Philosophical and Empirical Investigations in Nanoethics

Marion Godman

Division of Philosophy,
Department of Philosophy and History of Technology,
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ABSTRACT

The term **nanotechnology** is most commonly taken to refer to a field of engineering on the scale of 1-100 nanometre. **Nanoethics** represents the emerging field of research that concerns the ethical issues raised by nanotechnology along with issues related to the convergence between nanotechnology and other technological/societal developments. This thesis consists of an introduction and three essays that fall within the scope of nanoethics.

**Essay 1** discusses the nature of nanoethics as a sub-discipline of applied ethics. A distinction is made between those issues that may ensue once nanotechnology applications become available, and procedural issues that should be integrated into the decision structure of the development. A second distinction concerns the kind of value that is at stake when an ethical issue is raised about nano-research and applications.

**Essay 2** (co-written with Sven Ove Hansson) explores public views on **nanobiotechnology** (NBT) by means of **convergence seminars**, held in four distinct regions of Europe. One of the most common recommendations expressed by participants at the convergence seminars, was that NBT research and industry should focus on solutions for developing countries and to global environmental problems. The methodology was judged as successful in relation to aim of developing a participatory method for decision-making under uncertainty. Participants stated that their advice was influenced both by considering different possible future developments and the different views of their co-participants.

**Essay 3** (co-written with Henrik Carlsen, Karl Henrik Dreborg, Sven Ove Hansson, Linda Johansson, and Per Wikman-Svahn) argues that a new participatory methodology is needed for assessing and guiding decisions on potentially **disruptive technologies**. We propose a methodology named **multiple expert interaction** (MEI), where a group of participants generate and evaluate several scenarios. The scenarios should be relevant from a policy perspective and explore different **co-evolutionary paths** between society and candidate technological artifacts. This process is designed to include different “experts” in the scenario planning as well as in the assessment stage.

**Keywords**: Nanotechnology; Ethics; Convergence seminars; Public participation; Novelty; Decision-making under uncertainty; Disruptive technologies; Scenario planning; Technology assessment
LIST OF ESSAYS


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CONTENTS

Abstract
List of essays
Acknowledgements
Introduction

Essay 1. But is it unique to nanotechnology: Reframing nanoethics

Essay 2. European public advice on nanobiotechnology –
   Four convergence seminars

Essay 3. Assessing socially disruptive technological change

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Marion Godman
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INTRODUCTION

A brief history of nanoethics

How should an ethics be conducted which concerns the nano-scale? Before even beginning to understand the subject matter of nanoethics, the problem of defining the technology itself emerges. Most often nanotechnology is taken to refer to the body of knowledge constitutive of a certain field of engineering, namely that of engineering matter in the 1-100 nanometre range (Ratner & Ratner 2003; Royal Society 2004). This will also include the tools, such as special microscopes that enable us to image, probe, and manipulate these extremely small units. Some commentators find it instructive to use the term “nanotechnology” more broadly to include the actual and prospective technological applications where nanotechnology is embedded. After all, the main reason why nanotechnology in the past couple of decades has been taken to carry such promise is the enhanced, and in some cases unique, properties that products gain thanks to engineering at the nano-scale.

In contrast some commentators have claimed that the term nanotechnology implies a rather confusing lumping together of several distinct technologies (Drexler 2004). Others favour the plural term nanotechnologies (Weckert 2007) or subsuming nanotechnology under the umbrella term, converging technologies (see e.g. Roco & Bainbridge 2004; EC 2004). As the latter term emphasises, the real revolutionary force of nanotechnology might lie in its ability to interact with other fields such as biotechnology, information technology, and cognitive science, generating a wide range of different applications. Although I sympathise with these concerns, I will keep to the conventional term – nanotechnology – in what follows. I understand it to have a wide definition so as to include the combination and convergence of nanotechnology and other technologies\(^1\) as well as the assimilation of nanotechnology in future products or devices. Essay 1 gives some justification for why such a conceptualization of nanotechnology should inform the ethical discourse.

From the outset however, the focal point of the ethical debate on nanotechnology did not foremost concern its capacity to converge with other technologies. Instead the debate surrounding nanotechnology was initially provoked by the prospect that it might bring about some fairly spectacular scenarios of runaway nano-

\(^1\) In Essay 2 Hanson and I use the more specific term nanobiotechnology (NBT), to denote the specific convergence between nano- and biotechnology.
machines. In 1986, nanotechnologist Eric Drexler published *Engines of Creation*, *The Coming Era of Nanotechnology*. In retrospect, Drexler’s book rather inadvertently instigated more fear than hope in nanotechnology when it suggested the possibility of bottom-up self-replicating molecular manufacturing. It seems fair to say that the mainstream ethical debate was properly incited when Michael Crichton in 2002 elaborated some of Drexler’s ideas in the fiction novel *Prey*. Here the reader is confronted with a kind of “grey goo scenario” where so-called nanobots run amok creating predatory swarms that attack humans and threaten to take over their minds. A perhaps more reasonable basis for concern was the fact that a growing number of researchers were beginning to address the toxicological risks which humans and the environment might face with the increase of manufactured nanoparticles (see e.g. Colvin 2003; Hoet et al. 2004). This provoked not only a public but also royal concern about nanotechnology with the Prince of Wales calling for moratorium on nanotechnology research.¹

Partly in response to these worries, several influential governmental and non-governmental reports were commissioned on the risks, ethics, and societal implications of nanotechnology.² The academic and philosophical discussion over nanoethics was not late to follow. As Kjellberg and Wickson (2007) note, a marked peek in the field appears in 2004 with the release of the UK Royal Society report on nanotechnology and nanoscience; the academic journals *Hyle* and *Technoi* both devoting special issues on nanotechnology and ethics/philosophy; and the release of an important anthology on the subject (Baird et al. 2004). These reports and articles highlight a broad span of issues concerning health risks and occupational hazards, regulation, privacy in the application of nano-sensors and -chips, and emerging global equity problems. In March 2007, the burgeoning field received its own journal, *NanoEthics*, where the editor states the objective as follows: “to advance the examination of ethical and social issues surrounding nanotechnologies in a philosophically rigorous and scientifically informed manner” (Weckert 2007, p. 2).

This thesis contains three essays on nanoethics conceived as a philosophical field of applied ethics, a field of public participation, and of empirical investigation. Before introducing each essay, allow me to distinguish three interrelated themes that appear in the papers.

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¹ For an especially evocative account of the emergence of nanotechnology in the broader societal and cultural context in Great Britain, see Ball 2003.

² See for instance Roco et al. 2002 (USA); ETC 2003; European Commission 2004; Royal Society 2004 (UK); Teknologirådet 2006 (Denmark); Wood et al. 2006 (ESRC, UK).
Novelty

The above (very) brief history of the field describes concerns for nanoethics being largely ignited by the possibility of novel bottom-up manufacturing of nano-machines. Hence novelty has been at the heart of the debate over nanotechnology from the very outset. However, while the prospect of engineering matter from the bottom up with some accuracy is indeed a unique feature of the technology itself, one should at least not assume that this novelty is carried through to applications and to the receiving end; generating genuinely new ethical dilemmas for patients, consumers and policy-makers.

In fact in Essay 1 I argue that we lack a good reason to suppose that the novelty feature within nano-related engineering will be transposed to the societal and ethical domain. Indeed, Hanna Arendt claimed that while there is genuine novelty in scientific discoveries: “In the realm of ideas there is only originality and depth, both personal qualities, but no absolute, objective novelty” (1958[1958], p. 259). In Essay 1, I contend that rather than organise the nanoethical discourse around potentially unique emerging issues (e.g. Grunwald 2005), the discourse should concern whatever pertinent ethical issues may arise in the development, regardless if they are genuinely unique to nanotechnology.

Nor should the facilitators of public participatory activities prematurely delimit the agenda to the more novel issues that the technology may or may not raise. This has become a consideration for the scenario development of the convergence seminar (Essay 2) and MEI (Essay 3) methodology. Rather than try to artificially divorce nanotechnology from other technologies and societal processes, the scenarios and the methodology itself, embrace the fact that nanotechnology is prone to interact and reinforce other developments.

Uncertainty

Perhaps there is a sense in which ethicists nevertheless do face a rather novel situation with nanotechnology; namely in respect to the timing of the ethical debate. It is at least arguable that one faces an unprecedented opportunity to include the public in an early ethical discussion of the technology and its application (see following section). At the same time, researchers, decision-makers, and public alike face a very high degree of

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*That is of course not to ignore that, within what is referred to as nanotechnology, there is a great deal of top-down manufacturing at the nano-scale, which appears more like a natural progression from microtechnology.*
uncertainty about the implications of the technology and the impacts it might have on a rapidly developing modern society (Dupuy & Grinbaum 2004; Hansson 2004).

In Essays 2 and 3 my co-authors and I argue that for these and related reasons a traditional risk analysis is likely not to be applicable for nanotechnology and other emerging technologies, since the probabilities of different outcomes cannot be assigned and most relevant features are yet unknown or at least cannot be neatly distinguished. But while traditional risk analysis might not be useful, it would also be a mistake to take our current uncertainty as a reason to postpone all policy-making and ethical debate until more information is available. As is claimed in Essay 1, we should rather take the early attention given to nanotechnology as an opportunity to address what I call procedural ethical issues. For instance one might want to take present concerns for just access and distributed benefits as a reason to concentrate on establishing fair research priorities that will benefit those who are least advantaged (Rawls 1999[1971]). This might also justify attempts to focus on an early international harmonization within regulation. This is also in line with the advice that participants had in discussions at the convergence seminars reported in Essay 2 (see sections Research Priorities; Access, Distribution, and Equality; International Regulation).

Although uncertainty is a reiterated concern in the nanoethics literature, it is rarely brought up in the context of public participation. This is both surprising and unsettling. If we want to engage a broader public in this complex development it is neither fair nor helpful to give an impression that there are fixed outcomes or pre-established moral dilemmas to which we want public input. Instead one needs to find a reasonable procedure to assist decision-making and participation that is able to capture the uncertainty to some extent. This was also one of the main incentives behind the methodology of the convergence seminars that Sven Ove Hansson and I developed for our project described in Essay 2. The theoretical basis was in Professor Hansson’s ethical theory of hypothetical retrospect. This theory was within the structure of the convergence seminars, transformed into a practical decision-aiding method. It involved groups exploring different branches of future development, where each branch represented outcomes of alternative decisions. The groups then retrospectively evaluated the decisions according to their moral appraisal of the resultant branches of development (See Essay 2, section Theoretical Background to the Methodology, or for more details see Hansson 2007).
In using the convergence seminar methodology, Professor Hansson and I hoped to create a forum where participants could give their advice on morally justifiable decisions and regulations, in the face of the development of nanobiotechnology being highly uncertain. We also found it helpful for identifying relevant mid- and long-term ethical issues that could ensue from the development. Essay 3 goes on to suggest a systematic approach at the scenario-planning stage. Here the MEI methodology focuses particularly on the uncertainty inherent in the co-evolution between technology and society.

Public participation in technology development

There is a growing consensus that technology must integrate more public participation in its decision-making. Nanotechnology in particular has become a timely testing ground for further public involvement in shaping the technological trajectory (Gavelin et al 2007; Jones 2008). There are several moral reasons for further public involvement one might offer. Some were suggested by participants at the NBT convergence seminars themselves such as securing that nanotechnology would be beneficial to different members of society and in different parts of the world (see Essay 2, section Encouraging Public Debate and Deliberation). In Essay 1, it is suggested that such exercises may assist decision-making on crucial mid- and long-term ethical issues as they involve perspectives from a broader section of society.

Some reasons for more public engagement have more to do with historical circumstance. Nanotechnology arrived at a time where Europe and other parts of the world had faced heated public debate – often outrage – in response to the introduction of genetically modified (GM) crops and the BSE (mad cow disease) crises. Our convergence seminars also showed that these experiences were relevant to participants’ judgements of nanotechnology as they made several comparisons based on the GM debate, but also on what they felt were dubious practices in the pharmaceutical industry.

One should not be too hasty and dismiss these concerns as irrational comparisons. Despite there being obvious differences between nanotechnology and these other developments, many of the analogies that occur in argumentation may indeed be morally relevant. This seems especially true of objections that concern the structure and decision-procedures of the scientific and industrial institutions. Nor does it seem

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5 See Kitcher 2001 for an excellent discussion of the democratic governance of technology and science in general.
advisable to aim at mitigating public “misconceptions” or lack of confidence in nanotechnology by means of standard risk communication. Such activities often imply problematic asymmetries in communication and information about the risks (Hayenjhelm 2006). Hence they fall short of meeting the requirements for genuine public participation. Moreover, it would be particularly unfortunate to only produce a one-way information flow to the receiving public since many risks of nanotechnology are yet unknown, even to experts.

So how should engagement and participation from the public in nanotechnology development be realised? Certainly the considerable attention given to nanotechnology has itself stimulated the development of different participatory methodologies. A number of innovative projects have been performed in various countries during the past few years.⁶ Some of these methodologies including surveys, workshops, citizen panels, citizen juries, and focus groups are described within the wider scope of participatory technology assessment in Essays 2 and 3. Professor Hansson and I had our own opportunity to develop a participatory methodology within an interdisciplinary science and ethics project, NanoBio-RAISE, in order to gain public recommendations on nanobiotechnology development.⁷ The convergence seminars, mentioned in the previous section, were performed for the first time within this project and were held in four distinct regions of Europe. The process is described in Essay 2. These seminars do not represent an attempt to replace existing participatory methods. Instead it is suggested as a method that is particularly helpful for drawing attention to the high degree of uncertainty, which we argue cannot be neglected in the ethical assessment of nanotechnology.

The third essay expands on some of the ideas related to the convergence seminars within the methodology of multiple expertise interaction (MEI). The latter methodology also addresses some of the limitations that we found when using the convergence seminar method. First it provides a more thorough procedure for developing the scenarios under consideration. It also allows for the inclusion of a range of different actors in the scenario planning stage. As the name, MEI, indicates, the public is not merely included as receiving–end consumers, but as citizens capable of bringing their own expertise to the scenario-planning and decision-making table. Moreover while the methodology of the convergence seminars explicitly was developed to be non-resource-

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⁶ For helpful overviews of these projects see Lafitte & Joly 2008 and Gavelin et al. 2007.

⁷ For a description of the project and final report, see project website http://nanobio-raise.org/
consuming, the MEI methodology might be viewed as a more comprehensive model if there are more time and means available. One of our unexpected positive experiences with the convergence seminars is also integrated at the heart of the MEI. When conducting the convergence seminars we found that when some researchers in nano-related areas attended as members of the public – not merely as stakeholders – they claimed that this actually broadened their own understanding of the technological and societal process (see Essay 2, section Methodological Results).

Of course there is no consensus on the extent to which the public should be informed in the technological development or the influence they should have over the decision-making and regulatory process. To be sure, we are only beginning to discover what democratic governance of technology might be. The modest proposal within this thesis is that the public should at least be able to advice decision-makers and feedback into the development in a way that goes beyond consumer choice and dodging public backlashes. The hope is that the methodologies suggested in Essays 2 and 3 may be explored further for this purpose. Participants in our convergence seminars (2007) also emphasised that it is important that one creates a multitude of forums for promoting the curiosity of, and interaction, with the public. Moreover they recommended that the public receive as unbiased information as possible from research institutions and industry (see Essay 2, section Encouraging Public Debate and Deliberation).

Finally it is worth emphasising that most efforts to consult the public would be in vain if policy-makers, researchers, and funding institutions are not properly adapted to integrate public advice into their own decision-making.

Synopsis of the essays

Essay 1

This essay uncovers some relevant ethical issues of nanotechnology and offers recommendations of how to organise a discourse such as nanoethics. The first part of the essay is a critique of a tacit approach in the literature on nanoethics, namely of what is referred to as the uniqueness approach. The paper rejects this method first on the basis of the very nature of nanotechnology since it is highly likely that the success and impact of the technology is, or in the future will be, caused by the ongoing intertwining between nanotechnology and other fields of research, technology, and industry. Hence one should

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8 Incidentally, the results from our convergence seminars (2007) indicate that the participants themselves, while unanimously encouraging more public engagement, did not have a clear view on how this should be conducted and by whom (Essay 2, section Encouraging Public Debate and Deliberation).
not aim for a clear-cut division between ethical issues belonging to for instance biotechnology, ICT (information and communication technology), and nanotechnology.

The paper also argues against the uniqueness approach for the reason that it fails to reflect the uncertainty in, and public concern for, the development. At worst, it narrows in on issues that, while they might indeed be the most unique to nanotechnology, are far from the most pertinent ethical issues. This part of the paper concludes that while “uniqueness” may certainly be a justified concern for risk assessment of nanoparticles, the tactic is very unhelpful when it comes to investigating the ethical issues of nanotechnology.

The second more constructive part of the paper contends that an emerging technology such as nanotechnology indeed can affect the ethical discourse in other ways than by producing novel issues. Two distinctions within nanoethics are suggested. First the paper distinguishes between procedural ethical issues that occur within the regulation and decision-making of nanotechnology, and ensuing ethical issues that may arise once nanotechnology is applied to other technological fields and products. This distinction for instance allows us to better locate and address uncertainty in technological development. It also argues that concerns of trust, just access and distribution of nanotechnology should, contrary to what often occurs in the debate, be considered a procedural rather than issues arising as a result of the development. The second distinction runs across the first one and distinguishes between internal and external values in the research and development of nanotechnology.

I close by suggesting that both of these distinctions shed light on some central ideas involved in the call for further public involvement in nanotechnology and the development of participatory methodologies, such as described in essays 2 and 3. The first distinction gives two forms of ethical justification for public participation. By conducting public participatory activities we create a forum for early normative deliberation on ensuing ethical issues. At the same time we are going some lengths to ensure that procedural issues of justice and democracy are addressed in the development just by including different actors and gaining their advice. The second distinction might rather serve as a framework for the kind of discussion one might want the public to engage in. Does one on the one hand want to find criteria for risk acceptance, where for instance human health is largely considered to be an uncontroversial motive in the development? Or does one, on the other hand, want to invite the public in to a broader discussion on defining the core values of technology development should be?
Essay 2

The second essay is written by Prof. Sven Ove Hansson and myself and discusses the procedure and outcomes from our pilot European public participation project on nanobiotechnology (NBT). Participants were asked to advice NBT decision-makers at seminars held throughout 2006 in four distinct cultural regions of Europe: Visby (Sweden), Sheffield (UK), Lublin (Poland), and Porto (Portugal). The objective of the project was two-fold: (1) to test a new model for public participation, (2) to gain advice from the public that may inform decision-makers of NBT.

In this project we developed and used a new model for public participation called convergence seminars. The main reason for our developing the methodology was that we hoped it might address the uncertainty associated for instance with the development of NBT. The theoretical basis of the convergence seminars is a model of ethical decision-making called hypothetical retrospection originally developed by my co-author Professor Hansson (2007). In brief, the theory attempts to give guidance to ethically defensible decisions through looking at different possible future developments and making a moral assessment based on the actual moral values one has at the time of decision-making.

This theory was translated into a convergence seminar methodology with three different phases, where the term “convergence” refers to the converging structure of this seminar. During the first phase participants were divided into three “scenario groups” that discussed different future scenarios. These scenarios depicted different outcomes of NBT as it is applied to different areas, such as medical treatment and diagnostics, ICT, and environmental remediation. In the second phase the participants were regrouped into three “convergence groups”, each of which contained representatives from each of the groups in the first phase. In the third and final phase, all participants met for a moderated concluding discussion, giving an assessment of the different scenarios and advising decision-makers.

In spite of the wide differences among the participants in geographic, demographic, and professional terms, some views were widely expressed and supported at all four of the convergence seminars. It was agreed that the research priorities in NBT should be those that meet crucial societal needs, particularly as concerns the needs of the developing world. Participants generally agreed that NBT applications that target global environmental problems and benefit human health should be prioritised; novel consumer products and military applications should not.
Views were more divided on how much regulation is needed to curb unwanted developments. Some participants believed that a strong regulatory scheme is necessary as it deters malevolent use while others argued that regulation (and indeed bureaucracy) was required for insight into long-term impacts. In contrast some said that over-regulation would be a problem since it might imply a loss of potential benefits and would generate (economic) unbalances between countries. Most participants shared a concern to make the regulatory bodies robust and to strive for an international harmonisation.

Participants made comparisons with recent experiences with other technological, societal, and pharmaceutical developments where they felt that the objectives to create a cheap and accessible product had not been realised. The discussions in fact showed that the participants’ chief concerns for NBT were in the earlier stages of the development where decisions on research priorities and the structure of regulatory institutions would be made. Further public engagement in the different stages of NBT development was unanimously encouraged although there was some disagreement over who should be responsible for it.

We found that the methodology of the convergence seminars fulfilled its objective by giving rise to discussions on how today’s decisions should be influenced by different possible future developments. The responses the participants gave in discussions and questionnaires also indicated that their advice was influenced both by different possible future developments and by the points of view of their co-participants.

Professor Hansson and I worked together on developing the methodology and scenarios to fit the principles of hypothetical retrospection. I arranged the seminars along with very helpful contacts at each location and had the benefit of attending all of them, acting as a moderator at three of them. Though we collaborated closely in the analysis of the material from the seminar, Professor Hansson is mainly responsible for Theoretical Background and I am chiefly responsible for all remaining sections.

Essay 3

The third essay was written together with Sven Ove Hansson and Linda Johansson at the Royal Institute of Technology and Henrik Carlsen, Karl Henrik Dreborg, and Per Wikman-Svahn at the Swedish Defence Research Agency, as a result of an ongoing collaborative project Copetech.9

9 I thank all my co-authors for allowing me to include this article in this thesis. Copetech website: http://www.foi.se/FOI/Templates/ProjectPage___5734.aspx
This essay discusses some key methodological principles for guiding decisions on socially disruptive technologies. Nanotechnology, or at least some aspects of it, might be considered one of these technologies. The first section of the essay analyzes some basic features in assessing emerging, potentially disruptive, technologies. The interaction between technological development and social change is especially discussed. In some cases such a co-evolutionary process between society and technology might lead to a technology becoming socially disruptive, which is defined in the business and technology management literature as a technology that invents a new performance parameter. Roughly, this parameter represents a fundamentally altered use or application of technology that might not only be relevant for society but also for the subsequent technological development itself (e.g., digital camera, mobile phones etc.).

Drawing on this view of disruptive technological change, the essay suggests desiderata for a decision-guiding methodology in the form of four principles. First, several scenarios of society’s development should be taken into account. Second, these scenarios should explore co-evolutionary paths for society and artifacts based on the technology. Third, these co-evolutionary scenarios should be relevant from a policy perspective. They should highlight ethically and politically controversial issues and shed light on situations that demand a policy response. Finally, an assessment process should be designed for the involvement of different members of the public, technological experts, as well as persons experienced in the scenario methodology itself.

The essay then goes on to analyze existing assessment methods (e.g., technology assessment, technology road-mapping, scenario planning, and also convergence seminars) but we argue that they all fail to satisfy some or several of the principles suggested above. Instead a Multiple Expertise Interaction (MEI) process is suggested that attends to these requirements as well as integrates some methodological elements of the existing approaches, including: (1) interdisciplinary groups of experts that assess the internal development of a particular technology, (2) external scenarios describing how the surrounding world can develop in respects that are relevant for the technology in question, and (3) a participatory process, largely modeled on the convergence seminars.

My contribution to the essay falls into two parts. First, I participated in the theoretical discussion of socially disruptive technologies that became section 2 of the essay. Second, I contributed to the development and integration of the convergence seminars into a more comprehensive procedure.
References


