue to argue that they should be allowed to develop and deliver nanotechnology, while NGOs should look after other considerations.

Co-evolution at the collective level adds greater complexity to the dynamics of the problematic situation. Indeed, enactors may not grasp the full extent of its complexity. Social scientists, including myself, can contribute insights about patterns at the collective level. There is a separate role for actors at the collective level who have a different perspective because of their position. In a sense, they are able to see 'organized irresponsibility' because its effects create problems for them. One response then is a call for responsible development of nanotechnology; actors at the collective level, such as the European Commission, are *telling* individual actors that they are part of the problematic situation and must do better than just adding to 'organized irresponsibility'. This is not just an exhortation to individual actors. My analysis demonstrated that more reflexivity and action at the institutional level is necessary as well. However, that does not absolve the individual actors of continuing in their existing roles. They are a key part of the dynamics and they can have a role in reflexivity and action at the institutional level.

This brings me to my second research question:

> Given the ethical stances and choices of actors in the world of nanotechnology and the dynamics of the current division of moral labour, what kinds of responses might lead to new ways of 'organising' responsibilities and a reconfigured division of moral labour? How can this be done, if at all?

Responsibility is distributed across actors. Thus, if scientists and industrialists are to pursue reflective inquiry at the micro-level, the shaping effect of patterns and dynamics at meso-and macro-levels needs to be acknowledged. This is where the analyst can contribute, not only by making the reflective inquiry sociologically informed (that is how, in Chapter 5, I positioned my analysis in Chapters 6-8) but also by deploying the multi-level co-evolutionary perspective to identify entrance points for modulating ongoing patterns and dynamics at the micro-, meso- and macro- levels and in interactions between the levels.

In Chapter 6, the promises and ambivalences of nanotechnology are shown to lead to responses deriving from the enactor perspective at the level of individual actors, thus closing down the open-ended nature of the problematic situation very quickly with recourse to standard repertoires and positions. In fact, the justification for doing so relates to the particular regime of innovation at the meso-level in which actors and actions are embedded - the regime of economics of techno-scientific promises (Joly, Rip & Callon, 2010). One can speculate whether another regime of innovation identified by Joly et al. (2010), the regime of collective experimentation, offers opportunities for opening up. As was argued by the European Expert Group on Converging Technologies (Nordmann, 2004), the open-ended promises of converging technologies, including nanotechnology, actually require some form of articulation of desirable directions. They offer suggestions for how to organise such 'reflective inquiry' at the meso-and macro-levels. [64]

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[64] In Chapter 7, I described, following Rip (2009), two possible divisions of labour for micro-level reflection on desirable directions. One scenario involves the 'outsourcing' of ethical reflection to socio-humanistic consultants. In a second scenario, social scientists and ethicists work with scientists to contribute to the articulation of directions in which to proceed.

My implied criticism of recourse to standard repertoires is about the process: closing down of what is just opening up as a 'problematic situation'. The content of the standard repertoire and thus the responses drawing on it may well be adequate. However, these responses should be the result of reflective inquiry, rather than being mobilised because they are standard. For that reason, I argued, in Chapter 7, that scientists should be supported in articulating their reflexivity and I discussed modulations at the level of the individual actor. Such support is being offered already in a variety of ways but mainly focusing on individual scientists and research groups. Addressing "organized irresponsibility" also necessitates enhancing ethical reflexivity at the meso-level of institutions. Funding agencies (and perhaps sponsors of responsible development) can play a role here - and are actually starting to do so - thus introducing modulations in interactions between the micro - and meso- levels.

At the macro-level, current divisions of moral labour for science and industry (addressed in Chapter 8) form a backdrop to problematic situations faced by scientists and industrialists and their responses to them. An accepted division of moral labour can always be used to justify ethical stances and actions. While this reduces the extent of reflective inquiry, it may well be productive. This of course depends on the quality of the division of moral labour as such and in the face of novelty and uncertainty introduced by newly emerging science and technology. The quality of the division of moral labour thus has a processual element as well: some opening up of the taken-for-granted nature of existing divisions of moral labour is necessary, to check its adequacy for the new challenges and to allow space for new configurations of moral labour. In fact, opening-up is occurring sometimes in unexpected places (cf. my brief discussion, in Chapter 8, of the role of 'third parties'). This happens against the backdrop of larger changes in our late-modern societies, in particular what Beck et al. (1994) call 'reflexive modernization'. For newly emerging science and technology, the opening-up of their institutions and the exploration of new roles may lead to new configurations in the moral division of labour, with reflexive interactions between enactors and other stakeholders. This can be discussed as the politics of responsible development because the *de facto* constitution of our society changes (and in the direction of a neo-corporatist division of political labour).

9.3 Future storylines?

The brief forward look at larger macro-level changes should be complemented by a discussion of what might be happening in and around the world of nanotechnology. I am interested in the thrust of such changes, which can be captured as a storyline about evolution of the present into the future.

Thus far I have shown that responses to the call for the responsible development of nanotechnology are determined by roles and mandates and a robust institutional context. However, this is not the entire story. 'Responsible development' is an open term and weakly structured which makes it difficult for actors to *know* how to respond to the call for the 'responsible development' of nanotechnology (cf. Davies et al., 2009). It constitutes an ideograph, referring to something which is considered to be "good", without much further specification. As I have shown in Chapter 4, it is often unclear what responsible development means in practice. There are attempts, however, to create a stronger structure for 'responsible development'. This is particularly visible in the active efforts of the European Commission which is using its proposed Code of Conduct as a means of identifying distributed responsibilities with principles which transgress roles.

If a stronger structure for 'responsible development' is created, it may emerge as a 'macro-trajectory' (Nelson & Winter, 1977) or what Rip (2010a) terms a "second-order trajectory" in which "working towards responsible development" of nanotechnology becomes a trajectory of technological development, similar to the broad design heuristics of mechanisation (since the 19th century), automatization (from the 1950s onwards) and miniaturisation (from the 1980s on).

There are indications that elements of the second-order trajectory of 'responsible development' may already be in place. For example, chemical companies are including environmental, health and safety (EHS) aspects at an early stage in initiatives and measures for nanotechnology. Similar moves have been made in the world of science. In the proposal for the National Science Foundation-funded Center for Biological and Environmental Nanotechnology (CBEN) at Rice University in Texas, a substantive focus on bio-engineering and environmental applications of nanotechnology, along with a component devoted to studying toxicity, environmental effects and 'implications' more broadly was proposed (McCarthy & Kelty, 2010). This was taken further in the establishment of the International Council on Nanotechnology (ICON), an offshoot of CBEN, tasked with the mission of assessing, communicating and reducing environmental and health risks associated with nanotechnology, while simultaneously maximising the benefits of nanotechnology to society. The result of this arrangement was the attempt to make 'safety' a fundamental property of new nanomaterials or, as it was labelled, 'safety by design' (Kelty, 2009).

Rip (2010a) notes that there is no guarantee that the second - order trajectory of "working towards responsible development" will be taken up. However, in the attempt to create a "better" technological path, actions, interactions and anticipations will take place between actors. We see this already in the diffuse call for 'responsible development'. When actions, interactions and anticipations get entangled, articulation of choices will take place and some stabilisation will occur (Rip, 2010c). Diffuse societal agenda building will be carried out prior to institutionalisation. Rip & Van Amerom (2009) have traced these 'processes of entanglement' (Rip, 2010c) in their analysis of the evolving "risk landscape" in the nano-world. They show how actions and interactions have further effects because actors respond to what happens elsewhere, anticipate and mobilise, thus getting entangled. One outcome of these processes of entanglement was the emergence of a repertoire relating to how to think and talk about nanoparticles.

Although we see a largely traditional response to problematic situations related to the 'responsible development' of nanotechnology, there are also signs of actions, interactions and anticipations in activities and practices around 'responsible development', e.g. the collaboration between DuPont and Environmental Defense. It is unclear as to the kinds of entanglements that might occur but one can devise two different scenarios for an outcome of the entanglements, in relation to the operationalisation of responsible development. In one scenario, one can see a lock-in created by the focus on EHS, in which working towards responsible development will be reduced to EHS aspects and the manner in which these are regulated. Actors will have 'recourse to the technical/procedural' in response to requirements for societal embedding.[65] In a second scenario, the focus on EHS aspects, particularly in relation to the move towards 'safety by design' becomes part of a broader move towards a 'license to operate'. The notion of a 'license to operate' exists already in European-level regulation of chemicals, where companies have to produce data about safety and environmental and

[65] McCarthy & Kelty (2010) argue that social scientists have overlooked the fact that EHS research is a legitimate attempt on the part of scientists to respond to demands for 'ethical' and 'responsible' science.

health effects ("no data, no market"). This can be broadened to become an operationalisation of responsible development, rather than a matter of complying with regulation. It would involve corporations taking substantive voluntary steps in order to persuade governments and the wider public that they are taking issues such as health and safety or the environment, seriously. Moreover, 'license to operate' could perhaps be extended to encompass possible societal impacts and distributive issues. This 'license to operate' would then become linked to scientists' and industrialists' mandate to work towards progress: the mandate would still be accepted but showing good-faith effort in considering responsibilities and impacts would be required for a licence to work towards progress.

Nanotechnology may not be as revolutionary in its impacts as some of its proponents suggest. However, it may well be revolutionary in that it is the occasion to explicitly and at an early stage put anticipation of and a focus on 'problematic situation' and 'reflective inquiry' (as in the call for responsible development) on the agenda. While the outcomes are unclear at this stage and recourse to immediate problem-solving may reduce open and reflexive approaches, the process is important and should be nurtured. I hope to have contributed to this process in a small way.

References

Agres, T. (2006). Making Ethics Fit. *The Scientist, 20,* 76.

Aho, E., Cornu, J., Georghiou, L., & Subirá, A. (2006). *Creating an Innovative Europe: Report of the Independent Expert Group on R&D and Innovation.* Luxembourg: European Communities.

Banks, S., Leach Scully, J., & Shakespeare, T. (2006). Ordinary ethics: lay people's deliberations on social sex selection. *New Genetics and Society, 25*(3), 289-303.

Beauchamp, T. L. (1988). Ethical Theory and Its Application to Business. In T. L. Beauchamp & N. E. Bowie (Eds.), *Ethical Theory and Business* (3rd ed., pp. 1-55). Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Beauchamp, T. L., & Childress, J. F. (2001). *Principles of Biomedical Ethics* (5th ed.). New York: Oxford University Press, Inc.

Beck, U. (1992). *Risk Society: Towards a New Modernity*. Sage Publications Ltd.

Beck, U., Giddens, A., & Lash, S. (1994). *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order.* Cambridge: Polity Press.

Beck, U. (1995). *Ecological Politics in an Age of Risk*. Cambridge: Polity Press.

Beck, U., Bonss, W., & Lau, C. (2003). The Theory of Reflexive Modernization: Problematic, Hypotheses and Research Programme. *Theory, Culture & Society 20*(1), 1-33.

Berg, B.L. (1989). *Qualitative Research Methods for the Social Sciences* (6th ed.). Boston: Allyn and Bacon.

Bowman, D. M., & Hodge, G. A. (2008). 'Governing' nanotechnology without government? *Science and Public Policy, 35*(7), 475-487.

Burchell, K. (2007). Boundary Work, Associative Argumentation and Switching in the Advocacy of Agricultural Biotechnology. *Science as Culture, 16*(1), 49-70.

Carroll, A. B. (1979). A Three-Dimensional Conceptual Model of Corporate Performance. *The Academy of Management Review, 4*(4), 497-505.

Carroll, A. B. (1999). Corporate Social Responsibility: Evolution of a Definitional Construct. *Business & Society, 38*(3), 268-295.

Caspary, W. R. (2000). *Dewey on Democracy*. Ithaca, New York: Cornell University Press.

Chesbrough, H. W. (2003). The Era of Open Innovation. *MIT Sloan Management Review Spring 2003*, 35-41.

Coeckelbergh, M. (2006). Regulation or Responsibility? Autonomy, Moral Imagination, and Engineering. *Science, Technology & Human Values, 31*(3), 237-260.

Crane, A., & Matten, D. (2007). *Business Ethics: Managing Corporate Citizenship and Sustainability in the Age of Globalization* (2nd ed.). Oxford University Press.

Davies, S. R., Macnaghten, P., & Kearnes, M. (2009). *Reconfiguring Responsibility: Lessons for Public Policy (Part 1 of the report on Deepening Debate on Nanotechnology)*. Durham: Durham University.

Davis, K. (1973). The Case for and Against Business Assumption of Social Responsibilities. *Academy of Management Journal, 16*(2), 312-322.

De Laat, B. (1996). *Scripts for the future. Technology foresight, strategic evaluation and socio-technical networks: the confrontation of script-based scenarios.* PhD Dissertation. University of Amsterdam.

De Laat, B. (2000). Scripts for the future: using innovation studies to design foresight tools. In N. Brown, B. Rappert & A. Webster (Eds.), *Contested futures. A sociology of prospective techno-science* (pp. 175-208). Aldershot: Ashgate.

Delvenne, P., & Rip, A. (2011). Reflexive Modernization in Action. Pathways of Science and Technology Institutions. *Manuscript submitted to Social Science Information.*

Den Boer, D., Rip, A., & Speller, S. (2009). Scripting possible futures of nanotechnologies: A methodology that enhances reflexivity. *Technology in Society, 31*, 295-304.

Deuten, J. J., Rip, A., & Jelsma, J. (1997). Societal Embedding and Product Creation Management. *Technology Analysis & Strategic Management, 9*(2), 131-148.

Dewey, J. (1920). *Reconstruction in Philosophy.* Beacon Press.

Dewey, J. (1929). *The quest for certainty: a study of the relation of knowledge and action.* New York: Capricorn Books.

Djelic, M.-L. (2005). How Capitalism Lost its Soul: From Protestant Ethics to Robber Barons. In D. Daianu & R. Vranceanu (Eds.), *Ethical Boundaries of Capitalism* (pp. 43-64). Aldershot: Ashgate Publishing Limited.

Dorbeck-Jung, B. R. (2007). What can Prudent Regulators Learn from the United Kingdom Government's Nanotechnological Regulatory Activities? *NanoEthics, 1*(3), 257-270.

Doubleday, R. (2004). Institutionalising NGO Dialogue at Unilever: Framing the public as consumer-citizens. *Science and Public Policy, 31*(2), 117-126.

Ebbesen, M., Andersen, S., & Besenbacher, F. (2006). Ethics in Nanotechnology: Starting from Scratch? *Bulletin of Science, Technology & Society, 26*(6), 451-462.

Elkington, J. (1997). *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*. Oxford: Capstone Publishing.
Elzinga, A. (1997). The science-society contract in historical transformation: with special reference to "epistemic drift". *Social Science Information, 36*(3), 411- 445.
Evan, W. M., & Freeman, R. E. (1988). A Stakeholder Theory of the Modern Corporation: Kantian Capitalism. In T. L. Beauchamp & N. E. Bowie (Eds.), *Ethical Theory and Business* (3rd ed., pp. 97-106). Prentice Hall.
Falck, O., & Heblich, S. (2007). Corporate social responsibility: Doing well by doing good. *Business Horizons 50*, 247-254.
Felt, U., & Fochler, M. (2008). The bottom-up meanings of the concept of public participation in science and technology. *Science and Public Policy, 35*(7), 489-499.
Felt, U., Fochler, M., Müller, A., & Strassnig, M. (2009). Unruly ethics: on the difficulties of a bottom-up approach to ethics in the field of genomics. *Public Understanding of Science, 18*(3), 354-371.
Ferrari, A. (2010). Developments in the Debate on Nanoethics: Traditional Approaches and the Need for New Kinds of Analysis. *NanoEthics, 4*(1), 27-52.
Ferrari, A., & Nordmann, A. (2010). Beyond Conversation: Some Lessons for Nanoethics. *NanoEthics, 4*(2), 171-181.
Finegold, D., & Moser, A. (2006). Ethical decision-making in bioscience firms. *Nature Biotechnology, 24*(3), 285-290.
Fisher, E., Mahajan, R. L., & Mitcham, C. (2006). Midstream Modulation of Technology: Governance From Within. *Bulletin of Science, Technology & Society, 26*(6), 485-496.
Freeman, R. E. (1994). The politics of stakeholder theory: Some future directions. *Business Ethics Quarterly, 4*(4), 409-421.
Friedman, M. S. (1970). The Social Responsibility of Business Is to Increase Its Profits*. The New York Times Magazine, September 13,* 1970.
Galison, P. (1997). *Image and Logic: A Material Culture of Microphysics*. Chicago: University of Chicago Press.
Garud, R., & Ahlstrom, D. (1997). Technology assessment: a socio-cognitive perspective. *Journal of Engineering and Technology Management, 14 (1997)*, 25-48.
Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case study. *Research Policy, 31*, 1257-1274.
Geels, F. W. (2005). *Technological Transitions and System Innovations: A Co-evolutionary and Socio-technical Analysis*. Cheltenham: Edward Elgar Publishing.

Giddens, A. (1979). *Central Problems in Social Theory: Action, Structure and Contradiction in Social Analysis*. Berkeley and Los Angeles: University of California Press.

Gilbert, N. G., & Mulkay, M. (1984). *Opening Pandora's Box: A sociological analysis of scientists' discourse.* Cambridge: Cambridge University Press.

Guston, D. H., & Keniston, K. (1994). Introduction: The Social Contract for Science. In D. H. Guston & K. Keniston (Eds.), *The Fragile Contract. University Science and the Federal Government* (pp. 1-41). Cambridge, Massachusetts: Massachusetts Institute of Technology.

Haberer, J. (1969). *Politics and the Community of Science*. New York: Van Nostrand Reinhold.

Hart, S. L. (1995). A Natural - Resource-Based View of the Firm. *Academy of Management Review, 20*(4), 986-1014.

Hessels, L., Van Lente, H., & Smits, R. E. H. M. (2009). In search of relevance: the changing contract between science and society. *Science and Public Policy, 36*(5), 387-401.

Hickman, L. A. (1998). Introduction. In L. Hickman, A (Ed.), *Reading Dewey: Interpretations for a Postmodern Generation* (pp. ix-xxi). Bloomington and Indianapolis: Indiana University Press.

Hiebert, J., Carpenter, T. P., Fennema, E., Fuson, K., Human, P., Murray, H., et al. (1996). Problem Solving as a Basis for Reform in Curriculum and Instruction: The Case of Mathematics. *Educational Researcher, 25*(4), 12-21.

Hoogma, R., Kemp, R., Schot, J., & Truffer, B. (2002). *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*. London: Spon Press.

Hoogma, R. J. F. (2000). *Exploiting Technological Niches: Strategies for Experimental Introduction of Electric Vehicles.* PhD Dissertation. University of Twente.

Howard, C. J., & Tracz, R. F. (1970). *The Responsible Man: Essays, Short Stories, Poems*. San Francisco: Canfield Press.

Hughes, T. P. (1983). *Networks of Power: Electrification in Western Society, 1880-1930*. Baltimore and London: The Johns Hopkins University Press.

Joly, P.-B., & Rip, A. (2007). A timely harvest. *Nature 450*(8 November 2007), 174.

Joly, P.-B., Rip, A., & Callon, M. (2010). Re-inventing Innovation. In M. J. Arentsen, W. Van Rossum & A. E. Steenge (Eds.), *Governance of Innovation: Firms, Clusters and Institutions in a Changing Setting* (pp. 21-32). Cheltenham, UK: Edward Elgar.

Kearnes, M., Macnaghten, P., & Wilsdon, J. (2006). Governing at the Nanoscale: People, policies and emerging technologies. *Demos publication.* London: Calverts.

Kearnes, M., & Rip, A. (2009). The Emerging Governance Landscape of Nanotechnology. In S. Gammel, A. Losch & A. Nordmann (Eds.), *Jenseits von Reguliering: Zum politischen Umgang mit Nanotechnologie* (pp. 97-121). Berlin: Akademische Verlagsanstalt.

Kelty, C. (2009). Beyond Implications and Applications: the Story of 'Safety by Design'. *NanoEthics, 3*(2), 79-96.

Keulartz, J., Korthals, M., Schermer, M., & Swierstra, T. (Eds.). (2002). *Pragmatist Ethics for a Technological Culture*. Deventer: Kluwer Academic Publishers.

Keulartz, J., Schermer, M., Korthals, M., & Swierstra, T. (2004). Ethics in Technological Culture: A Programmatic Proposal for a Pragmatist Approach. *Science, Technology & Human Values 29*(1), 3-29.

King, A. A., & Lenox, M. J. (2000). Industry Self-Regulation without Sanctions: The Chemical Industry's Responsible Care Program. *The Academy of Management Journal 43*(4), 698-716.

Kohlberg, L. (1981). *The Philosophy of Moral Development. Moral Stages and the Idea of Justice.* San Francisco: Harper & Row.

Kuhn, T. S. (1962). *The Structure of Scientific Revolutions.* Chicago: The University of Chicago Press.

Kundahl, G. A. (2008). Communications in the Age of Nanotechnology. In E. Fisher, C. Selin & J. M. Wetmore (Eds.), *The Yearbook of Nanotechnology in Society, Volume 1: Presenting Futures* (pp. 183-194). Springer.

Kupper, F. (2009). *Democratizing Animal Biotechnology: Inquiry and Deliberation in Ethics and Governance.* Vrije Universiteit Amsterdam.

Lakatos, I. (1970). Falsification and the methodology of scientific research programmes. In I. Lakatos & A. Musgrave (Eds.), *Criticism and the growth of knowledge* (pp. 91-196). Cambridge: Cambridge University Press.

Lakatos, I. (1978). *The Methodology of Scientific Research Programmes*. Philosophical Papers Vol. 1. Cambridge: Cambridge University Press.

Latour, B. (1991). Technology is Society Made Durable. In J. Law (Ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination* (pp. 103-132). London: Routledge.

Lee, R., & Jose, P. D. (2008). Self-interest, self-restraint and corporate responsibility for nanotechnologies: Emerging dilemmas for modern managers. *Technology Analysis & Strategic Management 20*(1), 113-125.

Levitt, M. (2003). Public Consultation in Bioethics. What's the Point of Asking the Public When They Have Neither Scientific Nor Ethical Expertise? *Health Care Analysis, 11*(1), 15-25.

Lewenstein, B. V. (2006). What Counts as a 'Social and Ethical Issue' in Nanotechnology? In J. Schummer & D. Baird (Eds.), *Nanotechnology Challenges: Implications for Philosophy, Ethics and Society* (pp. 201-216). World Scientific Publishing Co. Pte. Ltd.

Light, A., & Katz, E. (Eds.). (1996). *Environmental Pragmatism*. New York Routledge.

Lindblom, C. E. (1990). *Inquiry and Change: The Troubled Attempt to Understand and Shape Society*. New Haven and London: Yale University Press.

Lyon, T. P. (2003). 'Green' Firms Bearing Gifts. *Regulation, Fall 2003*, 36-40.

Mackie, J. E., Taylor, A. D., Finegold, D., Daar, A. S., & Singer, P. A. (2006). Lessons on Ethical Decision Making from the Bioscience Industry. PLoS Med 3(5): e129. DOI:10.1371/journal.pmed.0030129

Malsch, I., & Hvidfelt, N., K. (2009). Individual and collective responsibility for nanotechnology: First Annual Report on Ethical and Social Aspects of Nanotechnology. *ObservatoryNano Reports on Ethical and Social Aspects of Nanotechnology* March 2009. Retrieved 1 June, 2009, from http://www.observatorynano.eu/project/catalogue/4RC/

McCarthy, E., & Kelty, C. (2010). Responsibility and nanotechnology. *Social Studies of Science, 40*(3), 405-432.

McKenna, E., & Light, A. (Eds.). (2004). *Animal pragmatism:rethinking human-nonhuman relationships*. Indiana University Press.

McKeon, R. (1957). The Development and Significance of the Concept of Responsibility. *Revue Internationale de Philosophie, 39*, 3-32.

McWilliams, A., & Siegel, D. (2001). Corporate Social Responsibility: A Theory of the Firm Perspective. *The Academy of Management Review, 26*(1), 117-127.

Merkx, F. (2008). *Organizing Responsibilities for Novelties in Medical Genetics*. PhD Dissertation. University of Twente.

Merton, R. K. (1942/1973). The Normative Structure of Science. In N. Storer, W. (Ed.), *The Sociology of Science: Theoretical and Empirical Investigations* (pp. 267-278). Chicago: The University of Chicago Press.

Merton, R. K. (1976). *Sociological Ambivalence and Other Essays.* New York: The Free Press, A Division of Macmillan Publishing Co., Inc.

Minteer, B., A , Corley, E., A, & Manning, R. E. (2004). Environmental Ethics Beyond Principle? The Case For A Pragmatic Contextualism. *Journal of Agricultural and Environmental Ethics 17*, 131-156.

Mitroff, I. I. (1974). Norms and Counter-Norms in a Select Group of the Apollo Moon Scientists: A Case Study of the Ambivalence of Scientists. *American Sociological Review 39*(4), 579-595.

Mulkay, M. (1979). *Science and the Sociology of Knowledge.* London: George Allen & Unwin.

Mulkay, M. (1993). Rhetorics of Hope and Fear in the Great Embryo Debate. *Social Studies of Science, 23*, 721-742.

Nelkin, D. (1987). Science, Technology and Public Policy. *History of Science Society Newsletter* 16 (2). Retrieved 10 June, 2010, from http://depts.washington.edu/hssexec/newsletter/1997/nelkin.html

Nelson, R., & Winter, S. (1977). In Search of a Useful Theory of Innovation. *Research Policy, 6*(1), 36-76.

Nordmann, A. (2007). If and Then: A Critique of Speculative NanoEthics. *NanoEthics, 1*(1), 31-46.

Nordmann, A., & Macnaghten, P. (2010). Engaging Narratives and the Limits of Lay Ethics: Introduction. *NanoEthics, 4*(2), 133-140.

Nordmann, A., & Rip, A. (2009). Mind the gap revisited. *Nature Nanotechnology, 4*(May 2009), 273-274.

Nordmann, A. (2004). *Converging Technologies: Shaping the Future of European Societies* Luxembourg: European Commission, EUR 21357.

Novas, C. (2006). What Is the Bioscience Industry Doing to Address the Ethical Issues It Faces? PLoS Med 3 (5): e142. DOI:10.1371/journal.pmed.0030142

Pappas, G. F. (1998). Dewey's Ethics: Morality as Experience. In L. Hickman, A. (Ed.), *Reading Dewey: Interpretations for a Postmodern Generation* (pp. 100-123). Bloomington and Indianapolis: Indiana University Press.

Parsons, T. (1939). The Professions and Social Structure. *Social Forces, 17*(4), 457-467.

Prahalad, C. K. (2004). *The Fortune at the Bottom of the Pyramid*: Wharton School Publishing.

Prahalad, C. K., & Hammond, A. (2002). Serving the World's Poor, Profitably. *Harvard Business Review September 2002*, 48-57.

Prakash, A. (2000). Responsible Care: An Assessment *Business & Society, 39*(2), 183-209.

Radder, H. (1992). Normative Reflexions on Constructivist Approaches to Science and Technology. *Social Studies of Science, 22*(1), 141-173.

Ravetz, J. R. R. (1975). '...et augebitur scientia'. In R. Harré (Ed.), *Problems of Scientific Revolution: Progress and obstacles to progress in the sciences* (pp. 42-75). Clarendon Press.

Rejeski, D. (2007). Nanotechnology and the Trust Gap. Retrieved February 7, 2008, from http://www.nanotech-now.com/columns/?article=109

Renton, A. (2006). Welcome to the world of nano foods. *The Observer* Retrieved February 7, 2008, from http://observer.guardian.co.uk/foodmonthly/futureoffood/story/0,,1971266,00.html
Rettig, R. A. (1971). Science, Technology and Public Policy: Some Thematic Concerns. *World Politics, 23*(2), 273-293.
Rip, A. (1981). *Maatschappelijke verantwoordelijkheid van chemici*. PhD Dissertation. Universiteit Leiden.
Rip, A. (2002a). *Co-evolution of science, technology and society*. An Expert Review for the Bundesministerium Bildung und Forschung's Förderinitiative *Politik, Wissenschaft und Gesellschaft* (Science Policy Studies), as managed by the Berlin-Brandenburgische Akademie der Wissenschaften.
Rip, A. (2002b). Science for the 21st Century. In P. Tindemans, A. Verrijn-Stuart & R. Visser (Eds.), *The Future of the Sciences and Humanities. Four analytical essays and a critical debate on the future of scholastic endeavour* (pp. 99-148). Amsterdam: Amsterdam University Press.
Rip, A. (2004). Strategic Research, Post-modern Universities and Research Training. *Higher Education Policy, 17*, 153-166.
Rip, A. (2006a). Folk Theories of Nanotechnologists. *Science as Culture, 15*(4), 349-365.
Rip, A. (2006b). *Interlocking Socio-Technical Worlds*. STeHPS Colloquium, 14 June 2006, University of Twente.
Rip, A. (2007a). *Integrity in Research*. Research Directors Forum, 26 November 2007, Stellenbosch.
Rip, A. (2007b). Research Choices and Directions - in Changing Contexts. In M. Deblonde, L. Goorden, A. Nordmann & A. Rip, *Nano Researchers Facing Choices. The Dialogue Series #10* (pp. 33-48). Universitair Centrum Sint-Ignatius Antwerpen.
Rip, A. (2008). Discourse and practice of responsible nanotechnology development. Retrieved 1 June, 2009, from http://www.mbs.ac.uk/research/innovation/documents/ManchesterSept08ArieRip.ppt
Rip, A. (2009). Futures of ELSA. *EMBO reports, 10*(7), 666-670.
Rip, A. (2010a). De Facto Governance of Nanotechnologies. In M. Goodwin, B.-J. Koops & R. Leenes (Eds.), *Dimensions of Technology Regulation* (pp. 285-308). Nijmegen: Wolf Legal Publishers.
Rip, A. (2010b). 'NanoNed'. In D. H. Guston (Ed.), *Encyclopaedia of Nanoscience and Society.* Sage Publications, Inc.
Rip, A. (2010c). Processes of entanglement. In M. Akrich, Y. Barthe, F. Muniesa & P. Mustar (Eds.), *Débordements: Mélanges offerts à Michel Callon* (pp. 381-392). Paris: TRANSVALOR - Press des MINES.

Rip, A. (2011). Protected Spaces of Science: Their Emergence and Further Evolution in a Changing World. In M. Carrier & A. Nordmann (Eds.), *Science in the Context of Application* (Vol. Boston Studies in the Philosophy of Science pp. 197-220). Dordrecht: Springer.

Rip, A., & Goeman, H. (1978). *Social and Cultural Impact Statements.* Paper presented at the Conference Science, Society and Education, Amsterdam, August 14-17, 1978.

Rip, A., & Groen, A. J. (2001). Many visible hands. In R. Coombs, K. Green, A. Richards & V. Walsh (Eds.), *Technology and the Market: Demand, Users and Innovation* (pp. 12-37). Cheltenham: Edward Elgar.

Rip, A., & Kemp, R. (1998). Technological Change. In S. Rayner & E. L. Malone (Eds.), *Human Choice and Climate Change, Volume 2: Resources and Technology* (pp. 327-399). Columbus Battelle Press.

Rip, A., & Nederhof, A. J. (1986). Between dirigism and laissez-faire: Effects of implementing the science policy priority for biotechnology in the Netherlands. *Research Policy, 15*, 253-268.

Rip, A., & Shelley-Egan, C. (2007). *Review Statement: Ethics in the Real World. Deliverable D2: DEEPEN Project*.

Rip, A., & Shelley-Egan, C. (2009). *Contributing Report: Enhancing Ethical Reflexivity in the Real World. Deliverable D 17: DEEPEN Project*.

Rip, A., & Shelley-Egan, C. (2010). Positions and Responsibilities in the 'Real' World of Nanotechnology. In R. Von Schomberg & S. R. Davies (Eds.), *Understanding Public Debate on Nanotechnologies: Options for Framing Public Policy* (pp. 31-38). Brussels: European Commission.

Rip, A., Smit, W. A., & Van der Meulen, B. (1995). Radioactive Waste Disposal:Taking Societal Views into Account. In OECD Nuclear Energy Agency (1995). *Environmental and ethical aspects of long-lived radioactive waste disposal* (pp. 184-201). Paris.

Rip, A., & Talma, S. (1998). Antagonistic Patterns and New Technologies. In C. Disco & B. van der Meulen (Eds.), *Getting New Technologies Together: Studies in Making Sociotechnical Order* (pp. 299-322). Berlin: Walter de Gruyter.

Rip, A., & Te Kulve, H. (2008). Constructive Technology Assessment and Socio-Technical Scenarios. In E. Fisher, C. Selin & J. M. Wetmore (Eds.), *The Yearbook of Nanotechnology in Society, Volume 1: Presenting Futures* (pp. 49-70). Springer .

Rip, A., & Van Amerom, M. (2009). Emerging *De Facto* Agendas Around Nanotechnology: Two Cases full of Contingencies, Lock-outs, and Lock-ins. In M. Kaiser, M. Kurath, S. Maasen & C. Rehmann-Sutter (Eds.), *Governing Future Technologies: Nanotechnology and the Rise of an Assessment Regime* (pp. 131-155). Dordrecht: Springer.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a General Theory of Planning. *Research Policy, 4 (1973)*, 155-169.

Robinson, D. K. R. (2010). *Constructive Technology Assessment of Emerging Nanotechnologies : Experiments in Interactions .* PhD Dissertation. University of Twente.

Schellens, P. J. (1985). *Redelijke argumenten: Een onderzoek naar normen voor kritische lezers*. PhD Dissertation. Rijksuniversiteit Utrecht.

Schmandt, J. (1973). Review: [untitled]. *The Americal Journal of Sociology 78*(5), 1294-1296.

Schön, D. A. (1992). The Theory of Inquiry: Dewey's Legacy to Education. *Curriculum Inquiry 22*(2), 119-139.

Schot, J., & Rip, A. (1996). The Past and Future of Constructive Technology Assessment. *Technological Forecasting and Social Change, 54*, 251-268.

Schuurbiers, D. (2010) *Social Responsibility in Research Practice - Engaging applied scientists with the socio-ethical context of their work.* PhD Dissertation. Delft University of Technology.

Schuurbiers, D., & Fisher, E. (2009). Lab-scale intervention. *EMBO reports, 10*(5), 424-427.

Sims, R. R. (1992). The Challenge of Ethical Behavior in Organizations. *Journal of Business Ethics, 11*, 505-513.

Sismondo, S. (2004). *An introduction to Science and Technology Studies*. Oxford: Blackwell Publishing Ltd.

Sparrow, R. (2007). Revolutionary and Familiar, Inevitable and Precarious: Rhetorical Contradictions in Enthusiasm for Nanotechnology. *NanoEthics, 1*(1), 57-68.

Stegmaier, P. (2009). The rock 'n' roll of knowledge co-production. *EMBO reports, 10*(2), 114-119.

Stemerding, D., Swierstra, T., & Boenink, M. (2010). Exploring the interaction between technology and morality in the field of genetic susceptibility testing: A scenario study. *Futures, 42*(10), 1133-1145.

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

Strassnig, M. (2009). *"Ethics is like a book that one reads when one has time". Exploring lay 'ethical' knowledge in a public engagement setting.* Unpublished PhD thesis, Universität Wien.

Sutcliffe, H. (2008). How Can Business Respond to the Technical, Social and Commercial Uncertainties of Nanotechnology? In E. Fisher, C. Selin & J. M. Wetmore (Eds.), *The Yearbook of Nanotechnology in Society, Volume1: Presenting Futures* (pp. 195-200). Springer.

Swidler, A. (1986). Culture in Action: Symbols and Strategies. *American Sociological Review, 51*(2), 273-286.

Swierstra, T., & Rip, A. (2007). Nano-ethics as NEST-ethics: Patterns of Moral Argumentation About New and Emerging Science and Technology. *NanoEthics, 1*(1), 3-20.

Swierstra, T., Stemerding, D., & Boenink, M. (2009). Exploring Techno-Moral Change: The Case of the Obesity Pill. In P. Sollie & M. Duwell (Eds.), *Evaluating New Technologies. Methodological Problems for the Ethical Assessment of Technology Developments* (pp. 119-138). Dordrecht/Heidelberg: Springer.

Te Kulve, H. (2010). Emerging technologies and waiting games: Institutional entrepreneurs around nanotechnology in the food packaging sector. *Science, Technology and Innovation Studies, 6*(1), 7-31.

Te Kulve, H. (2011). *Anticipatory Interventions and the Co-evolution of Nanotechnology and Society.* PhD Dissertation (to be defended 21 April 2011).University of Twente, Enschede.

Thagard, P. (1988). *Computational Philosophy of Science.* MIT Press.

Toulmin, S. E. (1958). *The Uses of Argument*. Cambridge: Cambridge University Press.

Türk, V. (2008). Nanologue. In E. Fisher, C. Selin & J. M. Wetmore (Eds.), *The Yearbook of Nanotechnology in Society, Volume 1: Presenting Futures* (pp. 117-122). Springer.

Van de Poel, I. (2008). How Should We Do Nanoethics? A Network Approach for Discerning Ethical Issues in Nanotechnology. *NanoEthics, 2*(1), 25-38.

Van de Poel, I., & Zwart, S. D. (2010). Reflective Equilibrium in R&D Networks. *Science, Technology, & Human Values, 35*(2), 174-199.

Van den Daele, W. (1977). The Social Construction of Science: Institutionalisation and Definition of Positive Science in the Latter Half of the Seventeenth Century. In E. Mendelsohn, P. Weingart & R. Whitley (Eds.), *The Social Production of Scientific Knowledge* (pp. 27-54). Dordrecht: Reidel.

Van Lente, H. (1993). *Promising Technology: The Dynamics of Expectations in Technological Developments*. PhD Dissertation. University of Twente.

Van Rijswoud, E., Stemerding, D., & Swierstra, T. (2008). *Genetica, genomics en gezondheidszorg: Een toekomstverkenning.* Centre for Society and Genomics, April 2008.

Von Schomberg, R. (2007). *From the Ethics of Technology Towards an Ethics of Knowledge Policy and Knowledge Assessment.* Brussels: Working document of the European Commission Services.

Von Schomberg, R. (2010). Organising Collective Responsibility: On Precaution, Codes of Conduct and Understanding Public Debate. In U. Fiedeler, C. Coenen, S. R. Davies & A. Ferrari (Eds.), *Understanding Nanotechnology: Philosophy, Policy and Publics* (pp. 61-70). Amsterdam: IOS Press.

Walsh, S., & Medley, T. (2008). A Framework for Responsible Nanotechnology. In E. Fisher, C. Selin & J. M. Wetmore (Eds.), *The Yearbook of Nanotechnology in Society, Volume 1: Presenting Futures* (pp. 207-213). Springer.

Werhane, P. H. (2000). Business Ethics and the Origins of Contemporary Capitalism: Economics and Ethics in the Work of Adam Smith and Herbert Spencer. *Journal of Business Ethics 24*, 185-198.

Werhane, P. H., & Freeman, R. E. (1999). Business ethics: the state of the art. *International Journal of Management Reviews 1*(1), 1-16.

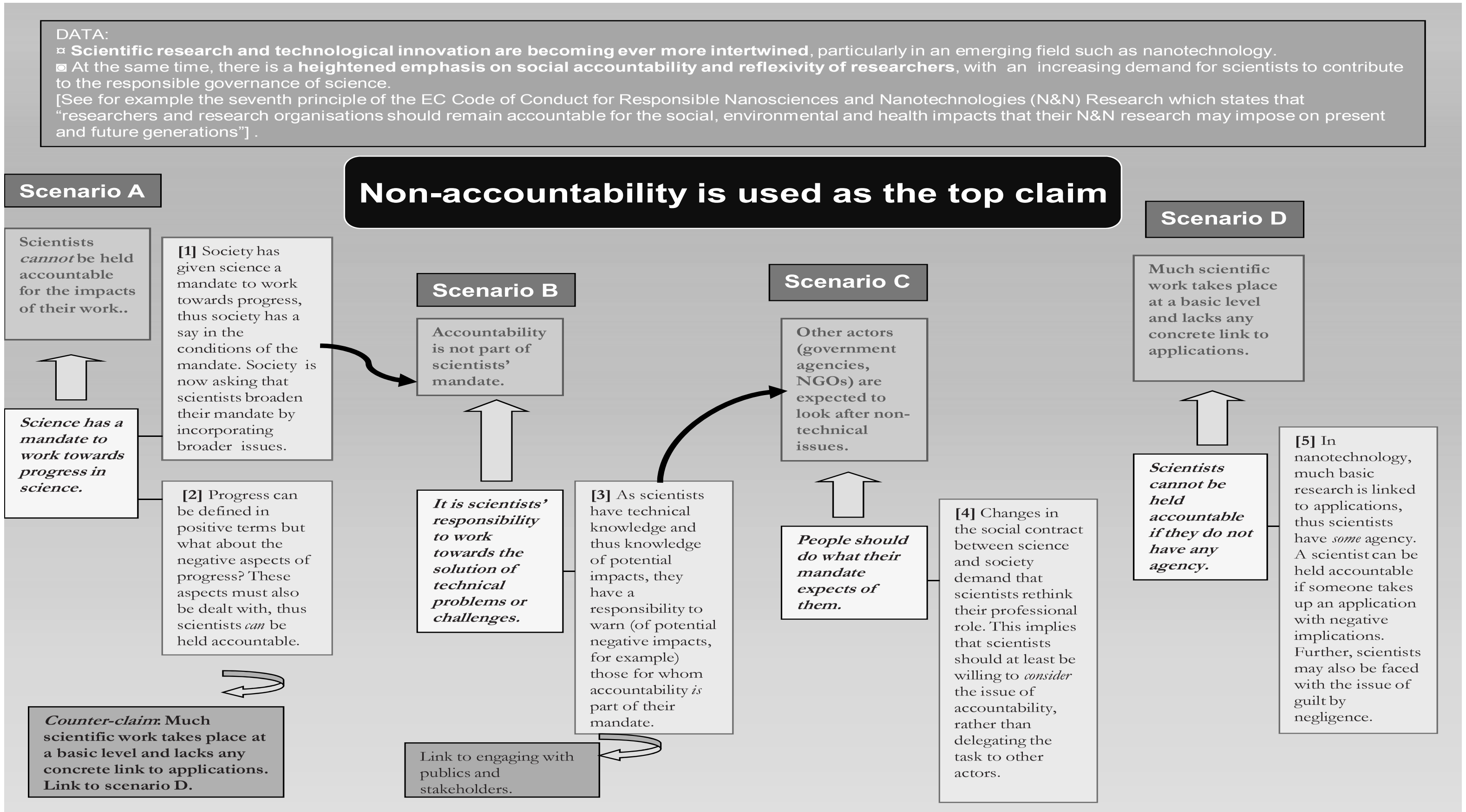
Whitley, R. D. (1977). The Sociology of Scientific Work and the History of Scientific Developments. In S. Blume, S. (Ed.), *Perspectives in the Sociology of Science* (pp. 21-50). Chichester, Great Britain: John Wiley & Sons Ltd.

Wiedemann, P. M., Clauberg, M., & Schütz, H. (2003). Understanding amplification of complex risk issues: the risk story model applied to the EMF case. In N. Pidgeon, R. E. Kasperson & P. Slovic (Eds.), *The Social Amplification of Risk* (pp. 286-301). Cambridge: Cambridge University Press.

Winner, L. (1993). Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology. *Science, Technology & Human Values, 18*(3), 362-378.

Woordenboek der Nederlandse Taal. (1959) (Vols. deel XIX (1), VER(V)-VERARMING). 's-Gravenhage en Leiden: Martinus Nijhoff en A.W. Sijthoff.

Ziman, J. M. (1998). Why must scientists be more ethically sensitive than they used to be? *Science 282 (5395)*, 1813 – 1814.



Appendix: Argumentation scenarios around the accountability/responsibility of scientists

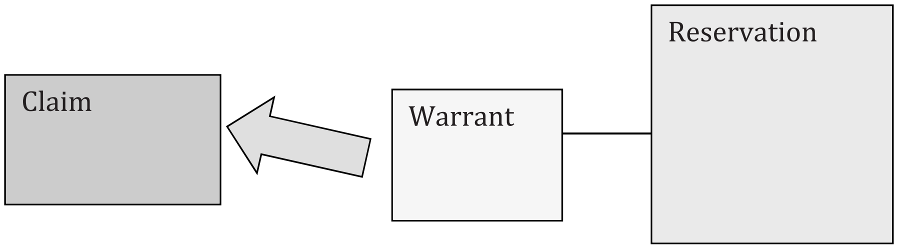


Figure 1: Claim, warrant and reservation in Toulmin's Model of Argumentation

The coloured boxes in this figure correspond to the claim, warrant and reservation, as laid out in the argumentation scenarios.

Claim: the statement which the "arguer" puts forward and wants to have accepted. In the case of a scientific argument, the claim will often be about empirical data. In the case of ethics, there might be relevant data but the claim has a normative character.

Warrant: the important part in an ethical argument. It offers a general ethical justification. Such a warrant can have a consequentialist, deontological or good-life character. A deontological argument is concerned with *duties* and *principles* which require people to behave in specific ways, regardless of the consequences. "Thou shalt not kill" is a deontological argument.

Reservation: possible limitations to the warrant, up to an argument against the warrant. For example, if the warrant is a deontological argument, there might be an argument against deontological ethics, from a consequentialist ethics perspective.

Summary

The development of a new and emerging science and technology (NEST) such as nanotechnology poses a number of challenges because it introduces novelty and uncertainty. Responses will initially take the form of 'tried and tested' approaches to previous new technologies. At the institutional/collective level, "organized irresponsibility" is an effect of standard responses to novelty because the explicit and implicit responsibilities of the past may not be adequate in the new situation. In nanotechnology, there is recognition of the problem of 'organising' responsibilities, for example, in discourse on the 'responsible development' of nanotechnologies. Although 'responsible development' is not operationalised and there are no specific, dedicated activities associated with it, actors nonetheless feel the pressure to respond. Scientists and industrialists are particularly interesting in this respect because they are co-constructing the novelty and thus are part of the circumstance that leads to "organized irresponsibility".

The aim of this thesis is to map the responses, particularly the ethical stances, of scientists and industrialists in relation to the challenge of the novelty and uncertainty of nanotechnology and to evaluate their responses with regard to opportunities and possibilities for responses which go beyond just adding to "organized irresponsibility". While this can be taken up as a straightforward sociological undertaking of mapping responses and trying to understand them, there is a normative concern as well: how can a social scientist contribute to better responses to the problematic situation he or she perceives? This normative concern is addressed through a sociological extension of the pragmatist ethics of Dewey.

The two research questions are specifications of these broader aims:

- What are the ethical stances, ethical choices and justification of interests and positions of actors (scientists and industrialists) who have a stake in the development of nanotechnology? What kinds of responses to the novelty of nanotechnology do they have?
  What is the current role of ethical stances and choices in the development of nanotechnology?
    - These questions relate to an analysis at the micro level of responses to the problematic situations related to the 'responsible development' of nanotechnology.

- Given the ethical stances and choices of actors in the world of nanotechnology and the dynamics of the current division of moral labour, what kinds of choices and responses might lead to 'new' ways of 'organising' responsibilities and a 'better' division of moral labour? How can this be done, if at all?
    - This question reflects an analysis at the meso and macro level (at the collective level) of institutional context and practices and the current division of moral labour, respectively.

In order to address these research questions, a pragmatist ethics approach, drawing in particular on the pragmatist ethics of American philosopher John Dewey and his notions of 'problematic situation' and 'reflective inquiry', is coupled with a multi-level co-evolutionary perspective of socio-technical change in society (Rip & Kemp, 1998; Geels, 2005) to develop a sociological extension of Dewey's pragmatist ethics which facilitates sociological understanding of problematic situations.

Chapter 2 offers a literature review of what is known about ethical stances and commitments at the micro-level of scientists' and industrialists' responses to the new developments and offers further considerations for the conceptual framework of the thesis. The definition of 'ethics' used in this thesis is described, as this conceptualisation of ethics informs the collection of the data. The emphasis in this thesis is on 'ethical stances' which relates to the justification of interests and positions and on 'ethical choices'. In interviews and discussions, this terminology moves away from actors' terminology of 'ethical' ('good') and 'unethical' (bad') and moves closer to questions of justification. In order to understand the particular context in which actors are embedded, a review of the literature on the moral stances of scientists and industrialists in their respective practices and in their actions and interactions in the outside world is carried out. Next, the enactor perspective of scientists and industrialists, their lay ethics, folk theories and patterns of moral argumentation are discussed as a means of understanding the particular perspectives these actors will bring to 'problematic situations'. This discussion is also necessary to support the research design.

Chapter 3 centres on a problematic situation related to the 'responsible development' of nanoscience and nanotechnologies, that is, the emphasis on increased accountability/responsibility of scientists. In order to understand whether scientists recognise the call for greater accountability/responsibility as a problematic situation, two groups of scientists were engaged in a discussion on this issue. While both sets of scientists recognised that a problematic situation exists, their responses tended to build on existing roles and their justification with reference to the standard repertoire of science, protecting the 'core business' of doing science. The recurrent problem definition was one of external pressures on the ongoing work of doing science. Scientists' reflection built on and was supported by considered arguments which are firmly located in the institutions of science. A clear example is the discussion of the necessary role of 'pimping' in writing research proposals and in the observation that, in order for real change to occur, it would have to be sanctioned or at least supported at the institutional level. Thus, in responding to the 'problematic situation' of the increasing emphasis on accountability/responsibility of scientists, individual scientists' responses refer to institutional and moral divisions of labour.

Chapter 4 comprises an empirical study which explores how industrial actors across the three main domains in nanotechnology deal with the 'wicked' problem of how to responsibly develop nanotechnology when there is little or no idea as to what this means and entails, while there is some pressure to do so. Responsible development of nanotechnologies is particularly important for the chemical sector, given credibility pressures and the need to strengthen trust and transparency in the chemical sector. This sector is proactively involved in responsible development of nanotechnologies, with the implementation of various measures such as Codes of Conduct and the establishment of nanotechnology issue management teams by some companies in the sector. Responsible development is not a salient issue for companies in the nanoelectronics and bionanotechnology domains. Given the strict safety and regulation measures that are already in place in the nanoelectronics and medical sectors, these sectors can afford to be forgetful of the responsible development of nanotechnology. Thus these sectors do not face the 'wicked' problem of how the development of nanotechnologies should be addressed when 'responsible development' is on the agenda.

While this is an empirical study, it speaks to a business ethics question, i.e. the question of moral practices in business. In new developments related to the responsible development of nanotechnology, there is, in addition to distributed responsibility, increased interaction with stakeholders in the outside world, requiring new practices and further ethical stances. Companies have to anticipate societal embedding and interaction with other actors; companies are forced to learn or 'die' and it appears that companies are cognisant of this. The development of Codes of Conduct may provide for such learning in addition to an opportunity for the broadening of ethical stances. Such practices and learning can contribute to making the 'wicked' problem of how to articulate and operationalise responsible development manageable. Thus while the problem of how to "do" responsible development may not be resolved, it is the *process* of responsible development that is important. The process can stimulate critical reflection on issues that are often backgrounded, such as the direction of the development of nanotechnologies, i.e. do we in fact *want* or *need* nanotechnologies?

Chapter 5 is a 'bridging chapter' in that it summarises the empirical findings and sets the scene for a discussion of further questions. Looking back and taking stock of the overall picture emerging from the empirical analysis, the contribution of the sociological consideration of 'problematic situations' becomes evident. Sociological consideration of 'problematic situations' offers more than simply empirical descriptions of what might be problematic for actors. It locates actors and their responses to 'problematic situations' in evolving contexts and allows some diagnosis, especially for change.

While actors' recognition of 'problematic situations' in terms of pressures on what they traditionally do, rather than in terms of organized irresponsibility linked to the functioning of institutions and/or the novelty and uncertainty of nanotechnology may be legitimate, it poses two challenges. The first challenge is that reference to existing roles and mandates as a warrant for actions and their justification also blackboxes them, so that they are not queried as to their justification. The second challenge concerns who is to take initiatives in a situation of organized irresponsibility. While it may be clear that the existing division of moral labour is insufficient to address organized irresponsibility (it may be part of the problem rather than part of the solution), the alternative is not clear either (or remains open ended, as in the call for responsible development of nanotechnology) and may be difficult to reach.

In order to address these challenges, the multi-level co-evolutionary perspective is combined with sociological understanding of the problematic situation of 'organized irresponsibility'. This facilitates the identification of building blocks for a more adequate and longer-term response to problematic situations, which takes into account overall dynamics and the possibilities of modulating these dynamics. Modulating ongoing patterns and dynamics and at different levels, is necessary because dynamics at one level form the backdrop to problematic situations faced by actors at other levels. Modulation of interactions *between* levels is necessary because processes at the meso- and macro-levels can affect change at the micro-level and *vice versa*.

The first cluster of building blocks offered in Chapter 6, starts with the ambivalence of promising technology; phrased as an ethical issue it is about whether "to exaggerate or not to exaggerate". This is a general issue but nanotechnology highlights existing ambivalences as promises which may turn into hype and introduces new ambivalences such as "size matters" and "nano inside". Ambivalences "imply that there is no simple resolution: an attempt to go for one side of the ambivalence brings out the problems linked with the other side" (Swierstra & Rip 2007, p. 16). Thus, it forces actors to be somewhat reflective about the situation and to recognise its problematic character. Further data from interviews with industrialists (see Chapter 4) are used to map their responses to this particular problematic situation. The promises and ambivalences of nanotechnology are shown to lead to responses from the enactor perspective at the micro - level of individual actors and thus close down the open-ended nature of the problematic situation very quickly with recourse to standard repertoires and positions. The justification for doing so relates to how actors and actions are embedded in a regime of innovation at the meso-level - the regime of economics of techno-scientific promises (ETP regime) (Joly, Rip & Callon, 2010). While the regime of ETP is hegemonic at the meso-level, it is not the only regime. Joly et al. (2010) argue that there is also a regime of collective experimentation. Experimentation "… does not derive from promoting a particular technological promise, but from goals constructed around matters of concern that may be achieved at the collective level" (Joly et al., 2010, p. 27). One can speculate whether this particular regime of innovation offers opportunities for opening up. Indeed the European Expert Group on Converging Technologies (Nordmann, 2004) proposed to develop the visions which inform enabling technologies like nanotechnology in spaces in which a variety of stakeholders are involved. This appears to be happening already to some extent but in an *ad hoc* manner.

The second cluster of building blocks offered in Chapter 7 discusses the limitations of the concept and practices of enhancing ethical reflexivity of scientists. The chapter begins with the characterisation of some current efforts in enhancing ethical reflexivity as belonging to an ethical deficit model. Characteristics of the 'ethical deficit model' include an emphasis on 'enhancing' and thus an assumption of deficiencies of scientists in this respect, as well as the positioning of social scientists, ethicists and humanists as knowing 'better' than scientists and industrialists. One argument presented against this 'ethical deficit model' is that scientists (and enactors, more generally) already have a competence for ethical reflexivity – it is the performance or the articulation of reflexivity that may be lacking. Indeed the empirical findings can be read as demonstrating that problems occur in the articulation of reflexivity. This particular limitation derives from actors' limiting their reflexivity by recourse to roles and mandates. Consequently, justifications are made not in terms of ethics but in terms of their role, work, institutional context and so on. While these are legitimate justifications for these actors, they are offered without reflective inquiry and thus allow short-circuiting of problematic situations.

Current approaches – both in the literature and in practice – to enhancing ethical reflexivity are evaluated in relation to their effectiveness in stimulating the articulation of reflexivity from a non-ethical-deficit perspective. The design and implementation of a tool (carried out as part of the DEEPEN project) aimed at facilitating the articulation of reflexivity in a focus group exercise in which 'design for difference' (heterogeneity) was an important requirement is also described and evaluated. These approaches go some way to overcoming the ethical deficit model. In order to circumvent – to some extent – the ethical deficit model, recognition of the competence of actors and articulation of reflexivity in action and interaction are important.

These approaches mainly focus on individual scientists and research groups; however, "organized irresponsibility" in relation to newly emerging science and technology of which individual scientists are a part cannot be addressed by such individual reflexivity alone. It is necessary to broaden the perspective to reflexiveness in the overall process at the meso-and macro-levels. The chapter concludes with a brief discussion as to how tools for reflexiveness of the process might function.

The third cluster of building blocks, addressed in Chapter 8, concerns current divisions of moral labour for science and industry which form a backdrop to problematic situations faced by scientists and industrialists and are a problematic situation in themselves (cf. 'organized irresponsibility'). The adequacy of such divisions of moral labour is discussed, particularly in the face of the novelty and uncertainty introduced by newly emerging science and technology. This leads to a diagnosis that the main division of moral labour in the world of nanotechnology functions well in terms of delivering on the 'enactor' perspective and producing workable solutions in the short-term. However, in changing circumstances, such as the move towards responsible development of nanotechnology, the 'solidity' of this division will be constraining for those who do not view the development of nanotechnology from the enactor perspective and for those who are seeking to renegotiate the current division of moral labour. The existing division of moral labour can thus no longer be taken for granted; some opening up is necessary in order to check its adequacy for new challenges and to allow space for new configurations of moral labour. Indeed opening up is occurring, for example, through the intervention of third parties who may take initiatives which might lead to change. This happens against the backdrop of larger changes in our late-modern societies, in particular what Beck et al. (1994) call 'reflexive modernization'. For newly emerging science and technology, the opening up of their institutions and the exploration of new roles may lead to new configurations in the moral division of labour, with reflexive interactions between enactors and other stakeholders. This can be discussed as the politics of responsible development because the *de facto* constitution of society changes (and in the direction of a neo-corporatist division of political labour).

The final chapter, Chapter 9, looks back at the story so far and offers a discussion of the sociological extension of Dewey's pragmatist ethics and a brief reflective inquiry into the contribution of sociology. This also indicates elements of what a sociological extension of Dewey's pragmatist ethics amounts to.

In order to understand the responses of individual actors to novelty and uncertainty of nanotechnology, one has to understand both the particular context in which the actors are embedded, along with co-evolution at the collective level. The call for 'responsible development' of nanotechnologies is something that impinges on the present roles and practices of actors. From their point of view, the call is another external pressure that has to be addressed somehow (e.g. on paper), in order to continue with their practices. The broader problematic situation of nanotechnology in society is reduced to the problem of how to handle further external pressure. However, co-evolution at the collective level adds greater complexity to the 'problematic situations' in which actors can find themselves, implying that Dewey's focus on the individual is no longer sufficient. The development and possible implementation of the EC Code of Conduct for Responsible Nanoscience and Nanotechnologies Research, for example, has a certain legitimacy, especially at the collective level. Individual actors cannot argue against it but can try to position it as creating problems for another responsibility, i.e. to advance science. Thus actors' responses at the micro-level to novelty and uncertainty will be shaped by their particular context and position, while they are also influenced by (and influence) behaviour and interactions at the collective level of institutions and sectors.

For this reason, a multi-level perspective is necessary. It is important for understanding overall dynamics and for understanding how morality can co-evolve with socio-technical change. Reflective inquiry, in Dewey's sense, can now become sociologically informed reflective inquiry. In addition, the multi-level dynamics of co-evolution of technology and society imply that reflective inquiry is located at different levels and with different actors. Interactions between levels and between actors then become important.

This sociological extension to Dewey's pragmatist ethics is not just a conceptual matter. It facilitates contributions to actors' perception of the problematic situation (e.g. recognition of multi-level dynamics) and actors' reflective inquiry (e.g. enabling actors to see themselves as part of the problematic situation).
The final section of the chapter offers a forward look at future storylines in relation to the evolution of the present situation into the future. This thesis has demonstrated that responses to the call for the responsible development of nanotechnology are determined by roles and mandates and a robust institutional context. However, this is not the entire story. 'Responsible development' constitutes an ideograph, i.e. it refers to something which is considered to be "good", without much further specification. If a stronger structure for 'responsible development' is created, it may emerge as a "second-order trajectory" (Rip, 2010a) in which "working towards responsible development" of nanotechnology becomes an integral part of the trajectory of technological development. While there is no guarantee that the second-order trajectory of "working towards responsible development" will be taken up, actions, interactions and anticipations get entangled, articulation of choices will take place and some stabilisation will occur (Rip, 2010c). One can devise two different scenarios for an outcome of the entanglements in relation to the operationalisation of responsible development. In one scenario, one can see a lock-in created by the focus on environmental, health and safety aspects (EHS), in which working towards responsible development will be reduced to EHS aspects and the manner in which these are regulated. Actors will have 'recourse to the technical/procedural' in response to requirements for societal embedding. In a second scenario, the focus on EHS aspects, particularly in relation to the move towards 'safety by design', becomes part of a broader move towards a 'license to operate'. The standard notion of 'license to operate' can be broadened to become an operationalisation of responsible development, rather than a matter of complying with regulation. Indeed it could perhaps be extended to encompass societal impacts and distributive issues.

Nanotechnology may not be as revolutionary in its impacts as some of its proponents suggest. However, it may well be revolutionary in that it is the occasion to explicitly and at an early stage put anticipation of and a focus on 'problematic situation' and 'reflective inquiry' (as in the call for responsible development) on the agenda. While the outcomes are unclear at this stage and recourse to immediate problem-solving may reduce open and reflexive approaches, the process is important and should be nurtured.