7 Stakeholder and public dialogue

7.1 Introduction

1 As has been seen for other technologies, such as genetically modified (GM) crops and food in the UK, public attitudes play a crucial role in the realisation of the potential of technological advances. A number of social and ethical issues have been outlined in Chapter 6 and, as will be seen below, through our research into public attitudes, which could valuably be addressed through stakeholder and public dialogue on nanotechnologies. In this chapter we consider current public awareness of nanotechnologies in Britain (based on market research commissioned for this study), discuss the value of public dialogue on new technologies, and examine possible mechanisms for future dialogue on nanotechnologies.

7.2 Current public awareness of nanotechnologies in Britain

2 There is currently very little research evidence available on public attitudes to nanotechnologies in the UK or elsewhere. A single quantitative item appeared on the 2002 Eurobarometer survey (Gaskell et al 2003), where over 50% of the sample answered 'don't know' when asked whether they thought that nanotechnologies would improve or make worse their way of life over the next 20 years. Of the remainder who did have an opinion, a clear majority felt that it would indeed improve their lives. However, the extremely high level of 'don't know' responses indicates very low general levels of awareness of the issue of nanotechnologies across Europe. A web-based survey conducted in 2001 in the USA jointly sponsored by the National Geographic Society and the National Science Foundation (Sims-Bainbridge 2002) found that 57% of respondents agreed with the statement that 'human beings will greatly benefit from nanotechnology, which works at the molecular level atom by atom to build new structures, materials and machines'. However, such a web-based sampling technique is inherently self-selecting in nature, drawing disproportionately from people who have ready internet access as well as those who are particularly interested in science and technology issues in the first place. Accordingly, it is impossible to extrapolate this result to attitudes among a sample of the general public. A further difficulty with both surveys is that we cannot know whether the responses obtained reflect genuinely considered beliefs about nanotechnologies, or a response to the questions based upon beliefs about the future impacts of technology more generally (where attitudes are known to be highly favourable). That is, neither survey gives us detailed information on how people might *interpret* a new development when it is described to them in some detail, something that is arguably more important as an indicator of the way in which public attitudes to nanotechnologies might develop in the future. Accordingly, BMRB International Ltd was commissioned by the Working Group to carry out preliminary research into levels of awareness of and attitudes to nanotechnologies with samples drawn from the general public. This research was both quantitative and qualitative, and comprised two strands (see BMRB 2004): (a) a representative national survey using three items; and (b) two in-depth workshops. Sections 7.2.1 and 7.2.2 outline BMRB's findings, as presented in its report to the Working Group.

7.2.1 Quantitative survey findings

3 The first strand was a three-question survey with a representative sample of 1 005 people aged 15 or over in Great Britain. This was designed to give a basic measure of awareness of nanotechnologies among members of the general public, establish whether those who had heard of it could provide any definition, and whether they thought it would have a positive or negative effect on quality of life. The questions used are shown in Box 7.1.

Box 7.1 The BMRB survey questions

The first question was asked of all 1 005 respondents

Q1. Have you heard of nanotechnology? (n = 1005)

If the respondent answered yes at question 1 they were then asked

Q2. What do you think nanotechnology is? (n = 262)

Finally, if a person said yes at question 1 and had not said don't know at question 2 they were asked

Q3. Do you think nanotechnology will improve our way of life in the next 20 years, it will have no effect, or it will make things worse? (n = 172)

4 As had been expected, there was limited awareness of nanotechnologies among the survey respondents.

5 In response to question 1, only 29%[1] of the survey respondents said they were aware of the term. Awareness was higher among men (40%) than women (19%), and was slightly lower for older respondents, falling from around one-third for those aged under 55, to one-fifth (20%) of those aged 65 or over. There was also a clear pattern by social grade, with awareness peaking at 42% of socio-economic group AB and falling to 16% of socio-economic group DE.

[1] *262 out of 1 005 respondents gave this response at the time of the interview, which is approximately 26%. However, the final data are weighted to the profile of all adults in Great Britain. This means that those 262 respondents represent more respondents (293) in the weighted data. In terms of the estimated percentage of all GB adults, this is 29%.*

6 At question 2, just 19% (172) of the survey sample could offer any form of definition. The most common centred on miniaturisation, or technology on a very small scale. Another frequent response relied on a particular application such as computing, electronics or medicine.

7 At question 3, the majority (68%) of those who were able to give a definition of the word felt that it would improve life in the future, compared with only 4% who thought it would make things worse. Thirteen per cent said unprompted that whether nanotechnology would make things better or worse depended on how it was used (despite the fact that this was not presented as an option on the questionnaire). This last finding is consistent with views presented in the qualitative workshops (discussed next), which also showed that participants' decisions about whether a technology is 'good' or 'bad' depends on what it is used for.

7.2.2 Qualitative workshop findings

8 The second strand of research consisted of two in-depth qualitative workshops with members drawn from a broad spectrum of the general public: one held in London (23 participants) and one in Birmingham (27 participants). The aim was to explore participants' ideas about and attitudes towards nanotechnologies, the everyday concepts that people might use to understand and interpret the technology, and to identify and discuss areas for concern and questions they might have. As expected (and congruent with the survey findings discussed above) prior awareness and knowledge of nanotechnologies among most workshop participants was limited. In anticipation of this, the nature of nanotechnologies was described as the workshops progressed, and participants could subsequently ask questions of a member of the working group who attended in the capacity of expert scientist[2]. The workshops also aimed to discuss the issue of the control and regulation of nanotechnologies.

9 The more in-depth exploration of respondents' views that was possible in the qualitative workshops revealed that, although there were major concerns about nanotechnologies, as with any new technology, there was also much that respondents thought was positive, or potentially so. However, it was also felt that nanotechnologies were very much untried technologies, and as such their potential benefits and drawbacks would only become clear over time.

10 The workshop participants were concerned about many aspects of nanotechnologies, including those outlined in Box 7.2. They felt that reassurances were necessary about the areas of concern, although the balance of concerns obviously varied from individual to individual.

Box 7.2 Aspects of nanotechnologies that caused concern in workshops

- Its financial implications: whether there would be an adequate return on any investment made by the UK; also whether the UK could afford not to invest; and who might make such an investment, and with what sort of hoped-for return;
- its impact on society: employment; social freedom and control; the position of the developing world in relation to industrialised nations; and the possibility of corporations gaining influence;
- whether or not nanotechnologies, and devices using it, would work: particularly for applications used within the human body;
- the long-term and side-effects of nanotechnologies: whether enough was being done to establish what these were, and whether or not lessons had been learned from the past (for example, from nuclear technology);
- whether nanotechnologies could be controlled: whether this could be done internationally as well as nationally; whether the public would be involved and whether they would be capable of making a contribution; also, whether the public's contribution to the debate would be listened to.

11 There was also much that participants in the workshops were positive towards. The key areas in which it was felt that nanotechnologies had a potential contribution to make, or which interested respondents, are listed in Box 7.3.

2 The scientist's role was confined to providing basic information on what nanotechnologies were, scenarios of possible developments in nanotechnologies, and then to be on hand to answer any questions raised by the group. The scientist did not take part in any other aspect of the moderating or running of the groups. The full methodology is described in BMRB (2004).

Box 7.3 Aspects of nanotechnologies that workshop participants were positive about

- The exciting nature of nanotechnologies: the sense that it was untried and, as such, had untapped potential, and an unknown number of ways in which humankind and individuals could benefit;
- the possible applications of nanotechnologies: respondents were particularly positive towards medical and, to a lesser extent, cosmetic applications;
- the possible creation of new materials, potentially being more useful and creating less waste;
- a sense that nanotechnology was a natural technological progression and that, in the future, arguments against nanotechnology developments will appear to be ridiculous;
- a hope that nanotechnology would improve quality of life, both through the creation of new products and new medical treatments.

7.2.3 Interpreting the research into public attitudes

12 In interpreting the findings from the survey and qualitative workshops, it should be borne in mind that both were exploratory exercises, conducted within the remit and financial resources available to the Working Group. They certainly should not be taken to represent a full exploration of current British attitudes to nanotechnologies. In addition, the findings should be interpreted in a British context only: no generalisations can be made from these data about public attitudes to nanotechnologies in other countries, particularly to cultural contexts outside Europe.

13 Several issues are, however, worthy of comment. The fact that awareness among the British population is currently very low (consistent with the 2002 Eurobarometer findings cited above) implies that much will hinge upon how attitudes to nanotechnologies are shaped over the next few years. In addition, when attempting to define this new development, the survey respondents made reference to other technologies with relatively positive associations (IT, medicines). This may well explain in part why the majority of those who could provide a definition also thought that nanotechnologies would improve the quality of life for people.

14 By contrast, in the qualitative workshops, where respondents deliberated the issues in greater depth, responses were more mixed and at times touched also upon issues with more negative connotations (such as nuclear energy and GM organisms)[3]. Four issues arising from the qualitative workshops can be placed in relation to what is already known about public perceptions of risk.

15 First, the need for informed and accessible commentary on, and consideration of, any long-term uncertainties associated with nanotechnologies. Uncertainty has potentially both positive and negative outcomes, as the workshop participants fully recognised. However, it is known to be a significant driver of public concerns about technological risks, particularly where doubts exist over future safety or environmental impacts. Uncertainty was identified as a key factor in some of the very first research into risk perception on nuclear energy, and subsequent studies of a wide range of risk issues (Royal Society 1992; Slovic 2000).

16 Second, questions over governance of nanotechnologies. Like the concerns over long-term uncertainties, these issues are not specific to nanotechnologies, but arise in public discourse about many other technological issues. It can be helpful to separate governance issues into two strands. The first involves the role and behaviour of institutions, and their abilities to minimise unintended consequence and adequately regulate. Such questions are not, as Wynne (2003) points out, the product of a mis-informed or 'irrational' public. Rather, they are legitimate questions touching upon areas of very real potential risk, albeit ones that are inherent to the way organisations and regulation operate, and as a consequence sometimes difficult to represent in formal quantitative risk assessments. Nor should such questions be seen as the product of views that are anti-science or anti-technology. Many people, as the current workshop findings also indicate, remain highly enthusiastic about the general impacts that science will have on their future lives (see OST/Wellcome 2000). A second strand (highlighted in Chapter 6) concerns the possible trajectories that nanotechnologies will follow as they develop: who can be trusted to ensure that these trajectories will be socially beneficial? Can the public play a role in determining which trajectories are realised? Such questions express genuine doubts that people have about the ethics, social uncertainties and future governance of the technologies. Such concerns are likely to be key ones that will arise in any dialogue process involving nanotechnologies.

17 Third, the enthusiasm that many workshop participants expressed for the possible ways that nanotechnologies would benefit their and others' lives. Perhaps not surprisingly, benefits are an important part (if not the only part) of the evidence that people weigh up, alongside perceived risks, when making a judgement about the acceptability or otherwise of a hazard that might impact upon them (Royal Society 1992).

[3] *It is important to recognise that the qualitative and quantitative research yield complementary findings, rather than one being in any sense more valid than the other. In addition, the total number of participants in the two workshops (n=50) may at first sight seem small compared with that of the survey (n=1005). However, this number is not untypical of qualitative social science research into risk attitudes, where the main objective is to explore the views of a group of people in depth, rather than gather a statistically representative sample of opinion. For example, the recent 'narrow-but deep' component of the UK GM Nation? public debate (Public Debate Steering Board 2003) involved 77 participants, selected as here to represent a cross-section of lay views.*

18 Fourth, BMRB (2004) also report that there was some mention in the workshops of ethical concerns over 'messing' with the building blocks of nature, in part in response to suggestions of scientists manipulating matter at the atomic level to create entirely new materials. An analogy was also drawn here by some workshop participants between nanotechnologies and GM. We know from both quantitative and qualitative risk perception research that this issue is one determinant of uneasiness over biotechnology (Grove White et al 1997; Gaskell et al 2000; Marris et al 2002) and other issues such as radioactive waste and nuclear energy (Sjöberg 2000). It follows that, not only does the potential exist for nanotechnologies to be stigmatised by such general association, but also some specific applications (as in the production of entirely new materials or properties, material/biological systems or organisms) are likely to raise significant ethical dilemmas.

19 In summary, awareness of nanotechnologies is currently low among the British population. In addition, the workshops reported here represent the first in-depth qualitative research on attitudes to nanotechnologies in the published literature, as far as we are aware. Their findings, although limited, provide a valuable indication of some of the wider social and ethical questions that ordinary people might wish to raise about nanotechnologies both now and in the future. Accordingly, **we recommend that the research councils build on the research into public attitudes undertaken as part of our study by funding a more sustained and extensive programme of research into public attitudes to nanotechnologies. This should involve more comprehensive qualitative work involving members of the general public as well as members of interested sections of society, such as the disabled, and might repeat the awareness survey to track any changes as public knowledge about nanotechnologies develops.**

7.3 Importance of promoting a wider dialogue

20 It would be easy to argue that the assessment and control of the impacts of nanotechnologies – as a highly technical and complex subject – should be an expert-led process, restricted primarily to the peer community of scientists and engineers within academia, industry and government. However, the discussion in Chapter 6, as well as the results of the public attitudes research described above, indicates that some of the social and ethical concerns that certain applications of nanotechnologies are likely to raise stretch well beyond the basic science or engineering of the matter. In this respect, we are in broad agreement with the Better Regulation Taskforce (2003), which has recommended that the government communicate with, and involve as far as possible, the public in the decision-making process in the area of nanotechnologies. This view is also in line with that of the European Commission, set out in their Communication 'Towards a European Strategy for Nanotechnology' (EC 2004a), in which coherent action 'to integrate societal considerations into the R&D process at an early stage' is endorsed.

21 In addition, several recent UK reports have recommended that scientists and policy makers engage in dialogue with interested parties about science and technology issues (House of Lords 2000; POST 2001), risk (Cabinet Office 2002; National Consumer Council 2003) and the environment (Royal Commission on Environmental Pollution 1998; Environment Agency 2004). In this respect, the events surrounding the bovine spongiform encephalopathy (BSE) crisis in the 1990s marked a turning point in the way UK science policy and risk assessment practice is viewed. The House of Lords Science and Technology Committee in particular, in its report on Science and Society, recommended 'That direct dialogue with the public should move from being an optional add-on to science-based policy-making and to the activities of research organisations and learned institutions, and should become a normal and integral part of the process.' (House of Lords 2000). Its rationale was that a crisis of trust had arisen in certain areas of UK science policy-making. To regain public trust, it recommended greater openness and transparency about science policy and scientific uncertainties. This assertion did not go unchallenged. O'Neill (2002) has argued that the evidence is not clear that the so-called crisis of trust is a response to greater untrustworthiness of officials in the UK: rather, many statements of mistrust might actually reflect a climate of suspicion, partly fed by media reporting of issues.

22 Dialogue with a range of stakeholders about risks also holds an increasingly important place in the work of many of the new advisory and regulatory bodies set up in the UK in the wake of BSE, such as the Food Standards Agency, the Agriculture and Environmental Biotechnology Commission, and the Human Genomics Commission. Dialogue-based processes have also been extensively used for addressing environmental and risk decision-making across Europe (Renn et al 1995) and the USA (Beierle and Cayford 2002). The Royal Society is undertaking its own dialogue initiatives through its 5-year Science in Society programme (see Royal Society 2004b). The aims of this programme are captured by the President of the Royal Society, in his 2001 Anniversary Address: 'Society needs to do a better job of asking what kind of tomorrow we create with the possibilities that science offers. Such decisions are governed by values, beliefs, feelings; science has no special voice in such democratic debates about values. But science does serve a crucial function in painting the landscape of facts and uncertainties against which such societal debates take place'.

23 The general case for wider societal dialogue about novel technologies, and with it greater openness about science policy, rests upon three broad sets of argument. Fiorino (1990) characterises these as normative, instrumental and substantive. The normative argument proposes that dialogue is a good thing in and of itself and as such forms a part of the wider democratic processes through which controversial decisions are made. The normative argument suggests, in particular, that it is important to make decisions sensitive, as far as is possible, to the ethical and value concerns of directly affected groups or populations. The instrumental argument suggests that dialogue, as one means of rendering decision-making more open and transparent, will increase the legitimacy of decisions and through this generate secondary effects such as greater trust in the policy-making process. Many of the arguments in the 2000 House of Lords Science and Society report focus upon the issue of the legitimacy of risk regulation and science. Finally, the substantive argument is that dialogue will help to generate better quality outcomes. In the field of environmental risk, non-technical assessments and knowledge have been shown to provide useful commentary on the validity or otherwise of the assumptions made in expert assessments (Wynne 1996; Yearley 2000). For upstream issues, where high levels of uncertainty exist, there may be particular benefits to opening up the risk characterisation process to a wide range of differing perspectives (Funtowicz and Ravetz 1992; Stirling 2004). The aim here is to avoid an overly narrow framing of the problem, through giving consideration to as full a range of impacts as possible, including potential 'shocks and surprises', many of which may not, initially at least, be open to formal quantitative analysis.

24 A US National Research Council report on Understanding Risk (Stern and Fineberg 1996) develops a detailed set of proposals for risk characterisation. They define the resultant analytic–deliberative process as combining sound science and systematic uncertainty analysis with deliberation by an appropriate representation of affected parties, policy makers and specialists in risk analysis. According to the authors, dialogue and deliberation should occur throughout the process of risk characterisation, from problem framing through to detailed risk assessment and then on to risk management and decision implementation. Likewise, the Royal Society's report on risk (Royal Society 1992) argued that the evaluation of whether a risk is tolerable or not involves judgements both about basic statements of fact (what types of harm might we run, and with what likelihood) as well as values (what level of a particular harm should we run). Even the basic statements of fact used in a risk assessment can be critically sensitive to 'framing' assumptions (that is, decisions about what factors to include or exclude, as necessary, to structure a risk assessment model). For example, probabilistic risk assessments have particular difficulty in accommodating the human and organisational causes of major technological accidents and failures, even though evidence from case histories shows that these are the principal determinants of major failures in complex engineered systems (Blockley 1980; Vaughan 1996; Turner and Pidgeon 1997). The National Research Council report argues here that failure to attend to dialogue at the early stages of framing the problem can be particularly costly, for if a key concern is missed in subsequent analysis the danger is that the whole process may be invalidated. As we argue below, the issue of framing is particularly relevant to the upstream nature of the debate on nanotechnologies, and the case for stakeholder dialogue at the present time.

25 Although there is clearly a considerable momentum in the UK and elsewhere to engage in dialogue over science and technology issues, this should not be viewed uncritically. A first challenge concerns defining who might be involved. A useful distinction in this regard can be made between 'stakeholders' and 'the public' as follows: 'the term, stakeholder refers to organized, official and defined interested parties in any decision, such as NGOs, environmental groups, industry, regulators. The term public refers to individuals and communities who have an interest or stake in an issue but who may be less organized and less easily defined and identified' (Petts 2004).

26 This distinction is particularly important when designing engagement processes, for who needs to be involved will depend upon the objectives of dialogue, and in turn will have a direct bearing upon the expected outcomes, their efficacy and legitimacy. For many issues even the category 'the public' should not be viewed as a single undifferentiated entity, particularly in terms of attitudes towards risk (Royal Society 1992). And as noted in Chapter 6 of the current report, with nanotechnologies special interests might lie with very specific groups in society such as those who suffer from particular disabilities or health problems.

27 Other difficulties with dialogue processes arise because, as Okrent (1998) points out, we do not yet know enough about the practicalities and impacts of using analytic–deliberative processes. One reason for this is that systematic evaluation of dialogue processes and their outcomes remains relatively uncommon, being difficult and expensive to do properly, and often not recognised as important by sponsors at the outset of the process of dialogue. In addition, a number of technical and institutional/cultural barriers, such as regulatory fragmentation (which may preclude discussion of all relevant issues if these fall outside the sponsor's legal remit), may thwart effective implementation of an otherwise well-intentioned and planned dialogue process (Petts 2004).

7.4 Nanotechnologies as an 'upstream' issue

28 Most developments in nanotechnologies, as viewed in 2004, are clearly 'upstream' in nature. There are at least three senses in which this is so: regarding current decisions, impacts and public acceptance, respectively.

29 First, many of the significant decisions that will affect the future trajectory of the technology, concerning research funding and R&D infrastructure, have yet to be made. As discussed in sections 6.3 and 7.2.3, one driver of the current concerns among NGOs (Arnall 2003; ETC 2003a) is a scepticism over whether the technology will be shaped in such a way that its outcomes will genuinely benefit society, the environment and people (particularly in the developing world) as is sometimes claimed. A timely and very broad-based debate might therefore focus upon which trajectories are more or less desirable, and who should be the ultimate beneficiaries of public sector investment in R&D, before deeply entrenched or polarised positions appear. Mehta (2004) argues that in the Canadian context the failure to consult the public early over biotechnology has led to several difficulties in the regulatory process, while Mayer (2002) also points out that the problematic issues that heralded the advent of biotechnology in the 1970s and 1980s did not go away, and that the participative technology assessment methods only now being developed for biotechnology might be usefully deployed in the upstream phase of nanotechnologies.

30 Second, as also noted in Chapter 6, many of the social and ethical impacts of nanotechnologies are yet to be envisioned, remain hypothetical, or will depend upon nanotechnologies' convergence with other technologies. Only over the medium (5–15 years) or far longer (more than 20 years) term will its precise outcomes and associated ethical implications become clear. Achieving meaningful dialogue today will therefore set several difficult challenges: to separate current hype from what is realistically achievable with the technology; to provide good-quality information on likely impacts; and to scope fully the potential sources of uncertainty. In turn, very specific applications might raise unanticipated social or ethical questions only well into the future or when the technology has reached a mature stage of development.

31 Finally, in terms of public acceptance, the research presented above illustrates that nanotechnologies have yet to gain any major place in public discourse in Britain, with awareness of the technology among the general population being extremely low. Although this has the potential to change rapidly, research on the factors that lead to risk issues becoming amplified or attenuated in public discourse shows that this rarely depends upon any single factor operating alone. Rather, this depends upon the combined impacts of a range of factors accumulating over time. These include: the balance of perceived benefits between individuals, private and the public sectors; analogies drawn with other (both stigmatised or accepted) technologies; patterns of media coverage; position of campaigning groups; the existence of significant scientific dispute; and attribution of blame for prominent 'accidents' were these to occur (Pidgeon et al 2003).

32 Viewing nanotechnologies in upstream terms suggests that lessons can and should be learned from the history of other similar technological innovations. Mayer (Mayer 2002) argues that the development of all major technologies should be viewed as social processes, and that framed in this way there are clear parallels to be drawn between nanotechnologies today and the position that biotechnology faced in the 1980s. Similarities include the levels of excitement and hype, a promise to control the future without critical consideration first of which futures are desirable and who might ultimately control them, and narrowly framed debates about risk issues not encompassing wider social and ethical issues. One can also draw parallels between nanotechnologies today and the nuclear energy industry in the 1950s. Wynne (2003) argues that a particular difficulty with the early history of that industry, unanticipated at the time, was that the over-optimistic early claims made for the technology laid the foundations for the deep public scepticism and opposition that was to emerge much later in the 1970s.

33 Ultimately, it is difficult at this stage to judge whether, and which, applications of nanotechnologies will necessarily prove more or less difficult than nuclear power, GM or any other controversial technology (although Chapter 6 and the research into public attitudes discussed above outlines some of the potentially sensitive issues). One can make the argument that with many of these more mature technologies public dialogue has typically arrived too little too late, only being seen as an optional 'add-on' when the decision-making surrounding an issue (for example, radioactive waste siting) has become pressing, difficult or uncomfortable for regulators or governments. Under such circumstances the existence of highly polarised positions can make it very difficult, if not impossible, to take any real dialogue forward.

7.5 Designing dialogue on nanotechnologies

34 We have reviewed, and are in broad agreement with, a number of submissions and papers that have argued for wider public dialogue and debate about the social and ethical impacts of nanotechnologies. However, the evidence presented to us also suggests that specifying the precise forms of such dialogue will be no simple matter. The objectives of dialogue, alongside who needs to take part, are likely to vary over time as the issues with nanotechnologies evolve. Equally, the methodologies available to meet dialogue objectives vary widely. Given that nanotechnologies are

likely to pose a wide range of issues (for example, regarding strategic direction and investment, specific applications, or convergence with other technologies) there is no single method to draw upon. Rather, dialogue methods must be designed specifically around the objectives at hand at any point in time.

35 Renn et al (1995) distinguish between three broad classes of citizen participation: genuine deliberative methods which allow for fair and competent debate and discussion between all parties, such as consensus conferences, citizens' juries and planning cells; traditional consultation methods, including public meetings, surveys, focus groups, and mediation, where there is little or no extended debate; and referenda, in which people do have democratic power but which are not generally deliberative in nature.

Box 7.4 Possible Approaches to dialogue

- Participatory and/or constructive technology assessment with stakeholders, particularly that which takes account of the dynamic interrelations between society and the development of nanotechnologies (see, for example, Rip et al 1995).

- Scenario analysis with stakeholders to identify significant uncertainties that might emerge with nanotechnologies. For example, the GM 'shocks and surprises' seminar organised by the Cabinet Office (2003).

- Direct public engagement such as citizen juries or panels for identifying at an early stage broad 'desired futures' for nanotechnologies, significant ethical concerns, or the acceptability of key applications and options. The quality of scientific and other input to such public engagement activities is critical to their success.

- Decision analytic methods draw upon more formal approaches for framing problems, as well as for identifying preferred options and their attributes (see, for example, Stirling and Mayer 1999; Arvai et al 2001)

- Multi-stage methods, which combine different approaches to framing, option appraisal and final choice in a sequence of linked activities, often with different groups of stakeholders and the public at various stages (see, for example, Renn 1999)

- Research into public attitudes, both qualitative and quantitative, to generate good quality 'social intelligence' (Grove White et al 2000) about nanotechnologies and public concerns.

36 Although referenda are not a typical engagement mechanism in the UK (unlike some other European countries such as Switzerland), government and other organisations have used various forms of traditional consultation on science and technology issues in the past, while consensus conferences occurred in the UK in 1994 for plant biotechnology (POST 1995) and in 1999 for radioactive waste management (UKCEED 1999). A useful summary of dialogue processes has been produced by the Parliamentary Office of Science and Technology (POST 2001); Box 7.4 lists some possible approaches.

37 Often dialogue processes need to be multi-stage (Renn 1999): that is, involving different participants and methodologies at different points in time. The GM Nation? public debate on the commercialisation of agricultural biotechnology, held in the UK in 2003, is a case in point in multi-stage design. GM Nation? had three main engagement components: initial issue framing (or foundation) workshops with randomly selected members of the general public were followed by a series of open activities (public meetings, interactive website) to which anybody could contribute, and finally a set of closed 'narrow-but-deep' groups, again comprising randomly selected members of the public (Public Debate Steering Board 2003).

38 Experience with GM Nation? (Horlick-Jones et al 2004) and deliberative processes elsewhere highlights several key requirements that any dialogue process involving nanotechnologies must meet and which we recommend. First, dialogue and engagement should occur early, and before critical decisions about the technology become irreversible or 'locked in'. Second, dialogue is not useful in and of itself, but has to be designed around specific objectives. Accordingly, clarity at an early stage about the objectives for dialogue is essential. Third, at least some form of commitment from the sponsor (typically government or some other agency) to take account of outcomes is required when commissioning dialogue processes: otherwise why should organisers and participants bother? Fourth, stakeholder and public dialogue should be properly integrated with other processes of technology assessment for nanotechnologies, as and when they occur. For example, the 2003 GM Nation? public debate was conducted in parallel with, and in part provided inputs to, both a science review of GM agriculture and an economic analysis of its costs, benefits and associated uncertainties. Finally, and not least, any dialogue process should be properly resourced, including the means for systematic evaluation (see also Petts 2004). Providing proper resources for dialogue processes is not a trivial matter, and one that Government should consider very seriously. The 1999 UK nuclear waste consensus conference costs were in the order of £100,000 (POST 2001), while the overall costs for the GM Nation? public debate totalled

£650,000 (Public Debate Steering Board 2003). Such costs, although at first sight large, must be viewed in relation to the far greater potential economic and social costs of getting decisions about investments in major areas of nanotechnologies wrong at this stage.

39 As discussed above, many of the issues currently surrounding nanotechnologies are 'upstream' in nature, providing a real opportunity for engagement to be designed in early. However, it seems likely that the precise requirements and objectives for such forms of engagement are much more difficult to specify, compared with the 'downstream' issues with which the UK has more experience. Accordingly, at the moment, we believe that we can only indicate generic areas of need. In the sections below we have applied the five generic objectives of dialogue and public participation mechanisms that have been proposed by Beierle and Cayford (2002) to nanotechnologies.

7.5.1 Incorporating public values in decisions

40 For nanotechnologies, decisions will need to be sensitive to public values where significant ethical issues arise. For example, the concerns raised in Chapter 6 about the nano-divide and the future trajectory of the technology suggest such a need. Similarly, some of the issues associated with the convergence of nanotechnologies with other technologies, and in particular developments in bio-nanotechnologies, are likely to raise novel ethical questions in the future requiring wide public debate. This in turn suggests a requirement for periodic reflection on possible emerging ethical questions, and initiating appropriate forms of dialogue with stakeholders or the public as appropriate, as the technology matures and its tangible applications become clearer.

7.5.2 Improving decision quality

41 The arguments above suggest that for upstream issues such as nanotechnologies the quality, as well as the acceptability, of initial decisions will depend heavily upon achieving appropriate framings for risk and technology assessments at an early stage. In particular, framing needs to incorporate both social as well as technical outcomes and concerns. Two important issues here, suggested by the research into public attitudes, would appear to be first the governance of nanotechnologies (who is to control and regulate nanotechnologies, and ensure that socially desirable goals can be identified and delivered), and second the long-term uncertainties. At a more operational level one could envisage the introduction of specific applications being accompanied by forms of stakeholder engagement on a case-by-case basis: one obvious issue would be to explore labelling requirements that people wish to see for specific classes for products, another the privacy implications of developments in sensing devices.

7.5.3 Resolving conflict

42 Unlike with some other issues of more mature technologies, nanotechnologies have so far not generated significant levels of conflict between stakeholders. However, as applications emerge and decisions are made, this situation might well change. The hope expressed in evidence submitted to the group is that methods for upstream deliberation may help society to find appropriate resolutions for potential conflicts in advance, by better anticipation of sensitive issues.

7.5.4 Improving trust in institutions

43 Although we note above some of the difficulties surrounding current discourses about openness and trust, a process of early debate and dialogue would signal to people a commitment by the UK Government, with the science and technology community, to a measure of transparency in the future development of nanotechnologies.

7.5.5 Informing or educating people

44 This is a particularly critical objective, given the upstream nature of most nanotechnologies. At a broad societal level there is a need for a mature debate that can discriminate between the many (and we note sometimes exaggerated) claims for the technology. However, information provision has to aim at more that just 'educating' the public as a presumed means of avoiding controversy, a view embedded in the so-called 'deficit model' of much traditional public understanding of science and science communication practice (Irwin 1995). Meeting such an objective has proven unrealistic time and again: in particular because people resent or resist attempts at direct manipulation, greater knowledge does not necessarily bring greater acceptance of risks, and one-way communication without genuine dialogue about science issues may not address people's wider concerns (see Wynne 2003). The ESRC report on nanotechnology (Wood et al 2003) makes clear that some current commentary on social science and nanotechnologies runs a similar risk of assuming an unproblematic relationship between the role of communication and technology acceptance. Moving beyond the deficit model will require more innovative approaches to information provision, ones that involve a genuine two-way engagement between scientists, stakeholders and the public. The development and incorporation of good-quality, independent scientific information will also be central to the success of any analytic–deliberative process, such as a citizens' jury or public debate, that is adopted for nanotechnologies, as well as the design of appropriate health communications for individuals potentially exposed to nanoparticles and other materials in the workplace (see Cox et al 2003).

7.6 Conclusions

45 As has been seen with GM crops and food in the UK, public attitudes can play a crucial role in the realisation of the potential of technological advances. The research into public attitudes that we commissioned indicated that awareness of nanotechnologies among the British population is currently very low, which implies that much will depend on how attitudes to nanotechnologies are shaped over the next few years. Many of the participants in the qualitative workshops were enthusiastic about the possible ways that nanotechnologies might benefit their lives and those of others. However, reassurances were sought for long-term uncertainties about the possible impact of nanotechnologies, and analogies were made with issues such as nuclear power and genetic modification. Concerns were also raised about the role and behaviour of institutions, specifically about who can be trusted to ultimately control and regulate nanotechnologies.

46 The qualitative workshops reported here represent the first in-depth qualitative research on attitudes to nanotechnologies in the published literature, as far as we are aware. They provide a valuable indication of the wider social and ethical questions that ordinary people might wish to raise about nanotechnologies, but they were by necessity limited. We have therefore recommended that the research councils fund further and ongoing research into public attitudes to nanotechnologies that will in turn inform future dialogue work.

47 The upstream nature of most nanotechnologies means that there is an opportunity to generate a constructive and proactive debate about the future of the technology now, before deeply entrenched or polarised positions appear. Our research into public attitudes highlighted questions around the governance of nanotechnologies as an appropriate area for early public dialogue.

48 We recognize that dialogue on nanotechnologies is likely to be taken forward over the next few years in a diversity of ways, and by a number of parties (not only Government). We welcome this and the opportunity that diverse activities are likely to present to identify best practice in public dialogue, and not just as applied to nanotechnologies.

49 We see an additional and important role for Government in supporting early stakeholder and public dialogue about nanotechnologies. A current particular strategic need is to ensure that the framing for subsequent public debate and technology assessments is drawn as widely as possible. This is particularly true for some of the governance questions highlighted in the research into public attitudes and in wider evidence, which would be appropriate for early public dialogue. Therefore, **we recommend that the Government initiates adequately funded public dialogue around the development of nanotechnologies. We recognise that a number of bodies could be appropriate in taking this dialogue forward**. For example, were issues about governance of nanotechnologies to be the subject of initial dialogue, as we suggest in this report, the research councils might be asked to take this forward as they are currently funding research into nanotechnologies. Others that could be appropriate to take forward, or co-sponsor, such dialogue include organisations such as the British Association for the Advancement of Science, the national academies, and major charities with experience of public engagement processes. Industry should also be encouraged to sponsor public dialogue. An example of this from 2003 was the citizens' jury on GM crops jointly convened by Unilever, Greenpeace, the Consumers Association and the Co-op in 2003. As noted above, the precise means of dialogue would need to be designed around specific objectives to be agreed by an independent steering board comprising a range of relevant stakeholders and experts in public engagement. Dialogue must be adequately funded (for example, a properly conducted citizens' jury or consensus conference would require minimum funding of the order of £100,000–£200,000) and properly evaluated, so that good public dialogue practice can be built on.