Democratic technologies?

The final report of the Nanotechnology Engagement Group (NEG)

Karin Gavelin and Richard Wilson
with Robert Doubleday

.involve

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Contents

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About Involve

Involve is a not-for-profit organisation specialising in understanding public engagement in all its forms. The organisation was set up by a number of leading practitioners and researchers in the public participation field and is chaired by Geoff Mulgan.

Involve provides advice, training, research, events and networking services to organisations and individuals interested in public participation. The organisation focuses on the practical reality of public participation and has four core activities:

— **Advocacy** building the case for genuine citizen empowerment
— **New Thinking** improving understanding of what works in public engagement
— **Better Practice** supporting institutions and citizens to engage effectively
— **Networking** bringing people from the participation and empowerment field together

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About the authors

Karin Gavelin is a researcher at Involve. She joined the organisation in 2006 to project manage the NEG. Her other work includes writing a Guide to Consumer Engagement for the Food Standard Agency and researching attitudes to public engagement in the civil service for the Sustainable Development Commission. Prior to joining Involve, Karin worked for the Scarman Trust.

Richard Wilson is the Director of Involve. He currently advises among others the BBC, Department of Health, Scottish Executive and the Welsh Assembly on their public participation strategies. Richard is also the Deputy Chair of Sciencewise, the OSI's public engagement scheme. He is a leading figure in the UK public engagement field who has written and spoken widely on the subject at home and abroad.

Robert Doubleday is a research associate at the Department of Geography, University of Cambridge. His work focuses on the social dimensions of science and technology, and collaborative approaches to including social reflection in science policy and practice. Robert's recent work includes coordinating the Cambridge Nanoscience Centre's role on the NanoJury UK and on the Nanotechnology Engagement Group (NEG). He is also founding member of the International Nanotechnology and Society Network and has given numerous talks and published journal articles in science and technology studies.

Foreword

Over the last few years, we have seen nanotechnology emerge as a focus for a variety of hopes and fears. Some are excited by the possibility that nanotechnology may be a new driver of economic growth or that it may help address pressing societal problems. Others fear that further environmental degradation and new health risks are more likely consequences. It is often not even clear or generally agreed what is meant by nanotechnology, an uncertainty that is reflected in the frequent use of the plural 'nanotechnologies'. What does seem to be less disputed, however, is that nanotechnology is essentially a goal-oriented activity. And, as soon as one talks about goal-oriented science, the question immediately follows: 'whose goals?' The aim of public engagement is to create a two-way dialogue about these issues, with the aspiration of making sure that the goals of the scientific enterprise are closely aligned with society's broader values.

To scientists like myself, these new concerns can seem unfamiliar, and even threatening, as discussions move away from questions defined by purely technical knowledge to ones revolving around values. In public engagement exercises of the kind looked at in this report, scientists have faced the challenge of stepping away from narrowly defined disciplinary expertise, and having some of our untested assumptions and conventional wisdoms challenged. Yet, to me, and to many other scientists, the experience has been very positive.

This report summarises the experiences of public engagement on nanotechnologies that have taken place over the last few years. The story isn't straightforward; there have been difficulties. Different groups have had expectations that were not aligned, and the uncertain nature of the subject itself has sometimes

made it hard to focus the discussions. For some, the aspirations they had for the processes have not been immediately fulfilled. Nonetheless, I believe that the activities outlined in this report are just the start of a very positive movement that seeks to answer a compelling question: how can we ensure that the scientific enterprise is directed in pursuit of societal goals that command broad democratic support?

Professor Richard Jones
NEG Chair and Professor of Physics at Sheffield University

Executive summary

This report presents the findings of the Nanotechnology Engagement Group (NEG). The NEG was established in 2005 to document the learning from a series of groundbreaking attempts to involve members of the public in discussions about the development and governance of nanotechnologies.

These experiments emerged in response to a growing awareness in government and in society of the need to create a more constructive and trusting relationship between science and society. After the tensions and public debates in the 1990s about bovine spongiform encephalopathy (BSE) and genetically modified (GM) crops, it was widely acknowledged that government needed to reconsider its approach to science and science governance. For the public to have confidence in science decision-making, policy-makers and regulators would have to change their approach to risk and risk communication, and become more responsive to the public's needs and aspirations for science and technology. Moreover, they would have to provide opportunities for the public to have a say early on in research and development, when there was still scope for the public's views to inform the development of new technologies. This notion of early-stage public engagement in science and technology became known as upstream engagement.

The activities documented in this report are the latest of a long series of initiatives to revive the relationship between science and society. This particular chapter began in earnest three years ago, with the publication of the Royal Society (RS) and Royal Academy of Engineering's (RAE) report 'Nanoscience and Nanotechnologies: opportunities and uncertainties'. The report called for

public dialogue early in the development of nanotechnologies, thus making nanotechnologies a test case for new ideas about upstream engagement.

The NEG studied six UK projects that sought to engage members of the public in dialogue about nanotechnologies. Our research has found that upstream public engagement in science and technology can produce impressive results:

— It can generate valuable messages about public concerns and aspirations, or open up new lines of questioning and debate. Such messages can contribute to **making science policy and research better informed and more aligned with public needs and aspirations**.
— It can open up science funding and policy structures to public scrutiny and debate, thus helping to **make science governance more transparent**.
— It can create space for scientists and decision-makers **to reflect on the wider, social implications of their work**, thus helping to **put science into context**.
— It can give public participants new knowledge and skills to engage with science and policy issues that affect them, thus creating **active citizens who are more scientifically aware**.
— It can help **overcome negative preconceptions and cultural barriers** between scientists, members of the public, and decision-makers, which can lead to greater appreciation among members of the public for the realities of science policy and research, and to greater appreciation among scientists and decision-makers of the ability of non-scientists to contribute meaningfully to science and policy discourses.

We have also identified some challenges for public engagement in science and technology, including:

— Creation of meaningful connections between public engagement and institutional decision-making.
— Lack of understanding and appreciation in decision-making institutions and science communities of the different impacts and benefits that public engagement can deliver.
— Lack of capacity and interest in public engagement within decision-making institutions and science communities.
— A need to distribute the benefits and impacts of public engagement among more people.

NEG recommendations

Here, we summarise the NEG's recommendations that have emerged from this study[1].

Recommendations for science policy (SR)

SR1 Government should spend money on nanotechnologies provided that priority is given to funding research and developments that contribute to a wider social good, such as new medical innovations and sustainable technologies.

SR2 Government should continue to identify the potential risks of nanotechnologies and nanomaterials, and create new regulation and laws for labelling based on such research.

SR3 Government should take steps to ensure that the governance and funding of nanotechnologies is made more transparent:

- **a** By the creation of maps to show how responsibilities for the regulation and funding of new and emerging areas of science and technology are distributed across the public sector.
- **b** By the publicising of information about the spending of public money on new and emerging technologies.
- **c** By striving to be open about uncertainties in science and science policy.

Recommendations for public engagement policy (PR)

PR1 A comprehensive Impacts Assessment Framework for public engagement in science and technology to be agreed by Department for Trade and Industry (DTI), Department for the Environment, Food and Rural Affairs (Defra), Research Councils UK (RCUK), and other stakeholders (including public engagement organisers and members of the public) for wide dissemination in government and other institutions that are affected by public engagement in science and technology.

PR2 Establish clarity among funders, organisers and participants on the purpose of a public engagement initiative, and create strategies to meet those needs.

PR3 Institutional staff involved in funding or responding to public engagement activities to allocate sufficient time and resources to engage directly with the activities at every stage of the process.

PR4 Institutions to respond formally to public engagement processes (within a reasonable timeframe) to explain what they are, and are not, taking forward and why.

PR5 Decision-making institutions to offer tailored support such as training, coaching, and mentoring of staff who are involved in, or affected by, public engagement activities.

PR6 Decision-making institutions to pilot action-learning networks to share and maintain capacity internally.

PR7 Public engagement to be included as a course at the civil-service college.

PR8 Scientific institutions to formally recognise public engagement.

PR9 Science-funding bodies to stress the importance of dialogue-focused public engagement, alongside one-way engagement approaches such as public lectures.

PR10 Organisations funding or delivering public engagement to explore new tools for communication of public engagement outputs and outcomes to large and diverse audiences.

PR11 Organisations funding or delivering public engagement to explore options for involving larger numbers of people in deliberations about science and technology.

PR12 Organisations funding or delivering public engagement to actively support innovation in public engagement through a focus on desired outcomes, not processes. Encourage collaborative innovation by formation of project teams that include public engagement practitioners, scientists, and policy makers to maximise innovation and build institutional capacity.

1 Members of the NEG group were not fully party to, and cannot necessarily be assumed to support, this report's recommendations.

1 Introduction

In laboratories worldwide, new scientific territory is being uncovered everyday: territory that offers groundbreaking opportunities for society, as well as new risks and unexpected challenges. Just as yesterday's science and technology has contributed to shaping the world today, these new technologies will help shape the world of tomorrow. The power of technology is clear, but its governance is not. Who or what makes these world-shaping decisions? In whose interests are they made? These are the questions posed by a growing number of researchers, non-governmental organisations (NGOs), citizens, politicians, and scientists who seek to challenge the way that science and technology is governed, and to invent new ways to democratise the development of new technologies. This report documents the progress of six projects that have sought to do just that.

In 2005, a group of pioneers, from various backgrounds and with different interests and motivations, set off on separate voyages into this new territory. Their mission was to explore how we might ensure that future developments in science and technology are governed in the interests of the many, not the few; that is, to bring democracy to these new, unchartered territories.

These journeys were made possible by an increasing awareness in government and society of the need to create a more constructive and trusting relationship between science and society. They were by no means the first attempts to forge such a new relationship: there is a substantial tradition of public engagement with science and technology in the UK and abroad. However, these initiatives were the first to move public engagement upstream, to look at new and emerging science and technology. The initiatives that started in 2005 built on previ-

ous experiences of public engagement in science and technology, but moved explicitly away from a focus on established technologies and debates. Instead, they sought to open up discussions about future technological trajectories to public input, at a stage when the big decisions about funding priorities and regulation might be still up for grabs.

This introduction gives a brief background to the development of public engagement in science policy, paying particular attention to calls for 'upstream' engagement. We explain how nanotechnologies came to be a test case for these new policy innovations, and explore the Government's aspirations for public engagement on nanotechnologies and the pioneering projects that are the focus of this study.

1.1 A recent history of science in society

The 1990s saw dramatic tension between science and society, and nowhere were these tensions more evident than here in the UK. The decade opened with assurances that 'there is no risk associated with eating British beef'[2]. The public debates that followed were described as the beginning of a 'crisis in confidence'[3] between the UK public and science decision-makers that has yet to subside. As the BSE crisis unfolded, it revealed widespread public concerns about the UK government's use of science in regulatory processes[4]. In 1996, the importation of genetically modified (GM) soya sparked new controversy, and this time it was not only the use of science in policy making that became the focus of debate and conflict within society, but the use of the science-based GM technology itself.

The experiences of the 1990s forced the UK government to reconsider its approach to risk and risk communication in science and technology[5]. In 2000, the Philips Inquiry recommended that openness and precautionary measures are necessary to establish public trust in science policy under conditions of scientific uncertainty. Moreover, lessons from the GM controversy included an acknowledgement that wider public concerns should be considered early during research and development when there is still scope for the public's views to inform the development of new technologies. These evolving assumptions about the changing role of citizens in science policy processes make up a changing social contract for science, which has led to a range of radical policy changes. Aside from innovations in public engagement, institutions and inventions to promote

social and ethical awareness in science have flourished (eg, societal issues panels, ethics committees, and science shops[6]). The focus on public engagement in this report is not intended to marginalise these other attempts to democratise science and technology. Rather, our aim is to document the progress of a particular aspect of the changing relationship between science and society: that of public engagement on new and emerging science and technology.

1.2 Public engagement on risk and regulation

The active development of public participation as an element of science governance began in the field of risk assessment and regulation[7]. In 1992, a report by the Royal Society (RS) stated that risk assessment should always involve the complex process of weighing-up both scientific facts and public values. The report suggested that to build public trust in risk governance, it would be necessary to give the public a role in risk decision-making and adopt a two-way approach to risk communication[8].

Arguments for the public to have a greater role in risk assessment and regulation were further elaborated by an influential US National Research Council study that proposed that every stage of risk analysis should combine analytical and deliberative elements. The report called for public engagement throughout the risk-governance process—from the framing of research questions to assessment of evidence and risk management[9]. The Royal Commission on Environmental Pollution (RCEP) further developed the case for public engagement in its 1998 report, which contained a careful analysis of the need to include deliberation of public values when setting environmental standards as part of the regulatory process[10].

In the UK, such arguments of public engagement in risk assessment and regulation have been adopted gradually as part of government policy across a wide range of policy areas. This trend was spurred on by reflection on what went wrong during the BSE crisis and GM controversy. In 2000, the House of Lords Select Committee on Science and Technology detected a crisis of public confidence in scientific advice to government, and inferred that this lack of confidence was underpinned by a deeper ambivalence about the role of science and technology in contemporary society[11]. The report 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'[12]. In 2000, the government's guidelines for the use of science in policy-making were updated with a recommendation that public engagement should be used to identify issues that need scientific advice and help frame the questions that scientific assessment should address[13].

1.3 Upstream public engagement

Even as a decade's worth of calls for public engagement in risk regulation were being adopted as official policy, increasing tensions about the role of science in society were leading to calls for public engagement to extend beyond end-of-pipe concerns with risk and regulation. The UK government's ten-year strategy for science and innovation, published in 2004, states:

The Government wants constructive, inclusive and open public debate and dialogue (...) To do this, the Government will work to move the debate forward—beyond simplistic notions of the public being ignorant of science, or being either pro-science or anti-science; and beyond crude notions of a particular technology being either 'good' or 'bad'. The Government will also work to enable the debate to take place 'upstream' in the scientific and technological development process, and not 'downstream' where technologies are waiting to be exploited but may be held back by public scepticism brought about through poor engagement and dialogue on issues of concern[14].

The drive to move public engagement upstream arises from a concern about the role of the public in helping to inform the setting of research strategies and conditions for technological development. The principal aim of such initiatives is to encourage public deliberation about the underlying purposes of scientific research and technological innovation. That is, public voices should not only be heard when it comes to the regulation of technologies, but can also help shape technological trajectories.

A Demos pamphlet published in 2004 describes the advent of upstream public engagement as a response to the public controversy over GM crops and foods[15]. The pamphlet argues that in the case of the GM controversy, public dialogue was entered into at a point when it was too late to influence the development of the technology. Thus, the public engagement activities overlooked a core element of the controversy: the fact that people were protesting not only

against the products and technologies that were emerging on farms and supermarket shelves across the country, but also against the underlying conditions and assumptions that had allowed these products and technologies to be developed in the first place.

This claim that the trajectory of technological development itself was at the centre of the controversy is based on understandings of public attitudes to new technologies developed by social-science research. Rather than public concern focusing on scientifically defined risks to human health or the environment, research has shown that public attitudes to a technology are conditional on how it is used, the social distribution of benefits and risks, and the capacity of government regulation to respond to unforeseen future consequences[16].

1.4 Nanotechnology as a test case for upstream public engagement

One of the first areas[17] of science and technology to become a test case for upstream engagement was nanotechnologies[18]. In 2004, the RS and Royal Academy of Engineering (RAE) identified three ways in which nanotechnologies can be considered upstream: first, the future direction of technological development was not yet established; second, the social and ethical impacts of nanotechnologies were uncertain; and third, public attitudes towards nanotechnology were not yet fixed.

The UK government's support of nanotechnology research dates back to the mid 1980s. However, it was the launch of the US National Nanotechnology Initiative in 2000, with funding now in the order of US$1 billion a year, that propelled nanotechnology to its current status as a global research priority. This excitement about potential benefits that proponents see flowing from research on nanotechnologies is not universally shared. In 2002, the Canadian-based environmental and development NGO, the Action Group on Erosion, Technology and Concentration (ETC Group), called for a moratorium on the use of manufactured nanoparticles in research or any new commercial products[19]. The ETC Group had earned a reputation as an ardent critic of corporate exploitation of agricultural biotechnology, and they applied a similar analysis to the burgeoning field of nanotechnology. In early 2003, the group published a critique of the direction nanotechnology research was taking. The report detailed many of the claims made by nanotechnology's more ardent proponents and argued that

these utopian visions raised serious questions for society, particularly in terms of the environment and economic development in the global South[20].

In the summer of 2003, the UK government commissioned the RS and RAE to study potential applications of nanotechnology and their possible environmental, health and safety, social, and ethical implications. This report, published in the summer of 2004, was taken widely at the time as an authoritative summary of the issues. It focused on detailed questions about risks posed by free manufactured nanoparticles, and on the need to review chemical regulations to ensure that they encompassed nanotechnologies. The report also discussed social and ethical issues raised by nanotechnologies in more general terms, and argued for the importance of public and stakeholder dialogue at the early stages in the development of nanotechnologies. The report recommends: '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'[21].

The UK government's response to the RS/RAE report endorsed the call for public dialogue as a central element in its goal of 'building a society that is confident about the governance, regulation and use of science and technology'[22] in the interests of 'securing a future for nanotechnologies'. The UK government stated its commitment to 'promoting constructive dialogue on nanotechnologies'[23] and agreed that 'properly targeted and sufficiently resourced public dialogue will be crucial in securing a future for nanotechnologies'[24].

In August 2005, the government published its awaited Outline Programme for Public Engagement on Nanotechnologies (OPPEN). The programme highlighted six main aspirations for public engagement on nanotechnologies:

1 Enable citizens to understand and reflect on issues related to nanoscience and nanotechnologies, both personally and through inclusive processes involving citizens, policy-makers, and researchers.
2 Enable the science community and the public to explore together both aspirations and concerns around the development of nanotechnologies.
3 Enable institutions working in the area of nanotechnologies to understand, reflect on, and respond to such public aspirations and concerns.
4 Establish and maintain public confidence in the development of technologies by understanding the public's concerns and showing their impact on government regulation.

5 Contribute to wider government initiatives to improve the general trustworthiness of science and technology-related institutions.
6 Support wider government initiatives to support citizen participation in public policy and service delivery.

OPPEN presented a group of public engagement projects and related activities, which it stated would support the government in achieving these goals. Three projects were funded by government, through the Sciencewise[26] public engagement programme and the Copus Grant Scheme[27]:
— Small Talk[28]
— Nanodialogues[29]
— The Nanotechnology Engagement Group (NEG)

A further seven projects and activities were listed as not funded by government, but relevant to the programme's objectives:
— Democs[30]
— NanoJury UK[31]
— Global Dialogue for Nanotechnologies and the Poor (GNDP)[32]
— Nanotechnologies, risk and sustainability[33]
— Nanologue[34]
— Institute of Nanotechnology[35]
— Nanoforum[36]

These projects did not form part of a bespoke strategy to meet the government's aspirations for public engagement on nanotechnologies: some took place entirely independent of government funds; all had different motivations for public engagement with nanotechnologies; and all set their own particular objectives. Nevertheless, all projects shared the same overarching mission: to explore the opportunities to open up this important area of science and technology to new voices and perspectives.

1.5 The Nanotechnology Engagement Group (NEG)

NEG was brought together by Involve in 2005 with the collaboration of the Office of Science and Innovation (OSI) and the University of Cambridge. It was set up to ensure that the learning from these pioneering public engagement projects was captured. Our objectives were to:

— Research different stakeholders' expectations of public engagement with nanotechnologies.
— Map current public engagement activities related to nanotechnologies in the UK and internationally.
— Identify lessons from other engagement activities.
— Analyse how the lessons learned relate back to the range of interested audiences and the spectrum of engagement activities undertaken.
— Communicate the learning to government, other stakeholders, nanoscience researchers, and the wider public.

NEG sought to achieve these objectives through a two-year programme of activities that have included: desk research; interviews; meetings with group members; and a workshop for scientists, project organisers, public participants, NGOs, and policy-makers held at the RS (London; June, 2006)[37]. This report presents the findings of this programme of activities.

1.5.1 Who we are

Members of NEG are: Chair, Professor Richard Jones, Sheffield University; Professor Mark Welland, Cambridge University; Dr James Wilsdon and Jack Stilgoe, Demos; Melanie Smallman, Think-lab; Dr Jasber Singh, Independent Participatory Action Researcher and Research Associate on the Nanojury; Professor Nick Pidgeon and Tee Rogers-Hayden, Cardiff University; Dr Tom Wakeford, PEALS, Newcastle University; Dr Joanna Coleman, EPSRC; Karen Folkes and Gary Kass, OSI[38]; Dr Steffi Friedrichs, Nanotechnology Industry Association (NIA); Steve Morgan and Chris Snary, Defra[39]; Hugh Knowles, Forum for the Future; Dr Donald Bruce, Society, Religion and Technology Project, Church of Scotland; Pippa Hyam, Dialogue by Design; and Lousia Bolch, Channel Four.

NEG has received additional support and input from RS[40], Greenpeace[41], The Environment Agency, and Right to be Heard (R2BH).

1.5.2 The core group

NEG has a core group of researchers who have been directed in their work by the full group. The core group are: Dr Robert Doubleday, Cambridge University; Karin Gavelin, Involve; and Richard Wilson, Involve. Faye Scott (Involve) also worked on the project in its early stages.

1.6 Definitions of key terms and actors

Here, we explain some of the key terms used in this document.

Public engagement is a generic term that describes all the different ways that institutions interact with the general public outside of formal democratic structures such as elections. This engagement ranges from one-way forms of interaction such as information campaigns and social research activities (eg, opinion polls), to more interactive public consultations and initiatives that seek to share decision-making power with members of the public[42].

However, for the purpose of this research, **NEG has focused exclusively on forms of public engagement that involve *dialogue*** between members of the public and scientists or decision-makers. By dialogue, we mean a reciprocal exchange of views and ideas between individuals or groups. Purely one-way forms of public engagement such as information campaigns or opinion polls are not included in this study[43].

NEG uses the term **decision-making institutions** to refer to organisations in the public sector that are involved in funding, regulating, or making policy that affects scientific research or development, or both. Similarly, we refer to the individuals who work for these institutions in these capacities as **decision-makers** or **policy-makers**.

The term **target audience** is used to refer to institutions or individuals who have committed, or have been called on, to respond to and make use of the findings of the public engagement activities.

NEG uses the terms **public participants** or **participating members of the public** to distinguish individuals who have been involved in public engagement activities in their capacity as citizens rather than in a professional role (eg, visiting scientists, decision-makers, or organisers). When referring to the wider public, we use the terms **members of the public** and **citizens** interchangeably. We define both these terms very widely to include all permanent residents of the relevant country or region, rather than only legal citizens.

NEG refers to researchers involved in public engagement activities as **scientists** rather than **experts**, in recognition of the many different forms of expertise that

different groups (including organisers, public participants, scientists, and decision-makers) have brought to these processes. The term 'expert' is used only to describe a participant in a public engagement activity when we are quoting the project's own literature.

NEG uses the term **project organisers** to refer to individuals or organisations who have been responsible for delivering public engagement activities. The term **project partners** refers to organisations or individuals that have been involved in planning or funding public engagement activities without being responsible for the delivery of the processes.

2 BSE Inquiry (2000). *BSE Inquiry Report Volume 1: Findings and Conclusions.* London: BSE Inquiry, para 657

3 House of Lords (HofL) Select Committee on Science and Technology (2000). *Science and Society,* London: HofL, chapter 1

4 BSE Inquiry (2000); HofL (2000)

5 BSE Inquiry (2000)

6 A science shop is a 'bottom-up' approach to research (applied in natural sciences and social sciences), whereby civil-society organisations collaborate with researchers and research institutions to identify and initiate new areas of research in response to concerns raised by civil society

7 See: Jasanoff S (2005). *Designs on Nature.* Oxford: Princeton University Press; Kleinman D (2000). 'Democratisations of Science and Technology'. In: Kleinman D (ed). *Science, Technology & Democracy.* New York: State University of New York; Wilsdon J, Willis R (2004). See Through Science. London: Demos

8 Royal Society (1992). *Risk: Analysis, Perception and Management.* Royal Society: London

9 National Research Council Committee on Risk Characterisation (NRC) (1996). *Understanding Risk: informing decisions in a democratic society,* Washington: National Academy Press

10 The Royal Commission on Environmental Pollution (RCEP) (1998). *Environmental Standards and Public Values: A Summary of the Twenty-first Report of the Royal Commission on Environmental Pollution*. London: RCEP.

11 HofL (2000)

12 HofL(2000) para 5.48

13 Department for Trade and Industry (DTI) (2000). *Guidelines 2000: Scientific Advice and Policy Making*. London: DTI, paras 7 and 17

14 HM Treasury (2004). *Science and Innovation Investment Framework 2004–2014*. London: HM Treasury. Para 7.8
15 Wilsdon J, Willis R (2004)
16 Grove-White R, Macnaghten P, Mayer S, Wynne B (1997). *Uncertain world: Genetically modified organisms, food and public attitudes in Britain*. Lancaster: Centre for the Study of Environmental Change
17 A more recent example of 'upstream engagement' taking place in the UK is the Science Horizons project, which is run by Dialogue by Design and funded by Sciencewise (www.sciencehorizons.org.uk)
18 Nanotechnology is an umbrella term for areas of science and technology that involve operating, or manufacturing materials, on a scale smaller than 1 _m (normally between 1–100 nm)
19 ETC Group(2002). *No Small Matter! Nanotech Particles Penetrate Living Cells and Accumulate in Animal Organs.* Ottawa: ETC Group
20 ETC Group (2003). *The Big Down.* Ottawa: ETC Group
21 Royal Society (RS) and Royal Academy of Engineering (RAE) (2004). *Nanoscience and Nanotechnologies: opportunities and uncertainties.* London: RS/RAE p 64
22 HM Government (2005a) p 3
23 HM Government (2005a) p 20
24 HM Government (2005a) para 80
25 HM Government (2005b). *The Government's Outline Programme for Public Engagement on Nanotechnologies.* London: DTI
26 www.sciencewise.org.uk
27 The Copus Grant Scheme was set up in 1987 by the Office of Science and Innovation (OSI, formerly OST) to encourage and support ways to make science accessible to public audiences in the UK. The scheme is now closed
28 See chapter 2 or www.smalltalk.org.uk
29 See chapter 2 or www.demos.co.uk/projects/thenanodialogues
30 See chapter 2 or www.neweconomics.org/gen/democs.aspx
31 See chapter 2 or www.nanojury.org.uk
32 See appendix 1 or www.meridian-nano.org
33 See chapter 2 or www.demos.co.uk/projects/nano
34 See appendix 1 or www.nanologue.net
35 www.nano.org.uk
36 www.nanoforum.org
37 See research methodology, appendix 4
38 Karen Folkes replaced Gary Kass as the OSI's representative on NEG in April 2007
39 Steve Morgan replaced Chris Snary as Defra's representative on NEG in January 2007

40 Represented by Darren Bhattachary until May 2007, then Matthew Harvey

41 Represented by Doug Parr

42 For a useful overview of the different categories of public engagement, see the International Association of Public Participation's (IAP2) 'Public Participation Spectrum' at: www.iap2.org/associations/4748/files/spectrum.pdf

43 With the exception of a small number of foreign projects included in appendix 1

2 Introducing the projects

This section introduces the projects that have been included in the study. They are the public engagement on nanotechnology activities that have been based in the UK and have reported on the results of public engagement focusing on nanotechnologies[44]. These projects are:

— NanoJury UK
— Small Talk
— Nanodialogues
— Nanotechnology, Risk and Sustainability
— Citizen Science @ Bristol
— Democs

Although the focus of this study has been UK nanotechnology public engagement projects, NEG has also mapped related activities taking place elsewhere in the world. A record of these activities can be found in appendix 1.

2.1 The projects

2.1.1 NanoJury UK

A two-way citizens' jury on nanotechnologies that ran in June and July, 2005. The first half of the jury process explored an issue that participants chose; the second half focused on nanotechnologies.

Organisers: Cambridge University Nanoscience Centre; Greenpeace UK; The Guardian; and the Policy, Ethics and Life Sciences Research Centre (PEALS), Newcastle University.

Objectives

— To provide a potential vehicle for people's informed views on nanotechnologies to have an impact on policy.
— To facilitate a mutually educative dialogue between people with diverse perspectives and interests, including critical and constructive scrutiny by a wider group of citizens of the hopes and aspirations of those working in nanotechnologies-related sectors.
— To explore the potential for deliberative processes to broaden discussions about nanotechnologies-research policy—both in terms of the range of issues and the diversity of people who are given a say.

Approach: A citizens' jury draws on some of the symbolism of a legal trial jury: a group of participants, or jurors, are brought together to examine a topic of social significance through discussions and meetings with a series of 'witnesses'. At the end of process, they are asked to deliver a 'verdict' on the subject, usually in the form of a set of recommendations.

NanoJury UK was made up of sixteen residents of the West Yorkshire Metropolitan Borough of Calderdale, who were involved through letters sent to people on the electoral register and via suggestions from youth and community workers.

The process involved a multi-stakeholder oversight panel to oversee balance and fairness in the process, and a science advisory panel to ensure accuracy and balance in the evidence presented. Professor Pidgeon and Dr Rogers-Hayden, when reflecting on (evaluating) the jury, identified the involvement of the multi-stakeholder panel in the NanoJury as one of its strengths.

NanoJury UK sought to give the jurors some control over the process by allowing them to address a topic of their choice before turning to nanotechnologies. The jurors chose to look at young people, exclusion, and crime in the local community, which they did over eight evening sessions of two and a half hours each. They subsequently discussed nanotechnologies in ten sessions of two and half hours each. After an introduction to nanotechnologies, they heard evidence from six witnesses who were selected by the oversight panel. In the last few sessions, the jurors wrote recommendations for nanotechnology's future development in the UK, and noted the degree of support among the jurors for every recommendation. These recommendations were presented to an audi-

ence of policy-makers, scientists, journalists, and social researchers at an event in London in September, 2005, which three jurors attended.

Timescale: The citizens' jury met in June and July 2005. The recommendations were launched in London in September 2005. A reflection on the Jury produced by Jasber Singh at PEALs is available on the website below.

Funders: The project was co-funded by Cambridge University Interdisciplinary Research Collaboration (IRC) in Nanotechnology; FRONTIERS Network of Excellence in Nanotechnology; Greenpeace UK; and PEALS.

Cost: The cash cost was £45,000 up to June 2005. Added to this was considerable volunteer time by PEALS staff.

Website: www.nanojury.org.uk (see also www.greenpeace.org.uk/tags/nanotechnology for Greenpeace's records of NanoJury, including a link to the recommendations).

Contact: Tom Wakeford, PEALS. peals@newcastle.ac.uk

2.1.2 Small Talk

A programme of activities aimed to support science communicators to facilitate dialogue about nanotechnologies between members of the public and scientists.

Organisers: Small Talk was project-managed by Think-Lab, in collaboration with The British Association for the Advancement of Science, Ecsite-UK, the Royal Institution, and the Cheltenham Science Festival.

Objectives

- Facilitate dialogue on nanotechnologies.
- Provide resources and support for organisations that run dialogue events and activities.
- Build a better understanding of the public's and scientists' aspirations and concerns about nanotechnologies.
- Share findings with policy-makers and the science community.
- Improve understanding and use of good practice in engagement with the public on scientific issues.

— Evaluate the impact of a coordinated approach and share findings with wider science-communication community.

A wider objective, as expressed by project director Melanie Smallman, was to see whether science-communication organisations can contribute meaningfully to the public engagement agenda[45].

Approach: Small Talk aimed to help the science-communication community work together on nanotechnology. The project gave suggestions to organisations who were interested in running public engagement on nanotechnologies about issues to cover, information about what had worked in previous events, evaluation information, and the opportunity to share findings with the wider science community and policy-makers.

Project components included 20 events attended by more than 1200 participants, a website, and a range of resources to support science communicators working on the topic of nanotechnologies. Advice offered by the Small Talk team included ways to make events participative, and how to enable attendees to enter into dialogue with scientists and policy-makers. However, it was up to the individual organisers to decide on the type of event they ran, and most early events were in a lecture or panel-debate format with question-and-answer sessions at the end.

Small Talk developed a postcard with space for participants to write their views on the risks, benefits, and moral implications of nanotechnologies to obtain opinions and to provide a channel for more reserved participants to contribute. These postcards were modified after a few events to make them less prescriptive. The newer postcards provided space for participants to write down what they would say to scientists or ministers about nanotechnologies, and to write the answers they would expect to receive; 60% of postcards were returned.

Timescale: The project began in September, 2004, and completed in the summer of 2006. The final report was published in November, 2006.

Funders: The programme was funded by the Copus grant scheme. Individual events were funded by the organisation that ran them.

Cost: The project received £49 900 of funding.

Website: www.smalltalk.org.uk

Contact: Melanie Smallman, Think-Lab. melaniesmallman@think-lab.co.uk

2.1.3 Nanodialogues—four experiments in upstream public engagement

A series of four experiments in new methods of upstream deliberative public dialogue, focusing on nanotechnologies.

Organisers: Demos and the University of Lancaster. Partners in the four experiments were: The Environment Agency (experiment one); Engineering and Physical Sciences Research Council (EPSRC) and Biotechnology and Biological Sciences Research Council (BBSRC; experiment two); Practical Action, Zimbabwe (experiment three); and Unilever (experiment four).

Objectives

— Experiment in a theoretically informed way with new methods of upstream public dialogue in societal debates about nanotechnologies.
— Ensure that these dialogue experiments are framed in a way that can inform processes of institutional decision-making and priority-setting.
— Generate intellectual and practical resources for enriched public, policy, and scientific debate about the social implications of nanotechnologies.
— Identify wider lessons and insights that can inform the policy and practice of public engagement in science and technology.

Approach: A series of practical experiments to explore whether the public can meaningfully inform decision-making processes related to emerging technologies in four different institutional contexts. The four experiments were:

Experiment one—a People's Inquiry on Nanotechnology and the Environment (January, 2006).
The Inquiry consisted of three deliberative workshops with a group of 13 east London residents, which focused on the use of nanoparticles to clean up chemically contaminated land. The workshops involved input from scientists, Environment Agency staff, government policy-makers, and other stakeholders, and ended with public participants drawing up a set of recommendations. After the process ended, a group of participants presented their recommendations to Defra.

Experiment two—Engaging Research Councils (May–June, 2006)
A deliberative dialogue process that involved scientists, members of the public, and research-council staff to explore and discuss the role of public engagement in research-council decision-making. Three workshops ended with a visit to the Research Councils in Swindon, where the recommendations were drawn up.

Experiment three—Nanotechnology and Development (July, 2006)
The project centred around the role of new technologies in potable water provision. Demos and Practical Action ran a three-day workshop, which involved policy-makers, politicians, and representatives from two communities. The focus of the discussion was whether nanotechnologies can be used to help achieve the millennium development target of halving the number of people without access to clean water by 2015.

Experiment four—Corporate Upstream Engagement (Autumn 2006)
A series of focus groups in Newcastle-upon-Tyne and London, which looked at the use of nanotechnologies in three types of consumer products: hair products; oral care; and food. In collaboration with Unilever research staff, Demos drew up several scenarios about these topics that were discussed at four focus groups. The findings from this project have not been published at the time of writing.

Timescale: The project ran from May, 2005, to Autumn 2006. The final report was launched in June, 2007.

Funder: The Sciencewise grant scheme. Funding for individual experiments also contributed by partner organisations (ie, The Environment Agency, BBSRC, EPSRC, Practical Action, and Unilever).

Cost: £210 000.

Website: www.demos.co.uk/projects/currentprojects/nanodialogues/
Contact: Jack Stilgoe, Demos. jack@demos.co.uk

2.1.4 Nanotechnology, Risk, and Sustainability

A research project to explore how social and scientific visions influence science policy and research, and experimentation with new ways to facilitate dialogue between scientists and the public on upstream scientific issues.

Organisers: Demos and the University of Lancaster. The project also involved input from scientists, members of industry, journalists, and the public.

Objectives: The project aimed to explore several questions:

— What can be learnt from the development of biotechnology since the 1970s, and associated public debates?
— How is it possible to improve dialogue between nanoscientists and the general public in order to integrate public responses into innovation processes, including industrial research and development?
— What methods could be used to integrate public concerns into the development of a socially and environmentally sensitive regulatory framework for nanotechnologies?
— At what stages in R&D processes is it realistic to raise issues of public interest, given the generally private and indeterminate nature of such processes? How, and on whose terms, should such issues be debated? And how adequate are dominant institutional discourses of risk and ethics in addressing such issues?

Approach: The project had five stages:

1 Learning from the biotechnology experience through research and interviews with key stakeholders in biotechnology regulation.
2 Research with nanoscientists, and policy-makers that aimed to identify the social, cultural, and political assumptions embedded in the development of nanotechnology.
3 Five focus groups, all done over two meetings, with a range of publics recruited on the basis of particular demographic criteria.
4 An interactive workshop for scientists and a select group of members from the focus groups (focus groups members were selected on a mix of enthusiasm, but also on a desire to have two members of every group present).
5 Writing and dissemination of the research. The final report, Governing at the Nanoscale, and a film of the dialogue event were launched on April 6, 2006, and are available to download from the Demos website.

The focus groups began by discussing the role of technology in society. Next, the participants were presented with a selection of consumer products that had been fabricated using nanotechnologies, and a set of concept boards to explain the subject. The concept boards included definitions of nanotechnologies, explanations of potential risks, and a series of contrasting 'visions' of how nanotechnologies may change society in the future, that had been developed in collaboration with nanoscientists and policy-makers in the earlier stages of the project. Three such visions were presented: one that presented nanotechnologies as a competitive advantage for the UK, leading to wealth creation and investment; a utopian vision of a future where nanotechnologies lead to extensive human enhancement and technological development, and a sceptical perspective which focused on negative implications and risks.

The organisers chose to move away from the traditional approach of a citizens' jury, and focused on how attitudes towards science and technology are formed and where the public may have a role in shaping the vision of nanotechnologies that is pursued. The organisers adopted this method because they were interested in understanding the underlying factors that will shape future public responses to nanotechnology.

The last part of the public engagement process was a meeting between a select group of focus-group participants and scientists who worked with nanotechnologies. This one-day event was divided into two parts: a series of small discussion groups, and a plenary session at the end. Discussions focused on the potential social and ethical implications of nanotechnologies, and issues relating to governance and responsibility.

Timescale: The project ran from January, 2004, to April, 2006.

Funders: Economic and Social Research Council (ESRC).

Cost: £226 000.

Website: http://www.demos.co.uk/projects/nano/overview

Contact: Matthew Kearnes, RCUK Fellow, Durham University. m.b.kearnes@durham.ac.uk

2.1.5 Citizen Science @ Bristol

A programme of activities seeking to engage young people in discussions about the role of science and technology in society. Two events focused on nanotechnologies.

Organisers: @ Bristol Science Centre and Bristol University.

Objective: To encourage young people through discussion and debate to form opinions about scientific issues and their social and ethical implications, and to encourage active citizenship by teaching them how to act on their views.

Approach: Various methods were used, including chat-show-style debates, website resources, teachers' materials, and online games. The first nanotechnology event included 100 sixth-form students. It was a day-long event with a choice of different activities including the Democs game (see below), a 'meet the experts' session, presentations, and plenary sessions. At the end, students voted on areas of nanotechnology research they would like to see funded, and the degree of regulation that they believed nanotechnologies should have.

Timescale: @ Bristol was a three-year Citizen-Science project, which ended in June, 2006.

Funder: The Wellcome Trust.

Cost: Not available.

Website: www.at-bristol.org.uk

Contac: Alex Garlick, @ Bristol. alex.garlick@at-bristol.org.uk

2.1.6 Democs

A conversation game designed to enable small groups of people to engage with complex public policy issues.

Organisers: The new economics foundation (nef).

Objective: To enable small groups of people to engage with nanotechnology policy issues.

Approach: Democs (originally an acronym for DEliberative Meetings Of CitizenS) is a method of engagement rather than a specific project. However, its practitioners at nef were funded to produce a version on nanotechnologies, among other subjects.

Democs uses a specially constructed game as an opportunity for people to learn about a topic and express their views. The game does not need to be facilitated, and can be played anywhere. Experts on the subject assist with writing the information included in the game, and others are consulted on it. Participants are dealt a series of hands of cards to read, and are asked to pick the ones that they feel are most important for the discussion. Participants make clusters to represent key themes of their discussion. At the end of the game, participants state their preferred policy positions on a subject by choosing from four pre-developed policy positions or developing one of their own.

Timescale: The project based on promotion of the games on scientific issues ran from November, 2003, to June, 2006. The nanotechnology kit is available for free download from the nef website. A new version specifically devoted to nanobiotechnology is being developed as part of the NanoBio-RAISE project (see appendix 1) to be used in May–June, 2007.

Funders: The Wellcome Trust and EU Sixth Framework.

Cost: Development of a game costs from £10 000–£20 000 and upwards.

Website: www.neweconomics.org/gen/democs.aspx

Contact: Perry Walker, nef. Perry.Walker@neweconomics.org

2.2 A note on project methods

Every project used a distinct approach to public engagement. NanoJury UK used a citizens'-jury model of engagement, where participants met over several weeks to discuss a topic of their choice and subsequently to learn about, and discuss, nanotechnologies. The jurors heard from a range of witnesses that gave different perspectives on the issues in question. At the end, the jurors were asked to come up with their own conclusions and recommendations for public policy.

Two projects—Nanotechnology, Risk, and Sustainability and Nanodialogues—used a deliberative focus-group approach, where public participants were given the opportunity to discuss science and learn about nanotechnologies in smaller groups before meeting scientists and policy-makers to continue the discussions[46]. In each case, public participants had time between meetings to digest what they had learnt and do their own research. Like the Nano Jurors, participants of the first two Nanodialogues experiments were asked to make recommendations for policy (although they were given less time to do so than were the Nano Jurors). The main aim of the recommendations was to summarise the views that had emerged in the discussions, and to give participants a degree of ownership of the process, rather than produce something that would be used by decision-makers. The Nanotechnology, Risk, and Sustainability participants were not asked to produce recommendations for policy. Instead, the project organisers summarised in a project report the discussions that had taken place and released a short film from the final session.

Small Talk and Citizen Science @ Bristol both ran several events and used a mixture of deliberative methods alongside more traditional science-communications approaches such as lectures and question-and-answer sessions. Neither project asked participants to produce formal recommendations for policy, but both projects collated public participants' views on issues selected by the organisers or those raised by the participants themselves. Small Talk asked people to write on a postcard what they wanted to say to the science minister and a scientist about nanotechnologies. Citizen Science @ Bristol used voting and the Democs game to collate participants' views.

Finally, Democs was not a public dialogue project in itself, but rather a tool for use in such processes. The game has been created to facilitate deliberations on complex scientific issues, and therefore no formal study of the issues raised in the nanotechnologies game was produced. However, some people who played the game reported the outcomes of their discussions back to nef, which is producing a summary of the findings.

2.3 A note on public participants

These projects also differed in their approaches to recruiting participants.

The sixteen Nano Jury UK jurors were recruited through letters sent to people on the electoral register and via links with community-based workers. The organisers explicitly sought to include a diverse group of people, focusing on people whose voices are rarely heard in science or policy discourses.

Nanotechnology, Risk, and Sustainability and Nanodialogues both recruited participants to reflect the ethnic diversity of the areas they covered, but did not make specific efforts to involve seldom-heard voices.

By contrast, most Small Talk audiences were self-selected and consisted of people with an interest in science, some of whom paid to attend the events. The main exceptions were a series of events, which, like the Citizen Science @ Bristol activities, were held for school students who were obliged to attend. As a result, the Small Talk audiences were of a slightly different demographic than the public participants of NanoJury UK; Nanodialogues; and Nanotechnology, Risk, and Sustainability, which recruited participants on the basis of particular demographic criteria.

A further difference in the projects was between participants who attended an event because they were interested in nanotechnologies, and those who attended because they were curious about the process or because they were paid. Most Small Talk participants attended the events because they were interested in the topic advertised. Many regularly attended science lectures and some paid to attend the events, which may explain why the Small Talk organisers found greater support for nanotechnologies among their audiences than did other projects. By contrast, participants of Nanotechnology, Risk, and Sustainability and Nanodialogues were not told that they would be discussing nanotechnologies

until they attended the first event. They were paid to attend, and many claimed to have no previous interest in science or science policy, which may account for the slightly higher levels of scepticism and concern about nanotechnologies amongst these participants compared with the Small Talk audiences.

These differences between the audiences in the different projects highlight the importance of clarity about how the term 'public' is defined, and on what basis participants in public engagement activities are recruited. Public engagement is increasingly being used to complement traditional democratic structures, but few public engagement activities conform to democratic principles. Many are small-scale, unrepresentative, and ad-hoc, and there is little agreement among public engagement practitioners about the correct definition of the term 'public'. The fact that public engagement activities take place outside of established democratic structures, while seeking to inform and complement traditional policy-making, highlights the need to ensure that these activities are founded on principles of inclusion and diversity. If a key aim of public engagement in science and technology is to inform institutional decision-making, it is essential that steps are taken to ensure that the people involved represent a diverse cross-section of society, with no group excluded on the basis of ethnicity, religion, disability, gender, or age[48].

44 The aim of NEG has been to study public engagement on nanotechnology projects that have formed part of the government's response to the RS/RAE 2004 report; hence the public engagement activities that were included in the RS/RAE study have not been included here.

45 Interview with Melanie Smallman, project director, Aug 31, 2005

46 In Nanotechnology, Risk, and Sustainability only a select group of focus-group participants attended the meeting with scientists

47 With the exception of the third Nanodialogues experiment in Zimbabwe, where participants knew the topics of the discussions before taking part

48 Promotion of diversity in public engagement is not only important to maintain democratic principles, but is also a legal requirement. The Race Relations (Amendment) Act 2000 makes it unlawful for any public authority (a loose definition for any institution who does functions of a public nature) to discriminate, directly or indirectly, against anybody on the basis of race. The Act also states that public authorities have a duty to promote equal opportunities and good relations between people of different racial groups. Similarly, the Disability Discrimination Act makes it unlawful to deny any person or group access to a service for any reason related to their disability

3 Lessons for science policy

This section summarises the outputs from the UK experiments in public engagement on nanotechnologies that are directly relevant to science policy. It draws together the principal findings and recommendations of the public engagement projects, and concludes with a discussion of the implications of these findings for nanotechnology decision-making in the UK.

Our discussion focuses on the following six projects based in the UK that have reported on the results of public engagement concerned with nanotechnologies:

— NanoJury UK
— Small Talk
— Nanodialogues
— Nanotechnology, Risk, and Sustainability
— Citizen Science @ Bristol
— Democs

3.1 Findings and recommendations

The majority of these projects explored how public attitudes to developments in nanoscience and nanotechnology are formed, and sought to capture the views and concerns that emerged in order to inform government policy on nanotechnologies. Nanotechnology, Risk and Sustainability did not explore public attitudes per se, as the project organisers were critical of the notion that the public participants would have pre-existing 'attitudes' to a technology that many had never heard of before. Instead, the project focused on exploring the underlying factors that shape public responses to new technologies.

All projects used different methods and different approaches to recruit participants, which affected the style and content of the outputs (recommendations and reports). They also differed in other ways: their motivations for engagement with the public were different, as were the project objectives, the specific topics covered, and the people involved. Despite these differences, the messages these projects produced for nanotechnology decision-makers contain several shared themes. In this chapter, we summarise these themes and discuss what they mean for government policy on science and technology.

None of the recommendations and findings summarised here provide representative accounts of the current state of public opinion, as they were the result of specific interactions through which participants learned about and reflected on issues related to nanotechnologies. Moreover, this summary does not do justice to the lengthy and rich deliberations that took place at the different public engagement activities. These projects all sought to draw lessons for a wider audience alongside policy-makers, including scientists and organisers of future public dialogue. Hence, the recommendations and findings are only part of the story. They do not account for the other kinds of learning that took place in the different activities, or for how the experiences affected those who took part. We return to this issue in the next chapter, where we explore other forms of impact of public engagement on nanotechnologies.

NanoJury UK: provisional recommendations (receiving unanimous support)*
September, 2005

a If public money is being spent, then members of the public and invited representatives of a wide range of organisations (including different social groups and faiths) should form a committee that decides at what stage(s) of research public juries should be set up. This committee needs to be open to groups in society, other than just experts.

If private money is being spent, public juries should have a role at the outset of the research to look at the ethical and possible social and environmental impacts of potential end products.

b There should be more openness on where public money is spent on nanotechnology research.

c Government should support nanotechnologies that bring jobs to the UK by investment in education, training, and research.

d If public money is to be spent, it should go on technologies that contribute towards the solving of longer-term issues, such as health and environmental problems. This spending should be combined with use of incentives and strings-attached for the private sector.

Government should set up partnerships with countries who lead in technologies that can improve health.

e All manufactured nanoparticles should be labelled in plain English, classified, and tested for safety as if they were a new substance.

Manufactured nanoparticles should be tested in controlled environments before they are let into the environment.

f Scientists should improve their communication skills, including going into schools to encourage science as a career path to all children.

Recommendations by jurors, taken from NanoJury UK *Our Provisional Recommendations*.

* 14 minority recommendations were also made. Furthermore, separate recommendations were made in the first part of the citizens' jury, which looked at young people, exclusion, and crime.

Small Talk: summary of findings (no formal recommendations were made)
November, 2006

People's attitudes to nanotechnologies are not significantly different from their attitudes to any new technology—and they are generally positive. Many people want Britain to be a world leader in nanotechnology.

There are significant parallels with attitudes to GM that emerged in the UK National Consensus Conference on Plant Biotechnology—particularly the call for openness and public involvement in decision-making.

On the subject of safety, people see danger in poor regulation rather than specific hazards associated with nanotechnology.

For nanotechnologies to be acceptable to the public, government needs to ensure that:

- Any possible risks are offset by real benefits (health and environmental) to the consumer, not just the manufacturer.
- Nanotechnologies do not exploit people who are less affluent (here or abroad).
- It helps the public to inform themselves about nanotechnologies.
- It helps the public to understand the relations between government, science, and industry.
- It helps the public understand regulation of nanotechnologies, ideally discussing government plans with them.
- It funds research to clarify any gaps in knowledge about safety.
- If regulation involves management of uncertainty (because of gaps in knowledge about safety or any other issue), then government should explain this issue clearly because the public is likely to expect that regulation is based on firm evidence and is a guarantee of safety.

Summary taken from Smallman M and Nieman A (2006). *Small Talk: Discussing Nanotechnologies*. London: Think-lab, p 26.

Nanodialogues experiment one—A People's Inquiry on Nanotechnology and the Environment: recommendations written and agreed by participants
March, 2006

1 Given what we have heard, nanoparticles should not be used to clean up contaminated land until we know more about their long-term effects.

2 This problem is more complicated than yes or no. Nanotechnologies should not all be treated as nanotechnology.
a Definitions of different areas of nanotechnology need to be made clearer.
b Distinctions need to be drawn between manufactured and existing nanoparticles.

3 Companies who use nanotechnology in the environment should be obliged to do long-term research, in real-life situations. They should constantly monitor for unpredictable effects and be flexible in the face of changing circumstances.
a New types of testing and modelling should be used to increase our understanding of the effects of nanoparticles.

4 Tests of nanoparticles in the environment should take into account their location, particularly nearby human populations.

5 Public declaration of the results of tests, good or bad, should be mandatory; research findings should be freely available.

6 We need a register of all organisations involved in nanotechnology to make monitoring easier. There is disagreement among the panel as to whether this should be voluntary (which would facilitate dialogue) or compulsory (which would be more robust and encourage public confidence). However, we support the efforts of Defra to put in place a notification scheme in the absence of legislation in this area.

7 We recommend the formation of a new group that contains specialists and lay people to oversee research, monitoring, regulation, and communication of issues about nanotechnology. This group would feed into all relevant government departments and agencies. It should have the power to recommend new areas of research.

8 In the management of nanotechnology, as well as thinking about the UK situation, we need to think both more globally and more locally.

a The UK needs to be part of a global effort to realise the benefits of nanotechnology, and to research the health and environmental effects of nanoparticles. We need to know more about worldwide testing and monitoring.

b Different areas of the UK will have different contexts. Local communities should be involved in decisions about nanoparticles and the environment.

9 We should consider the place of nanotechnology in education. We need to hear the voices of young people in decisions about new technologies and the environment.

10 The monitoring and regulation of nanotechnology needs to be done by a broad group of people, including Defra, the Environment Agency, Environmental NGOs, and lay people.

11 We need to increase the provision of information, debates, forums, and literature about nanotechnologies.

12 We need to engage the public in nanotechnology issues as early as possible, in plain English, and as economically as possible.

Recommendations by participants, taken from Environment Agency (forthcoming) *A people's inquiry on nanotechnology and the environment.* Bristol: Environment Agency.

Nanodialogues experiment two—Engaging Research Councils: summary of discussions and findings June, 2006

Key findings

There was support among the public participants for the idea of basic research, conducted in public by publicly funded researchers.

However, there was scepticism about current means of accountability in the governance of science and technology.

There was appreciation among public participants of the desire by research councils to open up to public and other stakeholder input, but public participants argued that this desire needs more thought through openness: dialogue and accountability will look very different at different levels of decision-making.

Public participants highlighted the need to link public engagement to discussion of where research agendas come from and who sets them.

Summary of discussions provided by Nanodialogues organisers.

Recommendations*

1 Science should be communicated in plain English. If the public are to be involved in science then they need to be able to understand it.

2 Science and scientists should engage actively with the public. Science should come to the public as opposed to the other way round. Science should be transparent.

3 The public should be involved at all levels of the research process. Engagement, however, should be different at different levels of the research process.

4 We support the move for more public engagement on nanotechnology. However, this engagement needs to be informed by the latest science.

Recommendations by participants, from Kearnes M and Stilgoe J (forthcoming). *Engaging Research Councils*—draft 2. London: Demos.

* Recommendations were written by the four public participants who attended the final session, and should therefore not be considered representative of the views of all participants in Engaging research councils. The main reason for producing these recommendations was to summarise and focus the discussion in the final session, rather than to inform BBSRC (Biotechnology and Biological Sciences Research Council) and EPSRC decision-making.

Nanodialogues experiment 3—Nanotechnology and Development: summary of recommendations July, 2006

Key Issues raised in workshops

1 Affordability: build resource capacity within communities; adopt open-access model that allows for local material use; implement a means-tested water-subsidy system.

2 Resource mobility: build resource capacity within communities; empowerment of communities to manage their resources; give priority to local research and development (R&D) on water; collaborate with other countries.

3 Awareness: service providers to work with communities; share knowledge about technologies with communities to educate and open dialogue by use of focus groups.

4 Acceptability: demonstrate the capabilities of new technologies to improve water quality and provide extension services; full

participation of communities at various stages of the project; service providers to work with communities.

5 Sustainability: promote local R&D and local ownership; solutions must be technologically, socially, and environmentally sustainable; develop/build economic and technical capacity to maintain the technology.

6 Policy framework: give tax incentives for public/private partnerships for water-related projects; review technology lessons every 2 years; evaluate science and technology policy regularly.

Issues raised by participants; summary from Grimshaw D, Stilgoe J, Gudza, L (2006). *The role of new technologies in potable water provision: a stakeholder workshop approach.* Rugby: Practical Action.

Recommendations for science in Zimbabwe

— Need to build capacity within communities.
— More funding for research in the country (public and private).
— Need to build a culture of research in local institutions.
— Equipment and money is needed.
— Civil society should have input into science agenda.
— More collaboration with other countries needed.

Recommendations for science in the UK

— Collaborate with other countries when there is "a story to tell"—ie, when possible applications are emerging.
  — Put the end user into the research agenda.
  — Agenda to be defined by need.
— Could a common research agenda be defined? Create a platform for collaborative research and planning.
— UK could lead research as long as it is driven by need.
— Make research knowledge applicable to developing countries.
— Scientists should collaborate and create trust in the people. There needs to be consultation before product development.

Summary of recommendations provided by project organisers.

Citizens Science @ Bristol: summary of findings January, 2006

Overall, participants were enthusiastic about the potential benefits of nanotechnologies, in particular in medical applications and information technology (IT).

Many discussions focused on participants' concerns about potential risks associated with nanotechnologies. In particular, participants expressed concern that they did not feel informed of what goes on in nanotechnology research and development, and that there is no way for them to have an input.

Most students were sceptical about the information they received about nanotechnologies through the media. Only 3% of respondents believed that press coverage of nanotechnologies is 'fairly reliable'. 29% agreed with the statement that it is 'undermined by lack of knowledge', and 23% that it is 'overblown hype or scare stories'. 30% claimed not to have read any press about nanotechnologies at all.

When asked who they thought should control nanotechnology research, 13% of respondents believed that the public should be able to vote on how funding is allocated; 13% stated that nanoscientists are better equipped to do this; 16% argued that it is the government's job; and 52% agreed with the statement that 'it should be a three-way dialogue between the government, the public and scientists'.

Summary by NEG, based on information provided by Citizen Science @ Bristol project organisers.

Democs: summary of findings
April, 2007

There was very high support (about 90%) for the policy position: 'Proceed with nanoscience but regulate. Allow scientific research in nanotechnologies to proceed in the normal way, setting new regulations alongside the potential developments which emerge'.

There was almost equally high support for adding 'public dialogue on the directions of research and applications'.

Most of the discussion was about risks and ethics. Two examples of descriptions of clusters are:

— 'Usages must be regulated. Impacts on society must be considered before use of technology. Human improvement must be justifiable.'
— 'Timing and risks; huge benefits; enormous risks and limited control; commercial exploitation issues. Technology already here; real issue is the level of operation and risk.'

Summary provided by Democs project organisers.

Nanotechnology, Risk, and Sustainability: summary of findings
April, 2006

Nanotechnology, Risk, and Sustainability did not produce formal recommendations for nanotechnology policy. However, the record of discussions in the project report highlights several issues that resonate with the findings of other public engagement on nanotechnology projects. These include:

— Enthusiasm among public participants about the positive role that technology in general has in society, and the potential for nanotechnologies to improve quality of life in the future (eg, through improved IT and medical innovations).
— Ambivalence about the 'downsides' of technological development, which were perceived to include, loss of community, invasion of privacy, and erosion of family and work boundaries.
— Increased concern among public participants as they became aware of some different nanotechnology applications and their potential social and ethical implications. Concerns focused on the potential toxicity of nanomaterials in food and cosmetics, the potential for nanotechnologies to enable greater forms of government and business control over everyday life, and nanotechnologies used in warfare and terrorism.

Summary by NEG, based on chapter 4 in: Kearnes M, Macnaghten P, Wilsdon J (2006). *Governing at the Nanoscale*. London: Demos.

3.2 Principal lessons for government policy on nanotechnologies

Despite differences between the projects included in this study, three common lessons about the public participants' attitudes to nanotechnologies and the governance of nanotechnologies can be identified. First, public attitudes are formed not only in relation to particular technologies, but also to the policies and values that shape the direction of technological development, and to the social and political conditions in which they emerge. Public participants were not only concerned with the potential benefits and risks of nanotechnologies, but also with who the benefits and risks are most likely to affect. Second, public attitudes to risk, uncertainty, and regulation tend to be concerned with the ability of regulation and regulatory authorities to manage complex risks. Third, there is consistent demand for more open discussion and public involvement in policy-making relating to science and technology.

These findings contain two levels of lessons for policy-makers. The first-order lessons are the insights into public views and concerns about nanotechnologies specifically. Although the attitudes presented here should not be considered representative of the wider UK population, they are one of few sources of social intelligence on the subject. As such, they provide important insights into what attitudes and concerns may arise once the wider public becomes more aware of nanotechnologies and their social, ethical, and environmental implications. The challenge for government is to take these views seriously and to respond in a way that explains clearly how public concerns are to be addressed. If public views are not going to be considered, then it is vital that the government make a detailed and thoughtful response that addresses the reasons for discounting public views.

The second-order lessons are what these findings and recommendations tell us about public views and expectations of science governance. These lessons pose a different set of challenges for government in how it deals with the risks and opportunities presented by new areas of science and technology.

3.2.1 Social benefits of nanotechnologies

The records of discussions show considerable optimism among public participants about the potential for nanotechnologies to deliver social benefits. Particular emphasis has been placed on nanotechnologies' ability to serve a social purpose, with calls for government and other funding institutions to prioritise research in health, energy, and environment, alongside more generic aspirations for nanotechnologies to benefit the UK economy or to improve information and communication technologies. A recommendation by NanoJury UK illustrates this point:

> 'If public money is to be spent, then it should go on those technologies that contribute towards the solving of longer-term issues, such as health and environmental problems. This should be combined with the use of incentives and strings-attached for the private sector'[49].

A survey done at a Citizen Science @ Bristol event placed similar emphasis on health and environmental benefits. Of 98 respondents, 43% prioritised funding for biomedical nanotechnology research 'to help cure disease', alongside 21% in favour of environmental nanotechnologies and 13% who prioritised computer technologies[50].

Similarly, at a Small Talk event with 20 health-care professionals, most participants mentioned improved medicine, such as targeted drug delivery and artificial implants, as a key benefit of nanotechnologies. Other benefits listed were computing and IT, quantum mechanics, and financial benefits[51].

3.2.2 Uncertainty and regulation

Most project recommendations have addressed issues about risk, uncertainty, and governance of nanotechnologies.

Uncertainty: A recurrent theme among the concerns raised by public participants has been how government manages the development new technologies under conditions of uncertainty. Participants were concerned with both uncertainty about the impacts of nanotechnologies and nanomaterials, and about how those impacts are to be handled, and by whom. In particular, public participants have expressed unease at discovering that little is known about the behaviour and long-term safety of manufactured nanoparticles, some of which are already appearing in ordinary household goods such as skin creams and cleaning products[54]. The fact that nanoparticles may be added to consumer products without this being stated clearly on the label has emerged repeatedly as a cause for surprise and concern[53].

Regulation: Another recurring theme has been concerns about the regulation of nanotechnologies. During dialogue activities, public participants expressed unease that the multidisciplinary nature of nanotechnologies may result in them slipping through the net of existing regulations, with no agency ultimately responsible for setting and maintaining safety standards. There was also concern that insufficient measures have been taken by authorities to address the new and often unknown properties of nanomaterials[54].

> 'New types of testing and modelling should be used to increase our understanding of the effects of nanoparticles'.[55]

> 'All manufactured nanoparticles should be labelled in plain English, classified, and tested for safety as if they were new substances'.[56]

These recommendations have been reiterated in the discussions that took place at Small Talk and Citizen Science @ Bristol events, and at the Nanotechnology, Risk, and Sustainability workshops.

These themes also reflect the recommendations of the RS/RAE's report Nanoscience and nanotechnologies: opportunities and uncertainties, which called for a more precautionary approach to the introduction of novel nanotechnologies—including a specific call for manufactured nanomaterials to be treated as hazardous and their release into the environment to be avoided until more is known about their impact. The report also called for an interdisciplinary research centre to conduct and monitor research on the possible adverse effects of nanotechnologies[57].

Distribution of benefits and risks: Some projects raised questions about how benefits and risks are distributed. Public participants from NanoJury and from some of the Small Talk events expressed concern that the development of nanotechnologies in the UK would benefit only the manufacturing industries and professionals, not the poor or unemployed. There were also concerns that any potential risks associated with nanotechnologies would disproportionally affect poor and marginalised people, in the UK or abroad[58].

The Small Talk project report calls for government to ensure that any possible risks are offset by real benefits (eg, health or environmental) to the consumer, not just by increasing profits for industry. It also asks that government take measures to ensure that the development of nanotechnologies in the UK does not involve the exploitation of less-affluent people here or internationally[59]. These points were reiterated at the third Nanodialogue experiment, where Zimbabwean public participants called for research agendas to be coordinated across international borders to ensure that the needs of developing countries are taken into account[60].

Concerns around the globalisation of nanotechnologies and its potential impact on poor and developing countries have been raised by several NGOs, most prominently the ETC Group[61], Greenpeace[62], and the Meridian Institute[63].

3.2.3 Openness, transparency, and public engagement

There have been repeated calls for more open decision-making on nanotechnologies, including more opportunities for members of the public to influence the development of nanotechnology policy and research.

Openness and transparency: An issue identified by public participants has been the lack of coordination and overview of the UK nanotechnology field—

whether in terms of the research that is taking place, the government departments that are responsible, or the testing that has been done on the safety of new nanotechnologies. The lack of clarity about who makes decisions about the development of nanotechnologies, and on what basis these are made, has surprised and worried public participants. Thus, questions about responsibility have been raised repeatedly in discussions and recommendations[64]. Recommendations have included:

> 'A register of all organisations involved in nanotechnology is needed'[65]

> 'The monitoring and regulation of nanotechnology needs to be done by a broad group of people, including Defra, the Environment Agency, environmental NGOs and lay people'[66]

> 'There should be more openness on where public money is spent on nanotechnology research'[67]

Public engagement: As we have seen, public participants from these events have stressed the need for publicly funded science to be socially grounded—ie, that it serves a social purpose, is informed by the views and concerns of the public, and that there are reasonable mechanisms in place to manage any risks and uncertainties it presents. Yet, they also have misgivings about the government's and private-sector's ability and willingness to manage the risks associated with nanotechnologies. There is a concern that nanotechnologies will be used to serve private interests, and that wider public interests will be overlooked. In response to this concern, public participants have called for more opportunities for the public's views to inform nanotechnology research and policy:

> 'If public money is being spent, then members of the public and invited representatives of a wide range of organisations (including different social groups and faiths) should form a committee that decides at what stage(s) of research public juries should be set up. This committee needs to be open to groups in society other than just experts.'[68]

> 'We need to engage the public in nanotechnology issues as early as possible'[69]

> 'The public should be involved at all levels of the research process. Engagement, however, should be different at different levels of the research process.'[70]

It is notable that most public participants consider decision-making in relation to nanotechnology a complex process that requires a wide range of inputs:

> 'I know there are experts out there who are concerned about nanotechnologies as well, and if our group adds to that sense of caution then that's a good thing. But for us to want to take the decision ourselves would be a step too far.'[71]

Public participants' main concern has been that decision-making processes in science and technology are made more transparent and trustworthy, and that more effort is made to incorporate ethical and social considerations into the setting of research and funding priorities. Flexibility and openness have been stressed as important: people are keen for as many voices as possible—including scientists, members of the public, NGOs, and industry—to be heard at the different stages of decision-making[72].

In a survey done at an Citizen Science @ Bristol event, 13% of respondents agreed with the suggestion that the public should be able to vote on funding allocation for nanotechnologies; 13% believed that nanoscientists are better equipped to do this task; 16% said that it is the government's job; and 52% agreed with the statement that 'it should be a three-way dialogue between the government, the public, and scientists'.[73]

3.3 Resonance with previous science engagement

There are significant parallels between these findings and the views expressed by public participants in public engagement activities on nanotechnologies elsewhere in the world. Most projects included in Involve's mapping study of public engagement on nanotechnologies internationally[74] found a similar mixture of enthusiasm and concern among public participants. Recurrent themes were calls for more research into the risks of nanotechnologies to human health and the environment, and calls for government to ensure proactively that nanotechnologies develop in a way that serves public needs[75].

The concerns about risk and uncertainty listed above resonate strongly with public concerns that have emerged in public engagement activities on GM crops and food. There are parallels with the 1993–94 UK National Consensus Conference on Plant Biotechnology[76] and the 2003 GM Nation debate,[77] both of which found significant concerns about the use and development of GM crops and food among public participants. Consistent with the nanotechnology experience, participants in these projects were not only concerned about scientifically defined risks (eg, risks to human health or the environment), but also about the social and political implications of GM (eg, who the risks and benefits would most likely affect). Furthermore, there was evidence of considerable concern among public participants about the government's and industry's ability to manage complex and unforeseen risks, alongside calls for more research and regulation until more is known about the long-term implications of GM crops on human health and the environment.

The similarity between public views on different areas of science and technology suggests that there are underlying values that guide people's views on new science and technology. NEG argues that decision-makers need to take these recurring concerns seriously, and do more to demonstrate the steps they take to ensure that new science and technology are developed in a responsible and trustworthy way. Decision-makers also need to be more open about the constraints of science governance. For instance, if the public continues to raise concerns that seem unrealistic or beyond the remit of decision-making institutions, then government needs to make clear why it is unable to address those concerns. NEG believes that an important function of public engagement in science and technology should be to raise awareness of how science decision-making works, and to clarify what levers of change do and do not exist.

3.4 Implications for science policy

The intended audience for the recommendations and findings summarised in this chapter have been nanotechnology decision-makers and researchers. In some cases, results have been reported directly to public institutions. For instance: the People's Inquiry on Nanotechnology and the Environment fed directly to the Environment Agency and Defra; Engaging Research Councils was done in collaboration with the EPSRC and BBSRC; both Small Talk and Nanodialogues presented results to the Nanotechnology Issues Dialogue Group (NIDG); and the NanoJury launch was attended by a representative from NIDG, who committed a formal response to the recommendations[78].

As we mention above, the project findings contain two levels of challenges for decision-makers. The first is to respond to the recommendations and findings that are concerned with nanotechnologies specifically, and explain how those are taken forward (or, if they are not being taken forward, explain why). The second level of challenges is to take on board what these recommendations and findings reveal about public participants' views and expectations of science governance, and consider what changes can be made to make science decision-making more trustworthy to the public.

3.4.1 Messages for nanotechnology policy

These projects reveal a mixed response to nanotechnologies among public participants. Alongside aspirations for how nanotechnologies may improve our health, environment, and economy[79] is widespread unease about the uncertainties and risks they bring, and, in particular, about the government's capacity for dealing with those risks. This finding supports the argument that public attitudes to new technologies are context-specific—ie, that they are formed not only in relation to particular technologies, but also to how they are used, who conditions their development, and the social and political context in which they emerge.

The issues raised by the members of the public in these projects mostly relate to broad aspirations and concerns about future implications of nanotechnologies, rather than responses to particular technological developments. Even when more specific issues have been the focus of discussions,[80] the final recommendations have tended to be broad in scope: addressing topics such as 'all manufactured nanoparticles'[81] or 'companies using nanotechnologies in the environment'[82]. Despite the lack of specificity, the findings presented in this chapter contain some clear and important messages for policy-makers.

First, there is evidence of enthusiasm among public participants for the anticipated social benefits of nanotechnologies—such as generation of new medical innovations or sustainable technologies, or benefit to the UK economy.

Second, although many discussions focused on potential risks such as toxicity of manufactured nanoparticles, public participants seem as concerned with the government's and industry's ability to deal with potential long-term risks and uncertainties associated with nanotechnologies as with the risks themselves. This includes a concern among some public participants about the government's and industry's ability to ensure that potential benefits and risks are distributed fairly.

Third, there have been calls for more open policy-making with respect to nanotechnologies, including opportunities for members of the public to input into nanotechnology policy and research. This includes better and more accessible public information about the conditions under which nanotechnologies are developed, and more debate about their social consequences. However, the calls for more public involvement is not indiscriminate: participants have recognised that nanotechnology decision-making is a complex process that is likely to benefit from input from a range of sources. The discussions and recommendations have focused on a desire to make decision-making about nanotechnologies more open and trustworthy—for example, by making public and corporate decision-making more accessible and better coordinated. This need is consistent with the recommendations made in the RS/RAE report Nanoscience and nanotechnologies: opportunities and uncertainties, in response to which these projects were conceived.

3.4.2 Challenges for decision-makers

A key reflection of these engagement projects is that the public aspirations and concerns about nanotechnologies do not fit neatly into the government's departmental structure of policy-making. Many of the public participants' recommendations combine issues of science and innovation policy, economic and industrial policy, and regulatory policy, and therefore do not come in a form that can be slotted easily into existing policy processes.

Moreover, the recommendations and records of discussions summarised in this chapter reveal several underlying assumptions held by public participants about how science and technology are, and should be, governed (many of which do not correspond with current approaches to science and technology policy). For instance, the calls for nanotechnologies to serve a 'social good' suggest that public participants see the government as playing an important part in shaping the social purposes of science and technology. Furthermore, although government and other public bodies have a powerful role in steering and regulating scientific research and development, they are not alone in shaping the future directions of science and technology. Technological trajectories emerge from a complex combination of forces that include private investment, market forces, public interest, and individual enthusiasm, not to mention chance. Hence, government alone cannot be held responsible for the direction of technological trajectories, although it can play a more or less dominant part in seeking to influence them.

NEG argues that although these recommendations may at first glance seem unrealistic or beyond the remit of government, they contain important messages about how the public want science and technology to be governed.

For instance, the findings demonstrate a concern among public participants about the role of private ownership in research and development, and a related desire for government to take a strong lead to ensure that science and technology develop in a socially responsible way.

They also reveal a concern for how the risks and benefits of new technologies are distributed, both within the UK and globally. Hence, these recommendations pose challenges for government not only in terms of how it deals with societal implications in the UK, but also how it incorporates global ethical considerations in the development of new science and technology.

The fact that many of these recommendations focus on broad aspirations and concerns for the future of science in society also suggests that the public participants, like the proponents of upstream engagement who initiated these activities, see a role for the public at the strategic level of science policy. NEG supports this notion. This study has demonstrated that upstream discussions about science and technology can benefit from public input in a number of different ways[83]. The challenge for government is to trust the public's ability to understand and contribute meaningfully to such policy discussions, and to find ways to incorporate members of the public directly in them. These initial experiments in public engagement on nanotechnologies offer invaluable experience and learning for making possible such government-led pursuits in upstream public engagement in the future.

49 NanoJury UK

50 Citizen Science @ Bristol (2006). *Live Science Zone Nanotechnology: the future of tiny science. Survey results.* Bristol: @ Bristol (draft)

51 www.smalltalk.org.uk

52 See www.nanotechproject.org/index.php?id=44

53 Such concerns have emerged in recommendations and records of discussions from: NanoJury UK; Nanotechnology, Risk, and Sustainability; The People's Inquiry on Nanotechnology and the Environment; and Engaging Research Councils

54 Environment Agency (forthcoming). *A people's inquiry on nanotechnology and the environment.* Bristol: Environment Agency p 17; Smallman M, Nieman A (2006). *Small Talk: Discussing Nanotechnologies.* London: Think-lab, p 20–25; Kearnes M, Macnaghten P, Wilsdon, J (2006). Governing at the Nanoscale. London: Demos, p 47

55 The People's Inquiry on Nanotechnology and the Environment

56 NanoJury UK

57 RS/RAE (2004). Recommendations R3, R4, and R5, p 85

58 Smallman M, Nieman A (2006), p 26. See also full list of recommendations from NanoJury at: http://greenpeace.org.uk/files/pdfs/migrated/MultimediaFiles/Live/FullReport/7249.pdf

59 Smallman M, Nieman A (2006), p 26

60 Grimshaw D, Stilgoe J, Gudza L (2006). *The role of new technologies in potable water provision: a stakeholder workshop approach.* Rugby: Practical Action, p 17

61 ETC Group (2006). *Nanotech Rx: Medical Applications of Nano-scale Technologies: What Impact on Marginalized Communities?* Ottawa: ETC Group (2003)

62 Arnall HA (2003). *Future Technologies, Today's Choices.* London: Greenpeace

63 See www.meridian-nano.org

64 Environment Agency (forthcoming) p 14; Kearnes M, Macnaghten P, Wilsdon J (2006), p 61–62; Kearnes M, Stilgoe J (forthcoming). *Engaging Research Councils: Nanodialogues report, draft 2.* London: Demos. See also NanoJury UK recommendations

65 The People's Inquiry on Nanotechnology and the Environment

67 The People's Inquiry on Nanotechnology and the Environment

68 NanoJury UK

69 NanoJury UK

70 The People's Inquiry on Nanotechnology and the Environment

71 Engaging Research Councils

72 Public participant 8, Nanodialogues (quote from interview with NEG) Smallman M, Nieman A (2006), p 20–25; Kearnes M, Macnaghten P, Wilsdon J (2006), p 66–67; Kearnes M, Stilgoe J (forthcoming), p10

73 Total number of respondents: 77. Citizen Science @ Bristol (2006). *Live Science Zone Nanotechnology: the future of tiny science* survey results

74 See appendix 1

75 See for example the Citizens' Attitudes Towards Nanotechnology survey in Denmark; the Madison Area Citizens' Conference on Nanotechnology in the USA; the Bendigo Workshop on Nanotechnologies and the Melbourne Citizens' Panel on Nanotechnologies in Australia; and the New Zealand Focus Groups on Nanotechnologies—appendix 1

76 www.ncbe.reading.ac.uk/NCBE/GMFOOD/conference.html

77 www.gmnation.org.uk

78 The NIDG's response to the NanoJury recommendations has yet to be delivered

79 See NanoJury UK recommendations, Small Talk summary of findings, and Citizen Science @ Bristol summary of findings

80 E.g. on discussion of the use of nanoparticles to clean up contaminated land at the People's Inquiry on Nanotechnology and the Environment, or on discussion of nanoparticles in skincare at the Nanotechnology, Risk and Sustainability focus groups and workshop

81 NanoJury UK

82 The People's Inquiry on Nanotechnology and the Environment

83 See chapter 4 for an analysis of impacts and benefits

4 Lessons for public engagement policy: uses and limits of public engagement on emerging science and technology

This chapter focuses on the lessons from public engagement on nanotechnology for public engagement policy. First, we look at the different kinds of impacts of public engagement in science and technology, focusing on how the experience of public engagement affects those who take part. Second, we explore how dialogue-focused public engagement opens up discussions and new lines of questioning that might otherwise be overlooked, and hence, as one scientist put it, helps 'put science into context'[84]. Third, we offer some reflections on the limits and challenges of public engagement in science and technology.

The findings presented in this chapter are based mainly on interviews done by NEG with organisers, participants (ie, scientists and members of the public), and target audiences who have been involved in public engagement on nanotechnologies. Interviews were conducted on a voluntary basis; therefore, the views presented here may not be representative of the wider groups who took part in these public engagement projects.

4.1 Beyond recommendations: different forms of impact and benefits

A central finding of NEG is that all too often the success of a public engagement process is defined too narrowly in terms of the effectiveness of written outputs (eg, reports and recommendations) to impact institutional policy[85].

Outputs such as recommendations only ever tell part of the story. They are commonly produced from a desire to find agreement among public participants or in order to produce something that is considered useful and succinct for policy-

makers. They do not capture the richness of the deliberations that have led to the final recommendations. Previous evaluations of public engagement activities[86] have found that the emphasis on agreed recommendations as an essential output of public engagement risks overly pressurising the process into delivering recommendations that inaccurately reflect participants' views and undermine the quality of the deliberations.

A side-effect of this focus on the written outputs of public engagement activities is that target audiences and commissioning institutions do not prioritise time to be involved directly in the activities. Instead, they assume that they can get sufficient benefits from reading the reports.

NEG suggests that to maximise the ability of public engagement to inform policy and research, decision-makers need to prioritise time to engage directly with processes before, during, and after they occur. We do not suggest that public engagement activities should be designed and delivered by civil servants alone; but rather that direct involvement of target audiences in these processes would help these groups gain a better understanding of how public engagement works in practice and what it can, and cannot, deliver.

In this chapter, we build this argument by showing how direct involvement in public engagement activities can have a transformative effect on those who take part, and how such effects can translate into real changes in decision-making in science and technology.

4.1.1 Impacts on participants: changing attitudes and outlook

For many people who were interviewed for this study, the experience of taking part in a public engagement project transformed their attitudes to science and the governance of nanotechnologies. Scientists, members of the public, project organisers, and project partners expressed the value they attached to the interactions with the other participants; the experience of engaging in dialogue rather than just feeding, or being fed, information; and to learning about science and policy-making. Respondents repeatedly emphasised the importance of face-to-face contact and of having time to listen to and discuss new perspectives.

Here we explore four different forms of impact on participants:
— Preconceptions dispelled: benefits of meeting face-to-face
— Public engagement as mutual learning
— Supporting active citizenship
— Supporting a culture of engagement and communication in scienc

Preconceptions dispelled—benefits of meeting face-to-face: For most people who were interviewed by NEG, participation in public engagement was a positive experience. Ten of 11 members of the public and seven of eight scientists interviewed said that taking part was worthwhile, and that they would get involved in a similar project again given the chance. The consensus among interviewees was that these processes help break down barriers between scientists and the wider public. An organiser commented that the process had produced a 'shared sense between the scientists and the members of the public that there is a vacuum of responsibility [on nanotechnologies]. The scientists are saying that they have an as limited sense of agency about the direction that nanotechnology takes us as the public does'.[87] The Environment Agency confirmed this notion when it wrote in response to Demos' people's inquiry[88] that the public participants' conversations 'closely matched that currently taking place between scientists in the UK.'[89] As one scientist said:

> 'As we talked, they started to realise that we were human, and that many of the questions that they were asking were questions that we also asked. You could really feel the them-and-us barrier break down as the day went on.'
> *Scientist 6, Nanotechnology, Risk, and Sustainability*

Members of the public in particular stressed how much they enjoyed and learned from meeting the scientists, organisers, and the other participants:

> 'It was interesting not only from the point of view of the subject area of nanotechnology, it was interesting also to meet people from different walks of life. Because [nanotechnology] is something that affects everyone, and everyone's got their own views on this.'
> *Public participant 4, Nanodialogues*

> 'You couldn't do it remotely, you couldn't do it by email, you couldn't do it by conference call. It was related to people moving around small groups,

> working parties, working groups; being given an hour and then stop, regroup and then reform, and then you find yourself softening on one view, and then adding something else to what someone else said. It was very well done.'
> *Public participant 7, Nanodialogues*

Many public participants were surprised by how well they were able to communicate with the scientists. Initial concerns among some members of the public that scientists would be arrogant and distant were overcome during discussions:

> 'It was great to sit with real scientists who were real people who didn't make us feel inferior and took us seriously; it was really worthwhile.'
> *Public participant 2, Nanotechnology, Risk, and Sustainability*

> 'You imagine university lecturers to have a certain pomposity about them because of the knowledge that they have, but they were completely the reverse. Very refreshing, very casual, very open to debate and to questions and answers.'
> *Public participant 4, Nanodialogues*

> 'I must admit that when the facilitators told us they would bring scientists and academics to the table we were all a bit in awe. I think some of us almost feared them. It was a bit like "look who's coming to tea". But the facilitators were good; they encouraged us to engage with them and brought it all down to the base level. They found ways round the terminology and so on'.
> *Public participant 9, NanoJury UK*

Moreover, many scientists found that members of the public did not live up to the stereotype of being 'anti-science', a finding that is confirmed by individual project reports and recommendations[90]. Five of eight scientists interviewed by NEG stated that members of the public were more accepting of science than they expected:

> 'I learnt about the willingness of people to accept that there is a role for fundamental science, for pushing forward the boundaries of knowledge without having an actual application in mind (...) there seemed to be more trust in scientists than I had thought there would be.'
> *Scientist 1, Nanodialogues*

> 'I was very encouraged by the positive response we got, the participants were not luddites and were excited at the possibilities of nanotechnology.'
> *Scientist 2, NanoJury UK*

Others were impressed by the level of understanding and knowledge displayed by members of the public. A scientist said: 'the [members of the public] are more educated sometimes than we give them credit for'[91]. Three scientists who were interviewed expressed surprise at how much information the members of the public had taken on board about nanotechnologies:

> 'I was very impressed by the questions that were asked. There were a number of quite insightful questions about nanotechnology. They'd really done a lot of research in some cases (…) For me it was a really useful and interesting experience.'
> *Scientist 1, Nanodialogues*

> 'I was pleasantly surprised by the level of engagement by the non-specialists. They really had questions that they wanted to have answered, and they were very actively engaged.'
> *Scientist 6, Nanotechnology, Risk, and Sustainability*

Our research suggests that many people involved in public engagement activities hold pre-conceptions about other participants. For instance, many public participants who were interviewed for this study said that before meeting the scientists they expected them to be 'pompous' or arrogant. Similarly, nearly half the scientists who were interviewed said that they were surprised that the public participants were able to understand and discuss nanotechnologies, suggesting that preconceptions about non-scientists' inability to contribute to scientific discourses remain common in science communities. The nanotechnology public engagement projects have demonstrated that such initial assumptions can be overcome through carefully facilitated face-to-face interaction. However, the fact that some projects had difficulty overcoming the social barriers between participating groups demonstrates that mutual understanding does not happen automatically. More frequently, it is the result of considerable planning and time commitment on the part of project organisers and facilitators.

Public engagement as mutual learning—changing awareness, attitudes, and outlook: NEG has found that an important achievement of the nanotechnology public engagement projects undertaken so far is the opportunities that they have provi-ded for all participants (ie, scientists, members of the public, policy-makers, and others) to learn more about science, technology, and policy, and to learn about the different perspectives of others.

For public participants, the experience of taking part in public engagement on nanotechnologies involved many different forms of learning. All those who were interviewed by NEG claimed to have learnt new things about science:

> 'I learned so much. And now, I look in the paper and in magazines, and when I find something about nanotechnology I feel that I know about it.'
> *Public participant 10, Nanodialogues*

> 'I knew nothing about nano or its applications before; how beneficial or troublesome it could be, how financially driven it could be, and its political connotations. I've become more aware of all those things through the discussions we had.'
> *Public participant 9, NanoJury UK*

> 'I found out about things I had no idea were going on, like the amount of money going into science. I remember at the start they showed how much money is spent on science research and I said that there's no way that's from government; they wouldn't pay that. But it was!'
> *Public participant 3, Nanodialogues*

> 'I found it fascinating. When we talked about nano at first we knew nothing about it. Then we all did some research and we were able to ask questions to the scientists about the implications of the things they worked on. The scientist we spoke to said that he just did his work, he didn't focus on the implications of it at all. And some of the things we asked him; he said he had never thought about them before.'
> *Public participant 3, Nanodialogues*

Other participants also observed this learning take place:

> '[The members of the public's] opinions and views evolved quite a lot through the different stages, after they'd gone away and thought about it and come back and had more discussions and met other people. I think their views were very different at the end of the process than they were at the start.'
> *Partner 1*

For participating scientists, the experience of a public engagement activity entailed a different kind of learning, by allowing them to reflect on the wider social aspects of their work and their social responsibilities as scientists. Six of eight scientists who were interviewed by NEG reported this type of impact, although three stated that they already incorporated such considerations into their work as a matter of course:

> 'It has really made me think about these types of issues [the role of the public in science decision-making]. I haven't got any answers yet, but it's really made me think about them.'
> *Scientist 1, Nanodialogues*

> 'There were some people there with very different views from me, people I wouldn't necessarily meet otherwise. Some of them had no experience of science at all, and they had ideas and concerns that I'd never thought of before.'
> *Scientist 3, Nanotechnology, Risk, and Sustainability*

> 'We (scientists) tend to be arrogant so hearing public concerns was interesting and pertinent. That was a lesson learnt.'
> *Scientist 2, NanoJury UK*

For one scientist in particular, discussions about ethics and responsibility had a significant impact on their subsequent research:

> 'I've been thinking more about what effects my work may have in the future (…) it's led me to write a grant proposal for further research looking into the biological response of cells to nanoparticles. (…) It was the fact that one of the women asked us "should I use this sunscreen with nanoparticles on my children?" And we just couldn't answer, because we don't know the answer.'
> *Scientist 8, Nanotechnology, Risk, and Sustainability*

Supporting active citizenship: These experiences of interaction and dialogue meant that many people walked away from the processes not only with some new knowledge, but also with changed attitudes to politics, science, and policy-making. Some members of the public who were interviewed by NEG said that the experience had made them more appreciative of other people's views and perspectives, and more confident about their own capabilities as citizens:

> 'I never realised before I went into the jury process how opinionated you could be. You'd go into a discussion and say something, and somebody else would disagree, and you had to take it into account. It changed my whole perspective and view of the debate process. (...) It made me realise that [the scientists] have all got their own ideas and agenda. Whereas before I would have said that one of them was lying, now I understand that they weren't lying—they were telling it the way it is to them.'
> *Public participant 9, NanoJury UK*

> '[I learnt] to be more tolerant of other people. To research more on the internet. To be more aware of the environment.'
> *Public participant 4, Nanodialogues*

> 'It was great, it was good for the brain, it was good to meet other people, to engage, and to feel you matter as a human being, and everybody wants to feel that.'
> *Public participant 4, Nanodialogues*

Some also reported a new appreciation of the role of science in society, politics, and the media. Sometimes, the experience had given them a more critical outlook:

> 'I'm far more aware of things than I was before. For example, I never used to pay any attention to adverts, say for beauty products, but they may be talking about using forms of nanotechnology. It's not that I think the adverts are lying as such but rather people lack the scientific knowledge they need to decode it and I'm glad I've been woken up to this.'
> *Public participant 5, Nanotechnology, Risk, and Sustainability*

> 'What the jury has taught me is to snoop even more, to dig deeper and learn more about the subject. I certainly won't walk away and dismiss it; I can't do that now.'
> *Public participant 9, NanoJury UK*

> 'I remember somebody was talking about how the media is so sensationalist when they write about science, and I have really noticed that that's true.'
> *Public participant 3, Nanodialogues*

These findings are reiterated by a study that took place at the University of Wisconsin's Citizens' Conference on Nanotechnology, which found that taking part in the conference had a positive effect on public participants' knowledge and sense of empowerment. The majority of public participants felt motivated to learn more and to continue participating in similar projects, and a group of former participants organised the area's first science cafe shortly after the conference[92].

These findings suggest that public engagement can help foster a culture of active citizenship[93]. Done properly, it can support the learning of those involved, help people form new opinions, and give them new skills. It teaches people about policy-making, scrutiny, and debate, and can lead them to be more interested—and willing to take part—in social and political activities elsewhere.

What we have also seen is that these projects can build the capacity of public participants to be more active and aware about how science and technology feature in their lives. Scientific information is pervasive in modern society: from newspaper headlines, to food labels and advertisements on the television. Our research suggests that public engagement can support citizens to receive this information in an active, rather than passive, way. Whilst in the past, public participants might have passively accepted scientific claims or might have ignored technical discussions, now the public engagement experience has prompted them to engage actively with such information. NEG argues that this development is promising and a vital step if we are to establish a more mature relationship between science and society—one based on mutual respect and ability to interact meaningfully.

Supporting a culture of engagement and communication in science: Scientists, too, found that interaction with members of the public brought unexpected

benefits. For some, there was new-found enthusiasm for public engagement both in terms of their own involvement and for the benefit of the wider science community:

> 'We did feel that the session had benefited all those concerned, and that it was definitely something that should be reproduced, and that the public engagement on nanoscience should be stepped up'.
> *Scientist 8, Nanotechnology, Risk, and Sustainability*
> 'To be honest we could have gone on talking for hours.'
> *Scientist 5, NanoJury UK*

> 'It was a really enjoyable and satisfying day, to be talking to people about nanotechnology, and feeling that maybe at the end of the roundtable discussion we were coming away with some positive ideas about public engagement. And it gave me an idea that maybe [public engagement] is something I'd like to get into a bit more.'
> *Scientist 8, Nanotechnology, Risk, and Sustainability*

Other scientists mentioned a new appreciation of the need to communicate more, and more clearly, with non-scientists:

> 'It made me think much more carefully about how we present this work. (…) it has made me take a step back and consider how we think about this and how I can explain why we should be doing it.'
> *Scientist 1, Nanodialogues*

> 'I learnt something about communication skills. The first question they asked me was why do scientists use big words. (…) I found that an interesting insightful experience, because they weren't afraid to say "I didn't understand that".'
> *Scientist 5, NanoJury UK*

4.1.2 Wider impacts: opening up and informing science

As these findings illustrate, public engagement on science and technology can have a significant, sometimes transformative, impact on those who take part. It can lead to learning and increased understanding among groups of participants. It opens up issues, concerns, and questions that may otherwise be overlooked. NEG argues that these benefits are not limited to those who are involved

directly in public engagement. Such shifts in attitudes can contribute to a wider cultural change in how the social dimensions of science and technology are addressed—among scientists, policy-makers, and members of the public. This study suggests that more attention should be paid to distributing widely the learning from these often small-scale deliberative processes.

All people who were interviewed by NEG agreed that public engagement in science and technology is important, and many thought it should be increased. Two key rationales dominated their arguments. First, scientists and members of the public who have taken part in this research have argued that a key function of public engagement should be to inform and educate the public about science and technology. This rationale was listed by most public participants and all the scientists interviewed. Both groups also stressed the need for public engagement to counterbalance the coverage of scientific developments in the media. In particular, concerns were expressed about negative coverage of science:

> 'We've got to a situation where if you're a scientist you're seen as growing two-headed mice or an atom bomb in your backyard, and I don't know where that's come from but it needs countering'.
> *Scientist 5, NanoJury UK*

> 'The danger is that there is too much information and especially bad information and scare tactics that some irresponsible newspapers might publish'.
> *Public participant 5, Nanotechnology, Risk, and Sustainability*

NEG argues that although education is an important benefit of public engagement for those involved (including members of the public, scientists, and decision-makers), the small-scale public dialogue approaches described in this study are not the best way to achieve wider public education about science and technology—they do not reach enough people. Instead, we argue that another important rationale for engagement of the public in in-depth dialogue about science and technology is that it helps open up discussions about science and technology, which can inform and improve science policy, research, and development. Such activities bring new perspectives into science and policy discourses, and allow diverse groups to raise questions and concerns of relevance to them; issues that might otherwise be overlooked. For many of those who were interviewed by NEG, there was a democratic argument behind this idea. Science

and technology affects everyone, hence members of the public should have the opportunity to input into decision-making. However, although most people who were interviewed by NEG have argued this point, they have also been pragmatic about the level of input that members of the public can have in science and technology decision-making. A member of the public said:

> 'Because decisions have to factor in a whole range of issues: politics, economics, the environment, and so on, it's very difficult to say that the public in general should make decisions. I couldn't go that far. But I would say that there should be some involvement.'
> *Public participant 8, Nanodialogues*

Rather, the main concern has been that decision-making should be more transparent and trustworthy, and that greater effort is made to incorporate ethical and social considerations in the development of new technologies[94]. The role of public engagement in the realisation of these aims is to inform the government and science community about public aspirations and concerns, not only through the established route of written recommendations but also through real interactions between decision-makers and members of the public:

> 'The man on the street has a lot to offer. His ideas might not always be better; but they are different, they give a different perspective. (…) Bringing a lot of different people together allows new ideas to develop.'
> *Public participant 9, NanoJury UK*

> 'If we got some feedback saying there had been even a slight change in how things work because of something we said, then that would be a success. And even if they came back to us and said that they had listened to us but didn't agree with what we suggested, then that would still be a success, as long as they had considered it.'
> *Public participant 3, Nanodialogues*

Many people who were involved in organising and evaluating these public engagement initiatives have shared this notion that public engagement should be used, as one scientist argued, to 'put science into context'.[95] They argue that public engagement does not have to be a statistically significant research exercise or a nationwide democratic process to be valid. What is gained from

smaller, more interactive processes is a depth of discussion that they claim is lost in large-scale public engagement. Two evaluators said:

> 'I've talked to a number of people who've said things like 'the jury must be replicated, to look at the findings of different groups', but I don't think that's the point. It's not about replicating findings across the country. These findings may not represent everybody, but they do raise some issues'
> *Evaluator 1*

> 'One of the things about [public engagement in science] is that you're opening up questions and questioning assumptions about risk and benefits more than you are saying "there is a decision to be made, let's inject public input into it".'
> *Evaluator 2*

The Environment Agency, which partnered with Demos on the People's Inquiry on Nanotechnology and the Environment, confirmed that early-stage, small-scale dialogue can give valuable insights for regulators and decision-makers. It argued that this is particularly the case when the agency finds that 'socially framed evidence is lacking' and that this situation may threaten its ability to carry out its work in the future[96]. The Small-Talk team, which ran several short one-off discussion events, also found that the processes gave useful insights, particularly highlighting public concerns and presenting participating scientists with questions and issues they had not considered before[97].

4.2 Limits and challenges

Our interviews with project organisers, evaluators, funding organisations, participants, and target audiences have identified several challenges for public engagement in science and technology. In this section, we address these challenges.

4.2.1 Clarity of purpose and roles—what are we doing here?

NEG argues that effective public engagement in science and technology relies on clarity on four points:

— What specifically is the process seeking to achieve?
— What contribution is expected of participating members of the public?
— What contribution is expected of participating scientists?
— Who is the target audience, and what is their role in the process?

What is the process seeking to achieve? NEG's research has identified a tension between the expectations of different groups for public engagement on nanotechnologies[98]. We found an expectation on the part of the public participants that the findings and recommendations would be used by decision-makers to inform nanotechnology policy. To date, there is little evidence that this happens. We have also found that decision-makers assumed that effective public engagement should be aligned with policy needs and provide outputs that fit neatly to policy-making structures. Several partner organisations and people identified as the 'target audience'[99] of these projects have expressed disappointment that the initiatives have not delivered 'robust social intelligence' to inform nanotechnology policy.

However, public engagement activities included in this study were set up not only to meet policy-makers' needs, but also had multiple experimental aims. These aims range from practical objectives (eg, testing and improvement of public engagement methods) to social research objectives (eg, exploration of public opinion or attitude formation), and to objectives for informing and influencing government policy, research, or institutional decision-making[100]. Every project had different motivations for engagement of the public on nanotechnologies, and all prioritised their aspirations differently.

This gap between explicitly stated objectives of the projects and subsequent expectations of those involved, highlights the importance in public engagement of setting clear goals and managing expectations. It is important to be clear and open about what every project seeks to achieve, and to tailor the process to that end. At times, this means acknowledging that a tension exists between different objectives, and taking a clear stance on which objective is being prioritised. For example, a policy consultation may require a specific structure and focus to meet decision-makers' needs. Another time, an organiser will have to get a particular decision-making body on board to ensure buy-in for their process. Both examples may involve some restriction of the scope of the debate and the public participants' input to maximise the impact of the outputs. Alternatively, the needs of the participants or researchers may be the main concern, and the process can be more flexible and open[101].

Another challenge in public engagement on nanotechnologies has been to create meaningful engagement on a topic that the general public knows very little

about. Nanotechnology policy is a highly complex area of science and technology, spanning various disciplines. In many areas it is also in the early stages of development, in the sense that the options for advancing the technology and for dealing with its related risks and uncertainties are still being debated by industry, scientists and decision-makers. And, whilst the aim of 'upstream' engagement is to explore these topics with the public at a stage when they can still be addressed, this has also meant that the discussions that have taken place have sometimes lacked focus. An evaluator and an organiser said:

> 'With an issue as upstream as nano is, it is very difficult to get a grasp of what there is to discuss, and a some of the discussions have been a bit flat.'
> *Evaluator 2*

> 'The members of the public and the scientists agreed that there was no one group or person taking responsibility or making decisions [about nanotechnologies]. (...) it leads to a question of what you are trying to engage with when you do this kind of thing'
> *Organiser 1*

Lack of agreement about the proper purpose and appropriate topics for public engagement underlie tensions experienced by some participants. There was frustration on the part of some scientists that members of the public were interested only in discussing certain aspects of science. Discussions tended to focus on applications that members of the public could relate to such as consumer goods and medical applications.

> 'We were discussing things like medicine, the environment, or transport: things that people feel strongly about. This helped; it made it less abstract. Nanotechnology is such a general thing, but when you put it into medicine or cars, it's a whole different debate altogether.'
> *Public participant 9, NanoJury UK*

The gap between this focus on technological applications and the basic research that constitutes the bulk of most nanoscience work proved difficult to bridge for some scientists:

> 'A couple of people got hung up on Marks and Spencer's socks, which have got nanoparticles in them apparently. They don't understand how chips work in computers, and so, if you like, the mainstream of nanotechnology, they couldn't really relate to so well. It is so technical. And they can relate better to things like "this is a risk, therefore don't do it" sort of thing. But that's superficial.'
> *Scientist 7, Small Talk*

These tensions highlight the fact that values and traditions that drive science are contested. Some people object to the notion of 'basic' or 'blue-skies' research, and instead call for research and development to be driven by specific goals and benefits. Others, including many public participants who have taken part in these activities, appreciate the value of 'basic' research and its potential for leading to new and unanticipated applications and benefits[102].

What contribution is expected of participating members of the public? The highly complex nature of nanotechnologies and the high degree of uncertainty about their development makes it difficult to create public engagement processes that satisfy all parties. Again, it is a question of being clear about the purpose of every party's involvement. If the aim is to discuss nanotechnology in terms that scientists or policy-makers have defined and are comfortable with, public participants are likely to find that challenging. They will need a high level of support and information in order to take part. If, on the other hand, the aim is to let the public participants lead the discussions, the risk is that the findings may not be considered meaningful by scientists and decision-makers, or will need a high degree of interpretation and analysis before they are recognised as such.

It is also a question of managing expectations. Ultimately, engagement of the public on an emerging discipline such as nanotechnologies will rarely be a question of recording public opinions, or tapping into existing debates. Instead, it is more helpful to see engagement as a way of enabling people to form opinions, allowing them to ask questions, and let them raise any concerns they have.

NanoJury UK; Nanodialogues; and Nanotechnology, Risk, and Sustainability allocated substantial time for participants to understand the process and the topic, and to get to know each other before deliberations with scientists started[103]. This extra time and support yielded results: organisers, scientists, and members of the public commented on the high quality of the discussions and the useful

contributions brought to the table by public participants[104]. The opportunity to reconvene was seen as particularly helpful, especially because it enabled participants to develop their opinions over time:

> 'One of the things that struck me was how well it worked to have people come back three weeks in a row. You could really see the evolution of participation as people became more comfortable with each other and the issues.'
> *Evaluator 1*

What contribution is expected of participating scientists? Interviews with scientists and project organisers have revealed that it is not always made explicit what role scientists are expected to have in public engagement. Although scientists tend to be invited to educate, teach, or inform public participants about a particular area of science to enable debate on the topic, there are often additional underlying expectations that the process should lead to increased self-reflection among scientists, and build their capacity for engaging with the public.

Some scientists who were interviewed by NEG have said that these types of objectives were not made explicit until the process was under way:

> 'I didn't realise until I got there that the actual day in itself was an experiment. I thought that it was really just an opportunity for scientists to talk to the public. (…) I was expecting it to be a discussion about science, more than a discussion about ethics and responsibility.'
> *Scientist 8, Nanotechnology, Risk, and Sustainability*

On the other hand, project organisers have said it can be difficult to get scientists to understand what engaging in dialogue entails:

> 'I was surprised at how little the scientists who were there had learnt from previous exercises in science communication. They were very much about "we do the facts—you do the values and opinions".'
> *Organiser* 4

The NEG argues that it is by providing active learning for scientists, members of the public and decision-makers, and offering opportunities for these groups to voice their views and concerns on science and technology, that public dia-

logue can add most value to discourses surrounding new and emerging science and technologies. An important factor in achieving this goal is to ensure that scientists who take part in public engagement in science and technology are sufficiently supported and briefed on the role they are expected to play in the process. Moreover, project organisers must be transparent about any expectations they have on participating scientists' own learning and development.

Who is the target audience, and what is their role in the process? So far, decision-making institutions have had little direct involvement in upstream public engagement delivery, because most activities have been done at arm's length by external contractors or independent practitioners. NEG suggests that this lack of direct involvement by decision-makers limits the ability of these groups to engage with, and respond effectively to public engagement activities. Hence, if the primary aim of a public engagement activity is to inform decision-making in a particular institution, the NEG argues that organisers should seek to involve the institution in question from the outset. It also means that project organisers need to be aware and considerate of how institutional timescales are likely to affect the ability of target institutions to respond to, and make use of, the findings. We develop this argument in the next section, where we look at how institutional capacity and culture affect public engagement in science and technology.

4.2.2 Institutional capacity and culture

Public engagement practice tends to focus on identification of the correct engagement method for a particular process. However, research by Involve has found that more often than not, the context in which the process takes place determines its ability to succeed, rather than the methods used. Involve uses an analogy with horticulture to highlight this point: public engagement activities are the seeds (eg, focus group or citizens' jury), and the context the soil into which they are planted. The soil is the participants, the political climate, the relevant history, the decision-makers, the infrastructures that connect them, and anything else that defines the context. The seeds determine the type of output that will emerge, but the quality of the soil determines if anything will grow (ie, whether the process achieves its aim or aims)[105].

How the findings of a public engagement exercise are received, and the extent to which they are incorporated into decision-making, depend largely on the culture and capacity of the institutions they seek to influence. By institutional culture

we mean the attitudes of decision-makers and scientists to public engagement. For instance, is public engagement seen as optional or essential? Are there set understandings of expert versus non-expert views that affect how the findings are received? Institutional capacity refers to the infrastructure, time, knowledge, skills, and resources needed to make public engagement happen and to make use of the findings. For example, do civil servants have the time and resources to commission public engagement, or to engage with the findings of other organisations' activities?

Together, institutional capacity and culture form an important part of the soil into which the seeds of public engagement are planted. Without institutional will and resources to connect with public engagement activities, they have little hope of informing the work of these institutions.

This idea that the policy value of engagement depends partly on the capacity of a commissioning institution also surfaced at an NEG workshop in June, 2006. Such arguments are arising not only in the context of nanotechnologies, but also in wider discussions of public engagement, that now prioritise institutional capacity building over that of methodological innovation[106]. The government's commitment to build capacity for public engagement has been evident in a number of recent initiatives, including the Department for Communities and Local Government's (DCLG) Together We Can programme[107]; the forthcoming People and Participation Online website[108]; the recently launched Beacons of Public Engagement project[109]; and a suite of initiatives set up by the Department for Constitutional Affairs (DCA), including the Innovations Fund and a civil-servant support scheme that is currently under development. In science and technology, related activities include the forthcoming Expert Resource Centre on Public Dialogue in Science and Innovation, run by Sciencewise[110].

Cultural challenges: Involve's research suggests that scientists' and decision-makers' attitudes to public engagement are influenced by preconceptions they hold about the public's ability to contribute meaningfully to science or policy discourses[111]. Nearly half the scientists who were interviewed for this research were surprised at public participants' ability to contribute to discussions about nanotechnologies, suggesting that some scientists' attitudes to two-way public engagement are influenced by stereotypes about the public's understanding of, and attitudes to, science. Commonly, these attitudes are based on scientists'

personal experience of talking with non-scientists among friends and family or in other contexts. A scientist commented:

> 'In general I find the level of knowledge about sciences to be pretty low, along with the time people spend thinking about the social and ethical implications of it. (...) So what was surprising for me was the level of response that we had at the meeting, which was significantly higher than what I'm used to.'
> *Scientist 6, Nanotechnology, Risk, and Sustainability*

These experiences affect how scientists perceive the value of public engagement. They might expect it to be another case of trying to discuss science with people who know nothing about it or who are uninterested. Consequently, our research found that many scientists see public engagement as an opportunity to teach the public about their work, rather than a form of joint exploration of the public and policy dimensions of nanotechnology. A participating scientist commented:

> 'It should be a two-way process, and I think when concerns and opinions are voiced, then scientists take them into consideration as best they can. But from my point of view, it really is a very one-way process. The public are reasonably apathetic until there is a subject that directly affects them, and so it is a case of scientists educating the public, whether they like it or not, until a point when something concerns them.'
> *Scientist 8, Nanotechnology, Risk, and Sustainability*

These findings are confirmed by the RS's 2006 survey of factors that affect scientists' participation in public engagement and science communication[112]. The survey found that when scientists were asked to define public engagement, most responded that it meant educating the public about science and its implications; only 13% stated that it meant listening to and understanding the public[113]. This situation has been a source of frustration for project organisers who built their processes around the assumption that scientists would listen to the views of members of the public and learn from them:

> 'What the scientists have been invited to do is to come along and listen and reflect on what they have to say to you (...) half of the point of them being there is to listen and they've missed out on that really.'
> *Organiser 5*

However, as the scientists involved in this study have pointed out, scientists who wish to engage in more deliberative, two-way forms of dialogue face institutional constraints such as lack of time, incentives, support, and resources. In many science institutions, public engagement is not a priority, and it can be difficult for researchers to convince their employers that it is a worthwhile time investment. An NEG interviewee stated:

> 'The key thing is that there is absolutely no kudos involved in doing public engagement, and the metrics that are used to determine how successful a university is does not recognise public engagement'
> *Scientist 1, Nanodialogues*

At a workshop held by NEG in June, 2006, participants discussed steps to overcome cultural and institutional barriers to public engagement in the science community. Most supported the call for more support to help scientists engage effectively with the public. The strongly supported suggestions included:

— Formal recognition for engagement with the public.
— Funding bodies to stress the need for dialogue-focused public engagement, alongside one-way engagement approaches such as public lectures[114].
— Change in institutional culture in universities and funding bodies to encourage and recognise the value of public input in research and development.

These issues are discussed at length in the RS's 2006 report on factors that affect scientists' involvement in public engagement. The report's recommendations correspond with those made by the NEG workshop attendees, and also include demands for more training and other forms of practical support, such as mentoring, for scientists taking part in public engagement[115].

These changes are already beginning to happen. In recent years, the RS and the RAE have established departments devoted to promotion and improvement of public engagement in the science community; so too have the EPSRC and the BBSRC, who have worked extensively over the past few years to find new ways to incorporate public perspectives into policy. For instance, the establishment of the BBSRC Bioscience for Society panel in 2005 guides the development of the BBSRC's public engagement work and advises the council and strategy board on social and ethical issues. Similarly, the EPSRC set up a Societal Issues Panel in 2006 to advise the Council on societal, political, and regulatory matters

(including issues related to public engagement). The Panel is of equal weight to the Technical Opportunities Panel and the User Panel, which advise the Council on research opportunities and industry interests.

NEG welcomes these developments, but argues that a continuing challenge for science institutions is to go beyond such formal commitments to public engagement and build a deeper public engagement capacity among individual scientists and in science institutions. Critically, these initiatives should be judged against their ability to support the cultural shifts outlined here—ie, to foster a greater appreciation in science communities of the different benefits and impacts of public dialogue in science and technology.

Institutional capacity: NEG's research has revealed limits in the ability of decision-making institutions to engage with, respond to, and make use of public engagement in science and technology. These limits include

— Lack of time and resources to engage with public dialogue activities.
— Lack of experience, training, and support to engage effectively with the public.
— Restricted definitions of policy impact, and a lack of understanding and appreciation of different kinds of impact and benefits of public engagement.

Lack of time and resources to engage with public dialogue activities: Many objectives for public engagement listed in chapters 2 and 5 depend on the establishment of a meaningful connection between the public engagement process and the institutions it seeks to influence. However, establishment and maintenance of connections take time. Our interviews with project organisers and civil servants show that staff at decision-making institutions frequently lack time and resources to connect effectively with public engagement activities. Instead, they assume that reading the final recommendations or project reports will be sufficient. NEG suggests that for government to maximise its ability to benefit from, and make use of, public engagement activities, people with decision-making power (eg, funders and researchers who sit on grant-giving panels) must be involved in different stages of the processes:

— At the start (when the process is being framed) to ensure that the correct institutional representatives are involved; that organisers are aware of the expectations of their target audience's constraints and timeframes; and that objectives of the process are realistic and useful for all concerned.

— During the process to ensure that decision-makers gain full benefits of the activity, are able to capture the richness of the discussions that take place, and can absorb and respond to the public participants' views and recommendations as they emerge.
— After the process to ensure that any outputs are responded to and taken forward by the appropriate institutions.

We do not suggest that decision-makers should have a more directive role in public engagement activities. Rather, NEG believes that decision-makers would benefit from taking part in a similar capacity to that of the scientists: ie, by listening to public participants, engaging in discussions with them, and offering their own perspectives on the issues discussed. Nor do we mean to say that recommendations are not important; the NEG believes that they are a very important and valuable tool for communicating project findings. However, they are not as important or valuable as the deliberations that produce them.

Lack of experience, training, and support to engage effectively with the public: Many project organisers and civil servants who have been interviewed by NEG for this study have said that staff who work at decision-making institutions commonly lack experience and training to engage effectively with the public. Two interviewees said:

> 'I don't think government is able to take it on; the training of civil servants systematically excludes these kinds of considerations. They are not minded to do it [engage with public engagement findings], and it is not explicitly encouraged from above'
> *Partner 4*

> 'Policy makers aren't trained really. It just isn't part of their make-up, their mindsets, to think in terms of "how should we engage the public early on in the policy process?" Because they see that as their job, effectively. And increasingly we are seeing policy-makers who are making assumptions about public values, without going out to test what they really are, or what direction they're heading.'
> *Target audience 8*

NEG therefore recommends that different forms of support, such as training, coaching, and action learning networks should be provided to decision-makers who are involved in, or affected by, public engagement activities.

Restricted definitions of policy impact: Overcoming these capacity gaps is complicated by established cultures of policy-making, which include a reliance on 'robust evidence', and a tendency to view public engagement as one-way forms of consultation or communication. As we explain in the first half of this chapter, public engagement can generate a wide range of impacts and benefits—both for the individuals who take part, and for institutions and professional communities. Hence, the tendency among policy-makers to view the written outputs of the processes as their only means of making an impact limits their ability to benefit from these activities.

NEG argues that organisations that have a role in planning, funding, or responding to public engagement in science and technology need training and support to better understand and make use of the broad spectrum of valuable impacts that public engagement can deliver beyond production of recommendations for policy.

4.2.3 Reaching more people

As this study has shown, public dialogue on science and technology brings many potential benefits for those who take part. An important challenge for future activities in this field will be to distribute more widely the learning and other benefits from these often small-scale processes. NEG argues that reaching more people is necessary if the broader aims of the public engagement agenda are to be met, such as raising awareness about science and building public confidence in science governance. We also believe that involvement of more scientists and decision-makers in public engagement processes would help build continued support for public engagement in the science community and decision-making institutions.

The benefits of public engagement can be distributed in two ways: by direct involvement of more people in public engagement activities; or by communication of the processes' outcomes and findings to more people. NEG argues that both avenues need exploration. More effort needs to be made to communicate the outputs and outcomes of public engagement to larger numbers of

people, through work with media partners, use of online tools, or through greater efforts to distribute printed reports to diverse audiences. Such communications strategies should focus on sharing, and as far as possible involving people in, the nuances of deliberations rather than just the outputs alone. New options need to be investigated for involvement of more people in public deliberations about science and technology, including face-to-face models, online debates, and broadcasting options.

In this section, we return to the original aspirations and expectations held for public engagement on nanotechnologies, and look at to what extent they have been achieved.

84 Scientist 2, NanoJury UK

85 See also chapter 5

86 Pigeon N (2004). *An Evaluation of GM Nation,* Norwich: UEA; Burgess J, Chilvers J (2004). *An Evaluation of COWRM.* London: UCL; Warburton D (2004). *Evaluating The National Waste Dialogue.* London: The Environment Council; AEA Technologies (2005). *An Assessment of Science & Technology Public Engagement*. London: Council for Science & Technology

87 Organiser 2

88 Nanodialogues, experiment 1

89 Environment Agency (forthcoming)

90 See chapter 3. Small Talk and Engaging Research Councils in particular found considerable support for the idea of basic research among the public participants. See Smallman M, Nieman A (2006); Kearnes M, Stilgoe J (forthcoming)

91 Scientist 4, Nanodialogues

92 Kleinman D, Powell M (2005). *Building Citizen Capacities for Participation in Technoscientific Decisionmaking: The Democratic Virtues of the Consensus Conference Model—Draft.* Madison: University of Wisconsin. See also a brief description of Madison Area Citizens' Conference on Nanotechnology in appendix 1

93 Active citizenship refers to 'citizens taking opportunities to become actively involved in defining and tackling the problems of their communities and improving their quality of life.' See www.togetherwecan.info

94 See chapter 3

95 Scientist 2, NanoJury UK

96 Environment Agency (forthcoming)

97 Smallman M, Nieman A (2006)

98 See chapter 5 for a detailed discussion of aspirations and outcomes

99 Decision-makers, members of industry, and scientists who are involved in nanotechnology funding, research, and development, and who are interested in, and affected by, public views on nanotechnologies

100 For details of every projects' objectives, see chapters 2 and 5

101 For a related argument about how public engagement can serve to 'open' or 'close' debates, see Stirling A (2005). 'Opening up or closing down? Analysis, participation and power in the social appraisal of technology.' In: Leach M, Scoones I, Wynne B. *Science and Citizens.* London: Zen

102 Small Talk, Engaging Research Councils, and Citizen Science @ Bristol have reported an appreciation among public participants for the need to continue funding of 'basic' research

103 NanoJury UK met over ten sessions of two and a half hours each; Nanotechnology, Risk, and Sustainability allowed every focus group to meet twice before a select group of participants met with some scientists in London; and the Nanodialogues experiments in the UK consisted of three reconvened events

104 By contrast, Small Talk (which ran short, one-off lectures and discussion events lasting between one hour and a day) was found by many public participants to be too limited to accommodate both learning and discussion. Many expressed frustration that they did not know what they were supposed to be discussing; scientists said that debates were superficial and that participants were not equipped to make informed judgements about the subject

105 Involve, Institute for Public Policy Research (IPPR), and Ipsos Mori (2006). *User Empowerment in Local Service Delivery.* London: Office of the Deputy Prime Minister (ODPM)

106 See for example DCLG (2006). *Strong and prosperous communities: the Local Government White Paper.* London: DCLG; House of Lords (HofL, 2000); Involve, IPPR, and Ipsos Mori (2006)

107 www.togetherwecan.info

108 People and Participation Online is a webguide set up to provide institutions and individuals with resources and advice related to public engagement. The initiative is funded by DCLG, the Sustainable Development Commission (SDC), and the Ministry for Justice (formerly Department for Constitutional Affairs, DCA). See www.peopleandparticipation.net (launched June, 2007)

109 Beacons for Public Engagement is a funding scheme set up to create a coordinated approach to recognise, reward, and build capacity for public engagement in higher education. The scheme is coordinated by the Higher Education Funding Council for England (HEFCE) in association with RCUK and the Wellcome Trust. See www.hefce.ac.uk/NEWS/HEFCE/2006/beacons.htm

110 www.dti.gov.uk/science/science-and-society/public_engagement/public_dialogue/page12695.html

111 This claim is based on interviews with scientists done for this study and interviews with civil servants done by Involve as part of a research project for Sustainable Development Commission (SDC; Involve, forthcoming)

112 Royal Society (2006). *Science Communication: Excellence in Science.* London: Royal Society

113 Royal Society (2006) p 9

114 Currently, the BBSRC requires that its researchers do public engagement as part of their research contracts, but does not specify what kind of public engagement

115 Royal Society (2006)

5 Aspirations and achievements of public engagement on nanotechnologies

5.1 Project aspirations and achievements

There is no direct relationship between the government's aspirations for public engagement on nanotechnology and the objectives of the projects included in this study. Most projects took place independently of central government funds, and none were commissioned explicitly to fulfil specific elements of the government's OPPEN. Rather, they emerged in response to available funds and organisational interest. Although this fragmented approach was part of the government's plan to learn from external organisations' perspectives on public engagement, this means that it would be wrong to critique the projects against the government's goals. Therefore, we begin this analysis of the achievements of public engagement on nanotechnologies by measuring the project outcomes against their own objectives. The objectives listed by the individual projects have three broad themes:

— Informing and improving public engagement practice.
— Enabling attitude formation and exploring public views on nanotechnologies.
— Informing nanotechnology policy and research.

In the next three sections, we discuss these themes and list the projects that had objectives under each theme.

5.1.1 Informing and improving public engagement practice

Objectives explicitly concerned with informing and improving public engagement practice

NanoJury UK
Facilitate a mutually educative dialogue between people with diverse perspectives and interests, including critical and constructive scrutiny by a wider group of citizens of the hopes and aspirations of those working in the nanotechnologies-related sectors.

Small Talk
- Facilitate dialogue on nanotechnologies.
- Provide resources and support for organisations that run dialogue events and activities. Improve understanding and use of good practice in engagement with the public on scientific issues.
- Evaluate the impact of a coordinated approach, and share findings with the wider science-communication community.
- See whether science-communication organisations can contribute meaningfully to public engagement agenda.

Nanodialogues
- Experiment in a theoretically informed way with new methods of upstream public dialogue in societal debates about nanotechnologies.
- Identify wider lessons and insights that can inform the policy and practice of public engagement in science and technology.
- Generate intellectual and practical resources for enriched public, policy, and scientific debate about social implications of nanotechnologies.

Nanotechnology, Risk, and Sustainability
- Explore possibilities for improvement of dialogue between nano-scientists and general public to integrate public responses into innovation processes, including industrial research and development.

— Explore methods that could be used to integrate public concerns into the development of a socially and environmentally sensitive regulatory framework for nanotechnologies.
— Explore the question: how are expert and public perceptions formed around the social, cultural, and environmental implications of nanotechnologies, including benefits, risks, uncertainties, and opportunities for re-design?

These projects were experiments in public dialogue on upstream science and technology, using nanotechnologies as a test case. Most projects[116] held aspirations concerned with informing and improving public engagement practice.

NEG argues that, overall, these objectives have been achieved. Collectively, the public engagement activities included in this study have:
— Demonstrated that it is possible to deliver mutually educative dialogue between scientists and members of the public on complex, upstream scientific topics.
— Improved understanding about how such mutually educative dialogue can be conducted.

As experiments in deliberative public dialogue, NanoJury UK; Nanodialogues; and Nanotechnology, Risk, and Sustainability have contributed, individually and collectively, to improved understanding of the benefits of direct involvement in deliberative public engagement for different participants. We explore the nature of these benefits and impacts in chapter 4[117].

The projects also achieved individual goals to improve public engagement practice. For instance, NanoJury UK demonstrated how two-way engagement can work in practice by inviting jurors to address a topic of their choice before looking at nanotechnologies. The organisers also dedicated substantial time and effort to support the jurors to develop their views and recommendations on both topics.

Small Talk demonstrated that science communicators can contribute to the government's public engagement in science agenda by encouraging science communicators to experiment with deliberative dialogue methods; addressing policy-relevant topics; and by collating participants' views to inform a policy report.

The dissemination and sharing of this learning will be critical for whether these projects achieve their goal of informing and improving public engagement practice. All four projects have produced and disseminated project reports for this purpose[118]. Sharing the learning from these projects is also an important function of NEG. A summary of practical lessons for public engagement can be found in appendix 2: NEG framework.

5.1.2 Enabling attitude formation and exploring public views

Objectives explicitly concerned with enabling attitude formation and exploring public views on nanotechnologies

NanoJury UK
'Explore the potential for deliberative processes to broaden discussions about nanotechnologies research policy—both in terms of the range of issues and the diversity of people who are given a say.'

Small Talk
'Build a better understanding of the public's and scientists' aspirations and concerns about nanotechnologies.'

Citizen Science @ Bristol
'Encourage young people through discussion and debate to form opinions about scientific issues and their social and ethical implications, and to encourage active citizenship by teaching them how to act on their views.'

Democs
'Enable small groups of people to engage with nanotechnology policy issues.'

Nanodialogues and Nanotechnology, Risk, and Sustainability did not explicitly state objectives concerned with enabling discussion and exploring the formation public attitudes to nanotechnologies. However, both projects recorded the issues raised in the discussions in theirproject reports, and Nanodialogues reported their findings directly to their partner organisations and to other relevant decision-making institutions.

Our research suggests that the public engagement on nanotechnology projects included in this study have achieved collectively the following in relation to this goal:

— Gathered information about informed public attitudes to nanotechnologies that, although not statistically significant, derive from a diverse range of social groups and are based on deliberative learning. As such, they provide useful insights into the aspirations and concerns that may arise once the wider UK public becomes more aware of nanotechnologies and their implications.
— Demonstrated that deliberative public dialogue can help members of the public learn about, and form opinions of, areas of science and technology they previously knew little or nothing about.
— Demonstrated how different approaches can be used to achieve this aim, thus helping to inform future practice of public engagement on emerging science and technology[119].

5.1.3 Informing nanotechnology policy and research

Objectives explicitly concerned with informing nanotechnology policy and research

NanoJury UK
'Provide a potential vehicle for people's informed views on nanotechnologies to have an impact on policy.

Small Talk
'Share the findings with policy-makers and the science community.'

Nanodialogues
'Ensure that these dialogue experiments are framed in a way that can inform processes of institutional decision-making and priority setting.'

NanoJury, Small Talk, and Nanodialogues made commitments and efforts to inform nanotechnology policy and research agendas. Thus far, all three projects have reported their findings to government and other relevant institutions. The responses they have received have been mixed, and only one institution has responded formally to the findings to date[120].

These three projects used very different approaches to communicate their findings to decision-makers. NanoJury UK greatly emphasised support for jurors before, during, and after the process to enable them to articulate and bring forward their views. In many senses, project facilitators acted as a campaign vehicle to ensure that jurors' views reached government. The jurors' recommendations were presented to an audience of policy-makers, journalists, social researchers, and scientists in September, 2005, at an event that three jurors attended. The Nanotechnology Issues Dialogue Group (NIDG) promised a response to the recommendations, which has yet to be delivered.

Small Talk, by contrast, did not support its public participants to write recommendations for policy. Instead, public views were collated from the different events that took place and these data were used to compile a summary of lessons for policy. The organisers reported their findings to the NIDG and to Defra's Nanotechnology Stakeholder Forum in October, 2006.

Nanodialogues emphasised the building of relationships with partner organisations[121] who committed to taking the findings forward. Engagement activities were designed with the organisations' needs in mind from the outset. Nanodialogues organisers reported the findings of the People's Inquiry on Nanotechnology and the Environment to Defra and the Environment Agency in 2006; the findings of the Engaging Research council experiment to the BBSRC and EPSRC in December, 2006; the findings of the Nanotechnology and Development experiment to Defra's Nanotechnology Stakeholder Forum in 2006; and the findings of the Corporate Upstream Engagement experiment to Unilever in 2007. Furthermore, the Nanodialogues organisers reported their general findings to the NIDG in April, 2006. At the time of writing, only the Environment Agency has provided a formal response to the findings. The BBSRC and EPSRC are in the process of formulating a response to the Engaging Research Councils experiment.

In chapter 4, we discuss three challenges that affect the ability of public engagement activities to achieve their objectives: clarity of purpose and roles; institutional capacity and culture; and distribution of the benefits of public engagement. NEG argues that an additional factor that affects whether a public engagement activity is perceived as effective is how those involved define the term 'policy impact'. Our interviews with project organisers, participants, and

target audiences showed that many in these groups define policy impact as being able to see a clear link between project outputs (usually written reports or recommendations) and subsequent decisions or policy documentation.

NEG contends that this understanding of policy impact is narrow. Such direct links between public engagement activities and decision-making rarely happen in public engagement on new and emerging science and technology, the outputs of which tend to address broad issues and concerns that do not fit easily into existing policy-making structures. Instead, we believe that public engagement activities are more likely to influence policy and decision-making through more subtle and indirect avenues. For instance, as we have seen, a public engagement activity may challenge the views and attitudes of those who take part, thus leading to a gradual change in the priorities of decision-makers or researchers. Public engagement can contribute to building new relationships between scientists, decision-makers, and members of the public, thus introducing new perspectives, information, or resources into decision-making processes. Moreover, a public engagement activity can inspire new debate among the public, science communities, or policy communities, which in time may lead to a change in decision-making agendas.

Another reflection on these objectives and achievements is that although all projects involved members of the public in their activities, their definitions of the term 'public' and their approach to the recruitment process differed. Some audiences were self-selected and participants paid a fee to attend, whereas others were recruited on the basis of demographic criteria and were paid to be there. Some projects made conscious efforts to involve a diverse cross-section of the population; others used no such criteria.

Audience diversity underlines the importance of being clear about how the term 'public' is defined and on what basis participants in public engagement activities are recruited. As we state in chapter 2, it also draws attention to the importance of ensuring that public engagement activities are founded on principles of inclusion and diversity[122]. If a key aim of public engagement in science and technology is to inform nanotechnology policy and research, it is essential that efforts are made to ensure that the people involved represent a diverse cross-section of society, with no section of society excluded on the basis of ethnicity, religion, disability, gender, or age.

5.1.4 A reflection on project methods

There are clear parallels between the six projects included in this study, but also clear differences. The motivations of the organisers for engaging the public were sometimes different, as demonstrated by the objectives listed above. The methods used to achieve their objectives also differed. These projects present a diverse cross-section of methods for public engagement, including a citizens' jury, an engagement game, traditional lectures and seminars, deliberative focus groups, and chat-show debates.

Despite differences in approaches used, the public views and attitudes collated from the different processes are strikingly similar, which suggests that in terms of recording public attitudes, the method does not make a great difference to the substantive output. However, as we explore in this chapter and the previous chapter, the outcomes of these projects were not equal in every way. For instance, some processes focused on specific policy issues, and generated slightly more focused outputs as a result.

The People's Inquiry on Nanotechnology and the Environment looked specifically at usage of nanoparticles to clean up contaminated land, and generated some recommendations on this issue. However, only three of the 12 recommendations produced relate to nanotechnologies and the environment, and only one of these is concerned specifically with the use of nanotechnologies to clean up contaminated land. Engaging Research Councils also focused on a specific issue: the role of public engagement in decision-making by research councils. Again, the recommendations generated by the process focused specifically on this issue. However, the findings presented in the draft project report reveal that the discussions that took place before the recommendations were drafted raised many of the same issues about science governance and regulation as in the other public engagement activities.

As we have seen, some processes were geared more towards encouragement of in-depth deliberation or building relationships between participants. This study suggests that these projects generated certain benefits and impacts that were not achieved when more traditional, one-way public engagement approaches were used[123]. These benefits included: fostering of mutual learning between participating scientists, decision-makers, and members of the public; overcoming negative stereotypes between groups; and supporting active citizenship among public participants.

Another observation is that all projects used established approaches to public engagement[124]. NanoJury UK used a citizens' jury model; Nanodialogues and Nanotechnology, Risk, and Sustainability used deliberative focus-group and workshop models; and Small Talk and Citizen Science @ Bristol used a mixture of deliberative and traditional question-and-answer approaches. NEG argues that there could have been scope for more methodological innovation among the projects. For instance, no organisation has thus far sought to address upstream science and technology issues by use of a more structured model for assessment of policy options through public dialogue that have been developed for downstream science governance and risk assessment[125]. Nor has any project sought to develop new public engagement methodology specifically for the purpose of addressing 'upstream' issues.

That is not to say that no innovation has taken place. NanoJury, for example, experimented with two-way engagement by running two parallel citizens' juries: one on nanotechnology and one on a subject of the public participants' choice. Nanodialogues organisers experimented with building strong institutional links in different settings, to give their dialogue activities a clear route of influence. Small Talk explored new ways of involving science communicators in the public engagement agenda. In this way, the projects have made significant headway in building relationships between publics, scientists, and policy-makers, as well as opening up the processes of science and science policy to wider public scrutiny and input. As such, they have provided this study and the wider debate about science and society with invaluable experience and expertise to draw on for future upstream engagement.

Nonetheless, NEG argues that if the government's aspirations for public engagement in science and technology are to be achieved, new approaches to public engagement are probably needed. Until more experimentation with different public engagement[126] approaches takes place, or more innovation occurs in upstream engagement, it is too early to draw any definitive conclusions about the uses, limits, and potential of public engagement on new and emerging science and technology.

5.2 Government aspirations for public engagement on nanotechnologies

Official government aspirations as outlined in OPPEN:

- Enable citizens to understand and reflect on issues related to nanoscience and nanotechnologies, both personally and through inclusive processes involving citizens, policy-makers, and researchers.
- Enable the science community and the public to explore together both aspirations and concerns around the development of nanotechnologies.
- Enable institutions who work in nanotechnologies to understand, reflect on, and respond to public aspirations and concerns.
- Establish and maintain public confidence in the development of technologies by understanding the public's concerns and showing their impact on government regulation.
- Contribute to wider government initiatives to improve the general trustworthiness of science-and-technology-related institutions.
- Support wider government initiatives to support citizen participation in public policy and service delivery.

As discussed in the beginning of this chapter, there is no direct link between these public engagement activities and the government's formal aspirations for public engagement on nanotechnologies. Here, we look at the government objectives outlined in OPPEN, and discuss the extent they have been met by the public engagement activities that have taken place.

Enable citizens to understand and reflect on issues related to nanoscience and nanotechnologies: NEG argues that this objective was at least partly achieved. The public participants who were interviewed for this research were able to understand and discuss issues related to nanotechnologies. It is more difficult to determine whether these projects have contributed to raising awareness and understanding about nanoscience and nanotechnologies beyond those who were involved directly in the activities. There is some evidence of

public participants talking about nanotechnologies with friends, family, and colleagues during and after the activities, but the ability of such exchanges to help raise wider public awareness is clearly limited. The reports and publications produced by the organisers from NanoJury UK; Small Talk; Nanodialogues; and Nanotechnology, Risk, and Sustainability have been aimed mainly at professional audiences who are involved in science policy or public engagement. The only known attempt to use these activities to contribute to wider public debate is the Guardian newspaper's involvement on, and press coverage of NanoJury

Enable the science community and the public to explore together aspirations and concerns around nanotechnologies: NEG argues that this goal has been achieved. All six projects in this study have supported forms of dialogue between scientists and members of the public about nanotechnologies. Collectively and individually, the projects have demonstrated that it is possible to create constructive and meaningful deliberations between scientists and members of the public about complex scientific issues. All projects have collated data about public participants' views and concerns about nanotechnologies that arose from the discussions; and four projects have reported these findings directly to government.

Enable institutions working in nanotechnologies to understand, reflect on, and respond to public aspirations and concerns: Our research suggests that this objective has been achieved only to a limited extent at this stage. Although four of the six projects have reported their findings to government and other relevant institutions[129], at the time of writing, only the People's Inquiry on Nanotechnology and the Environment has received a formal response to its recommendations[130]. Our interviews with project organisers and civil servants have indicated that institutions are not allocating sufficient staff time to public engagement to achieve this OPPEN objective. This does not mean that government has ignored these activities; it did not commit to respond to all projects. However, until the relevant institutions respond to the findings and recommendations, NEG is unable to comment fully on the extent to which this objective has been achieved.

An important reflection on the ability of the projects to achieve this goal is that the outputs of the public engagement activities have not always been directed at the institutions that funded the activities. For instance, although the main

funder of public engagement on nanotechnologies thus far has been the Office of Science and Innovation (OSI), many recommendations have been directed at Defra as the main regulatory agency in this field. Individual projects have had to make separate efforts to ensure that their findings would reach Defra, who also had no input into the planning or design of the activities in question[131].

Establish and maintain public confidence in the development of technologies by understanding the public's concerns and showing their impact on government regulation: A central critique of the projects considered in this report has been their lack of links with policy-making. Although there are notable exceptions, such as the Nanodialogues project which explicitly sought to involve target audiences in the activities, overall it is very hard to demonstrate a clear link between public concerns and a change in government regulation thus far.

In terms of the broader point of establishment and maintenance of public confidence, evidence suggests that the projects have supported public participants to improve understanding of governance of science and technology. The public participants have, in some cases, demonstrated empathy and understanding of the challenges that regulators face in dealing with emerging and rapidly developing technologies. However, there is no evidence that these projects have contributed to building public confidence among participants or in the wider public. This is not a criticism of the projects, because it is was not their goal to contribute to building public confidence in the governance of technologies.

Contribute to wider government initiatives to improve the general trustworthiness of science-and-technology-related institutions: Our research into the views of public participants suggest that people see trustworthy science governance as decision-making that is transparent and socially grounded—ie, science that responds to society's aspirations and concerns. We have previously commented on the difficulty at this stage of judging whether these public engagement activities have made the development of nanotechnologies more aligned with public needs and aspirations. Until it is possible to demonstrate a link between these activities and nanotechnology policy or research, NEG is unable to comment on whether they have contributed to improving the general trustworthiness of science-and-technology-related institutions.

However, we can comment on the contribution these activities have made to making the governance of nanotechnologies more transparent. In many senses,

the movement towards upstream engagement has been an attempt to bring into public scrutiny the wide range of factors that affect the construction of science[132]; and to expose the relationships, assumptions, and values held by those at the heart of science policy-making. In essence, to make transparent the social, political, and cultural foundations of any new and emerging science.

Our study suggests that this goal has happened to an extent. Public engagement on nanotechnologies has exposed the limitations of existing governance mechanisms for handling the development and regulation of nanotechnologies to scientists, members of the public, and decision-makers. It has also exposed the constraints that regulators work under when dealing with new and rapidly changing fields of science and technology. These discussions have generated a degree of appreciation among the participants of the complexities and challenges that surround science governance and research. Although this does not necessarily translate into greater public confidence, NEG believes that it nevertheless demonstrates how transparency is an important step towards the creation of a more mature and mutually appreciative relationship between science and society.

Contribute to wider citizen participation in public policy and service delivery: To understand the degree to which this goal has been achieved, we need greater clarity of why 'wider citizen participation' is sought. Is it to support the broader goals of creating more transparent and therefore more trustworthy governance; or is it about creating new democratic structures or providing new avenues for citizens to engage with government? In either case it would be wrong to judge this goal in terms of the numbers involved. That these projects have taken place is a contribution to wider citizen participation. As this report highlights, the projects have generated invaluable learning that we can take forward to the next stage of public engagement in science and technology.

5.2.1 Other government aspirations

Scrutiny of the goals of OPPEN brings us back to the need to understand the values and aspirations that are driving the government's agenda for public engagement in science. Is it driven by a desire to improve the legitimacy of government, to inform policy-makers of public concerns, or to create new avenues of influence for the general public? Or is it about building public acceptance for new technologies as a foundation for the economic rewards of a high-tech economy?

Through interviews with civil servants for this project and others[133], Involve's research has identified other government expectations for public engagement that are not covered by OPPEN. These were not substantive in terms of expressing divergent overall goals for public engagement, but arose more out of the assumptions that public engagement should be neatly compatible with current models of science and technology policy-making. One such expectation is the idea that public engagement on nanotechnology would provide a measure of existing public opinions on nanotechnology. Another is that public engagement should follow due processes of public consultation, implying a one-way flow of information from the public to decision-makers on specific policy issues. A third is the view held by some civil servants that the outputs of public engagement need to constitute 'robust social research' if they are to be taken seriously in policy-making.

Opinion measurement: From the start of the nanotechnology public engagement experiments, assumptions were made by the civil servants involved that the activities would be 'like putting a toe in the water of public opinion'. NEG argues that these expectations are unrealistic for an area of science as new and complex as nanotechnologies. Public engagement on nanotechnologies cannot tap into existing public debates about nanotechnologies because such debates have yet to be formed. Furthermore, public engagement cannot give detailed answers to existing policy questions, not least because the relevant policy apparatus is only beginning to form and the policy questions remain diffuse. Instead, the aim of these projects has been to enable members of the public to have an input in strategic discussions about science and science policy, before big decisions about research priorities and regulation are made[134]. NEG argues that these projects have made significant headway in developing the understanding and tools for the continued use and development of upstream public engagement.

Consultation culture: Public consultation is a well-established component of policy-making. Although the definition of consultation is being stretched by the emergence of new methods of interaction with the public; traditional approaches to consultation still dominate how many civil servants understand the role of public engagement in policy-making. Consultation provides a clear 'due-process' for the handling of public contributions to policy-making processes[135].

There is not yet an established approach in government to support or make use of two-way public engagement. It is one thing to act as the recipient of consultation submissions and amend policy documentation in response; and another, very different thing to enter into a two-way process of mutual learning or joint policy development—the aspiration in some of these activities. Traditional models of consultation are frequently premised on defence of particular policy positions, outlined in 'consultation documents'. By contrast, engagement in two-way dialogue or joint policy development requires a different set of skills that include flexibility, being receptive to different perspectives, giving appropriate feedback, and planning sufficient time to engage with the process and its outputs. NEG argues that decision-making institutions need to prioritise building these skills among its staff to gain maximum benefit from new developments in public engagement.

Evidence-based policy-making: The governance of science and technology is dominated by a culture of 'evidence based' policy-making. In practice, civil servants are expected to scrutinise inputs to policy-making and judge their value by the methods that have been used to generate them. The limitations of this approach is that evidence-based policy-making tends to favour large-scale and established public engagement methods that produce outputs that fit neatly to policy-making structures (eg, opinion data), while placing less value on more deliberative and exploratory public engagement activities that produce qualitative outputs.

In scientific policy, this situation is complicated further by the fact that many policy-makers have been trained in quantitative scientific disciplines and are used to dealing with quantitative scientific evidence. This has created a difficult environment for the outputs from public engagement on nanotechnologies, which have been qualitative in nature. In effect, there has been a mismatch between the format of public engagement outputs, and the disposition and expectations of some civil servants who are expected to respond to them.

NEG argues that these three groups of expectations represent a misunderstanding of what the public engagement on nanotechnology projects set out to achieve. Informing nanotechnology policy, research and development was only one of several objectives of these projects, and it is wrong to judge them on their ability to influence decision-making alone. We discuss the importance of recognising other forms of impact of public engagement further in the conclusion.

116 NanoJury UK; Small Talk; Nanodialogues; and Nanotechnology, Risk, and Sustainability

117 We are unable to comment on the ability of less deliberative activities to achieve such benefits because we did not have access to sufficient numbers of Small Talk and Citizen Science @ Bristol participants to interview for this study

118 Available from the project websites, see chapter 2

119 For a summary of practical lessons, see appendix 2: NEG framework

120 Note that BBSRC and EPSRC are formulating their responses to the Nanodialogues project at the time of writing

121 See chapter 2 for details of different experiments and list of partner organisations

122 See chapter 2 and appendix 2 (NEG framework)

123 See chapter 4

124 With the exception of the Democs game, a relatively new invention. However, Democs is a tool to be used in deliberative engagement activities rather than an approach in its own right

125 Such as deliberative mapping. See www.deliberative-mapping.org

126 For example by introduction of approaches from other public engagement fields, such as the co-production models suggested by Singh and Wakeford (forthcoming) in: *Polluted Waters: The UK Nanojury as upstream public engagement (draft)*, p 11–13

127 Eight of 11 members of the public interviewed by NEG stated that they had talked to friends, family, or colleagues about nanotechnologies since taking part in the public engagement activity

128 See http://www.guardian.co.uk/life/nanojury/

129 Exceptions are Citizen Science @ Bristol and Democs. Note also that Nanotechnology, Risk, and Sustainability did not produce recommendations for policy

130 From the Environment Agency. Note that BBSRC and EPSRC are formulating responses to findings of the Engaging Research Council experiment at the time of writing

131 With the exception of Nanodialogues and NEG, who both had a representative from Defra on their steering groups

132 Wynne B (2004). *Public Dialogue with Science: some complications from the case of nanotechnology.* Presentation to the BA (British Association for the advancement of science) science-communication conference, May 24–25, 2004

133 Involve (forthcoming)

134 See also Kearnes et al (2006), p 42–44

135 See for example: *Cabinet Office (2004). Code of Practice on Consultation.* London: Cabinet Office. www.cabinetoffice.gov.uk/regulation/documents/consultation/pdf/code.pdf

6 Conclusion and recommendations

Three years since the RS/RAE published their report Nanoscience and nanotechnologies: opportunities and uncertainties, what have we learnt from these experiments in upstream public engagement on nanotechnologies? Are we in a better place now, as the title of this publication asks, to democratise technology?

The public engagement activities considered in this study have made important headway in developing the tools and understanding for creating constructive dialogue between members of the public, scientists, and decision-makers. They have opened up science-governance processes to public scrutiny and debate, and have demonstrated that public deliberations can generate important messages for scientists and decision-makers about the concerns and aspirations held by members of the general public for their work. They have also demonstrated how public engagement (especially when involving high-level deliberation) can generate mutual learning, build new skills, and overcome preconceptions and social barriers between different groups. Thus, these projects have given this study and the wider debate about science and society invaluable experience and expertise to draw on for future engagement in new and emerging science and technology.

In this section, we summarise the findings from our study of public engagement on nanotechnologies, and put forward NEG's recommendations that have emerged from this research. First, we list our recommendations for nanotechnology policy and science policy, which are based on our analyses of the public views and concerns summarised in chapter 3. Second, we look forward to the practical options for future improvement of public engagement in science and

technology. Here, we pay particular attention to the need to build capacity in institutions to better understand and make use of the opportunities that public engagement provides.

We also go deliberately broader than the public dialogue activities that have formed the basis of this research, and call for more innovation in the different ways that science and society interact. Many goals for public engagement that have been listed by the government and in the individual project objectives are concerned with improving the relationship between science and society. They aspire to build public confidence in the governance of science and technology, or to develop science and technology that is aligned better with society's needs. There are many ways of achieving these goals, and public dialogue, in its different shapes and guises, can only reach so far. Hence, we need to explore other options for creating and maintaining a constructive relationship between science and society, including distribution of the benefits of public engagement to more people, supporting innovation in public engagement practice, and finding new ways to create socially responsive research. We do not, therefore, promote public engagement as an end in itself, but argue that it is an important and valuable component in the wider attempts to create and maintain a mature and constructive relationship between science and society.

Members of the NEG group were not fully party to, and cannot necessarily be assumed to support, this report's recommendations.

6.1 Recommendations for science policy

As we have seen, public engagement activities have revealed a mixture of enthusiasm and concern among public participants about nanotechnologies. In chapter 3, we summarise the project recommendations and findings under three headings:

— **Social benefits of nanotechnologies:** public support for nanotechnologies that are linked to a wider social good.
— **Uncertainty and regulation:** concerns about known and unknown risks associated with nanotechnologies; the ability of government and private sector to manage those risks; and concerns about the social distribution of risks and benefits.

— **Transparency, and public engagement:** calls for more open decision-making about nanotechnologies, including opportunities for members of the public to input into nanotechnology policy and research.

There were significant parallels between these findings and the outputs of public engagement on nanotechnologies in other countries. There is also some consistency with the findings of previous public dialogue on GM food and crops, particularly concerns about uncertainty, regulation, and the social distribution of risk and benefits. NEG argues that the recurrence of these concerns in different contexts demonstrates that little has changed to make the governance of science and technology appear more trustworthy to the public. These findings should therefore not be dismissed as 'predictable' or 'stating the obvious'; rather, they must be taken seriously by government.

NEG has produced three recommendations for science (SR) based on the issues raised by the public participants. These are not intended to be read as a summary of the recommendations from the individual projects, and we recommend that relevant institutions read and respond to the individual project findings separately. The first two recommendations are concerned with nanotechnology funding and research; the third recommendation relates to how the governance of nanotechnologies can be made more transparent.

Although these recommendations are concerned specifically with nanotechnologies, NEG argues that they are also relevant to the development and governance of other areas of science and technology.

6.1.1 Nanotechnology funding and regulation

The public participants of these projects have emphasised the need for publicly funded science to serve a social purpose and be informed by the views and concerns of the public. They have also called for reasonable mechanisms to be in place to manage any risks and uncertainties presented by nanotechnologies. NEG recommends that government takes these public aspirations seriously and strives to fund research and initiatives that correspond with the public's calls for socially grounded science and technology.

SR1 Government should spend money on nanotechnologies provided that priority is given to funding research and developments that contribute to a wider social good, such as new medical innovations and sustainable technologies.

SR2 Government should continue work to identify the potential risks of nanotechnologies and nanomaterials, and create new regulation and laws for labelling on the basis of that research.

6.1.2 Creation of transparency

An important argument for increased public engagement in science and technology is that it is seen to make decision-making more transparent—ie, it opens up decision-making processes to the scrutiny of citizens and stakeholders, and thus increases the opportunities for groups to influence and challenge science policy. However, our interviews with scientists, policy-makers, and public participants show that the governance of science is a very unclear arena—particularly for emerging fields of science such as nanotechnologies, where the options and mechanisms for dealing with the technologies and their related risks and uncertainties are still unresolved. Lack of transparency creates difficulties for public engagement. An organiser who took part in our study observed:

> 'The members of the public and the scientists agreed that there was no one group or person taking responsibility or making decisions [about nanotechnologies] (...) it leads to a question of what you are trying to engage with when you do this kind of thing'
> *Organiser 1*

NEG argues that public engagement on nanotechnologies has helped to make the governance of nanotechnologies more transparent, albeit to a limited extent. The projects have exposed the limitations of existing governance mechanisms for handling the development and regulation of nanotechnologies to scientists, members of the public, and decision-makers. They have also exposed the constraints that regulators work under when dealing with new and rapidly changing fields of science and technology. As such, the projects have generated a degree of appreciation among participating members of the public of the uncertainties and challenges that surround science governance and research. Although this increased appreciation for the complexities of science governance does not

necessarily translate into greater public confidence, NEG believes that it is nevertheless an important step towards the creation of a more mature and constructive relationship between science and society.

The challenge for government and the science community now is to continue to make the governance of new science and technology more transparent, in order to foster the development of a more mature and open relationship between science and society. NEG proposes three steps towards this goal. The first is to produce specific documentation that outlines how responsibilities for the regulation and funding of new and emerging science and technology are distributed across the public sector. Such 'technology-governance maps' should present, in a clear and accessible way, the key players, regulators, funding structures, and policy timetables for a particular area of science and technology. The second is to publicise information about where public money is spent on new and emerging technologies. The third is for government to be open about uncertainties in science governance, both in terms of unforeseen risks of particular technologies and of the mechanisms available for dealing with those risks and uncertainties.

SR3 Government should take steps to ensure that the governance and funding of nanotechnologies is made more transparent:

- **a** By the creation of maps of how responsibilities for the regulation and funding of new and emerging areas of science and technology are distributed across the public sector.
- **b** By publicising information about where public money is spent on new and emerging technologies.
- **c** By striving to be open about uncertainties in science and science policy.

6.2 Practical options for public engagement in science and technology

In this section, we summarise the findings of this study and present NEG's recommendations for the future of public engagement in science and technology (PR). We explore our arguments under five headings:

— Understanding impacts
— Connection with policy
— Institutional capacity

— Reaching more people
— Supporting innovation

Practical guidance for public engagement in science and technology can also be found in the NEG framework in appendix 2.

6.2.1 Understanding impacts

As we discuss in chapters 4 and 5, project outputs (ie, recommendations and findings) do not tell the full story of a public engagement activity. Public engagement has the potential to generate a wide range of different impacts and benefits, both for the individuals who take part and on a broader scale in the form of cultural change in institutions and professional communities. Hence, the tendency to view the written outputs of a process as its most important element is misguided. NEG argues that organisations who are involved in planning, funding, or responding to public engagement in science and technology need support to account for and understand the broad spectrum of impacts that public engagement can deliver.

Here, we briefly summarise the spectrum of impacts that we have identified as products of public engagement on nanotechnologies. NEG's recommendations for how government and science institutions can learn to make better use of, and benefit from, public engagement in science and technology in the future follow this summary.

— **Informed policy and research:** Public engagement on nanotechnologies has shown that it is possible to create constructive and meaningful deliberations between members of the public, scientists, and decision-makers about complex and diffuse scientific topics. Such discussions can generate valuable messages about public concerns and aspirations, or can open up new lines of questioning and debate. This can contribute to making science policy and research better informed and more aligned with public needs and aspirations.

— **Reflective science:** These public engagement activities have demonstrated that the active involvement of scientists in public dialogue activities can create space for scientists to reflect on the wider social implications of their work, thus helping to 'put science into context'. There is also evidence that

such activities can contribute to generating greater support and enthusiasm in science communities for public dialogue and communication.

— **Scientifically aware and active citizens:** As we describe in chapter 4, a central benefit of public engagement in science and technology (especially high-level deliberation) is its ability to support scientifically aware, active citizens. NEG has found that public participants from public engagement on nanotechnologies have become more aware and sometimes more critical of the role of science in their lives (eg, in advertising, newspaper headlines, or product packaging). Many have also reported an increased interest in taking part in political activities in the future. This suggests that appropriately conducted public dialogue can give participants new knowledge and skills; enable them to form opinions about complex science and policy issues; and make people more interested and willing to take part in social and political activities elsewhere.

— **Mutual understanding:** Our research has shown that carefully facilitated public dialogue can help overcome negative preconceptions and cultural barriers between scientists, members of the public, and decision-makers. In this way, public engagement can contribute to building a greater appreciation among members of the public for the realities of science policy and research. It can also contribute to building greater appreciation among scientists and decision-makers of the ability of non-scientists to contribute meaningfully to science and policy discourses.

None of these potential impacts and benefits are inevitable consequences of public engagement. NEG spoke to scientists and members of the public who had negative experiences of public engagement; who felt that they had learned nothing new and that their preconceptions of other groups were confirmed by the experience. However, positive stories overwhelmingly prevailed. Ten of 11 members of the public, and seven of eight scientists, interviewed said that taking part in a public dialogue activity was worthwhile and that they would get involved in a similar initiative again given the opportunity. This suggests that public engagement in science and technology has the potential to generate a wide range of impacts and benefits both for the individuals who take part and on a broader scale if done properly and with consideration for the needs and expectations of the different groups involved[136].

The challenge now is to help civil servants and others better understand and appreciate the different kinds of valuable impact that public engagement can deliver. NEG therefore recommends that government develop and disseminate a comprehensive Impacts Assessment Framework for public engagement in science and technology.

PR1 A comprehensive Impacts Assessment Framework for public engagement in science and technology to be agreed by Department for Trade and Industry (DTI), Department for the Environment, Food and Rural Affairs (Defra), Research Councils UK (RCUK), and other stakeholders (including public engagement organisers and members of the public) for wide dissemination in government and other institutions that are affected by public engagement in science and technology.

6.2.2 Connection with policy

A central critique of the projects considered in this report has been their lack of clear links to nanotechnology policy-making As we discuss in chapter 5, the public engagement activities included in this report were not part of a pre-conceived government strategy, but rather emerged in response to available funding and organisational interests. This does not devalue the activities that have taken place, but it is a critical frame with which to understand the limitations and achievements of these projects. It partly explains the projects' failure to deliver on several of the goals for public engagement on nanotechnologies outlined in OPPEN. Not only was there no overall strategy for ensuring that the government's ambitious goals for public engagement on nanotechnologies were met, but also there was no shared understanding of what success would look like. This situation has lead to a sense of confusion among those involved about what the public engagement activities actually set out to do and what their value has been. Our research has found that there is an aspiration on all sides that future public engagement processes should be better connected to institutional decision-making. Here, we outline three steps towards achievement of this goal.

1 **Clarity of purpose:** This study has highlighted the need for a shared sense of purpose and focus when embarking on public engagement. NEG recommends that if the government has particular priority outcomes for a public engagement programme, then it should define the

outcomes (not the process) as clearly as possible, and ensure that the public engagement activities that are commissioned will serve this end.

PR2 Establish clarity among funders, organisers and participants on the purpose of a public engagement initiative, and create strategies to meet those needs.

2 **Increase direct involvement of institutional staff:** At present, decision-making institutions tend to have little direct involvement in public engagement delivery, most of which is done at arm's length by external contractors. NEG argues that this approach denies civil servants and other institutional staff the opportunity to build their own individual and organisational capacity for engaging with the public. To maximise the potential of public engagement activities to inform policy, staff from the institutions that have commissioned, or are expected to respond to, an engagement activity need direct involvement in the process—before, during, and after it has taken place. They need to be involved before to ensure that the planning of the engagement activity is sensitive to their needs, expectations, and timeframes. They need to be involved during the process to participate themselves; to appreciate the richness of the discussions that take place; and to allow them to respond directly to public participants' questions and concerns. They need to be involved after the process ends to ensure that any outputs are taken forward in the relevant institutional structures and that the process receives an adequate institutional response.

We do not suggest that decision-makers should play a more directive part in public engagement activities, but rather that they would benefit from taking part in a similar capacity to that of the scientists: ie, by listening to public participants, engaging in discussions with them, and offering their own perspectives on the issues discussed.

PR3 Institutional staff involved in funding or responding to public engagement activities to allocate sufficient time and resources to engage directly with the activities at every stage of the process.

3 **Institutions to respond formally to public engagement activities:** Most public engagement activities that are conducted in collaboration with a decision-making institution expect a formal response from that institution to their recommendations or findings. An institutional response is an essential part of many public engagement processes: it shows that the process is taken seriously, that the participants' contribution is valued, and that the institution in question is willing to take account of their views. An institutional response also helps maintain communication between the public engagement project and its audience, and can help build public confidence in science governance.

NEG recommends that when public engagement has the support of an institution, that institution should respond to public engagement processes in a reasonable timeframe[138] to explain what they are, and are not, taking forward and why.

PR4 Institutions to respond formally to public engagement processes (in a reasonable timeframe) to explain what they are, and are not, taking forward and why.

6.2.3 Institutional capacity

This study has revealed limits in the ability of decision-making and science institutions to engage with, respond to, and make use of public engagement in science and technology. In particular, there is a lack of understanding and appreciation of the wider benefits of public engagement activities beyond the production of recommendations for policy. Overcoming these capacity gaps is complicated by established cultures of policy-making and science funding, which include a reliance on statistically significant evidence and a tendency to view public engagement as one-way forms of consultation or communication. Here, NEG presents suggestions for how these capacity gaps and cultural barriers can be overcome. First, we list our recommendations for building capacity in decision-making institutions, followed by our recommendations for science institutions.

Building capacity in decision-making institutions: NEG recommends that different forms of support, such as training, coaching[139], and action learning networks[140] should be provided to decision-makers who are involved in, or affected by, public engagement activities. This support should include public engagement training as a course at the civil-service college.

PR5 Decision-making institutions to offer tailored support, such as training, coaching, and mentoring to staff who are involved in, or affected by, public engagement activities.

PR6 Decision-making institutions to pilot action learning networks to share and maintain capacity internally.

PR7 Public engagement to be included as a course at the civil-service college.

Building capacity in science institutions: NEG recommends that science institutions formally recognise the value of public engagement (eg, through accreditation systems to value the time scientists put into public engagement), and that funding bodies take steps to support and encourage their researchers to engage with the public.

PR8 Scientific institutions to formally recognise public engagement.

PR9 Science-funding bodies to stress the importance of dialogue-focused public engagement, alongside one-way engagement approaches such as public lectures.

6.2.4 Reaching more people

As our list of impacts shows, public engagement on science and technology brings many potential benefits for those who take part. NEG argues that more attention needs to be paid to the wide distribution of the learning and other benefits from these often small-scale public engagement activities. This outreach is necessary if the broader aims of the public engagement agenda are to be met, such as raising awareness about science and building public confidence in science governance.

Therefore, NEG recommends that new options for communicating the outputs and outcomes of public engagement to more people are explored through work with media partners, use of online tools, or through greater efforts to distribute printed reports to diverse audiences. We recommend emphasis on the sharing of the nuances of the deliberations, rather than just the outputs themselves: sharing of recommendations alone risks undervaluing the process and may cause misinterpretation of findings.

NEG recommends that new options are investigated for the involvement of large numbers of people in public deliberations about science and technology, including face-to-face and online models, national debates, and broadcasting options. These options should be judged on the basis of their ability to deliver different outcomes such as cultural change or statistically significant evidence.

PR10 Organisations funding or delivering public engagement to explore new tools for communication of public engagement outputs and outcomes to large and diverse audiences.

PR11 Organisations funding or delivering public engagement to explore options for involving larger numbers of people in public deliberations about science and technology.

6.2.5 Supporting innovation

To meet the wider goals set for public engagement by government[141], we need to build on these experiences of public engagement on nanotechnologies, and explore new approaches to building a constructive relationship between science and society. New approaches to public engagement need to be tried, and different options for making science policy and research more aligned with society's needs need to be explored.

The call for innovation goes beyond a specific need to improve the public engagement approaches considered here, which have successfully shown that public dialogue can make useful contributions to science and policy discourses. Instead, NEG believes that innovation lies at the heart of maintaining a mature and constructive relationship between science and society. As we have seen, engagement of the public in new and emerging science and technology is difficult. Science and technology develop fast, and society is in similar flux. Social pressures and conditions are changing constantly: new demands on citizens' time, changing levels of education, and shifting public debates all affect how citizens relate to science and technology. To ensure that the continually changing social contract between science and society has traction, it must therefore respond to the needs of both parties. We must continually refine the means by which we maintain the relationship between science and society.

NEG proposes supporting innovation by a focus on the desired outcomes[142], rather than the process itself. Commonly, public engagement happens because it is seen as a necessary component of policy-making, without sufficient consideration of whether it is the right procedure in the circumstances. Moreover, engagement methods used are frequently chosen on the basis of the organisers' or funders' previous experience, rather than on careful consideration of what approach will deliver the desired outcome. NEG recommends that more efforts are made to support innovation actively in the science and society field, by focus on outcomes rather than process; avoidance of public engagement unless there are clear reasons for doing so; and by exploration of other options for making science more responsive to public needs.

PR12 Organisations funding or delivering public engagement to actively support public engagement innovation through a focus on desired outcomes, not processes. Encourage collaborative innovation by building project teams that include public engagement practitioners, scientists, and policy makers, with a view to both maximising innovation and building institutional capacity.

136 See the NEG Framework in appendix 2 for a list of practical lessons for public engagement in science and technology.

137 An exception is the Nanodialogues project, which worked in partnership with decision-making institutions on all four experiments

138 It is not possible to set an unequivocal 'reasonable timeframe', which will depend on context, but we would suggest that three to six months is a useful goal to aim for

139 At the time of writing, the DCA is developing a support scheme for civil servants who work with public engagement in Whitehall, which includes training, coaching, and mentoring

140 Action Learning Networks have been used successfully in the past by the Environment Agency and others to support and maintain institutional (as opposed to individual) capacity for public engagement

141 See HM Government (2005b)

142 See NEG framework (appendix 2) for a differentiation of outputs and outcomes

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8 Abbreviations and acronyms

BA	British Association for the advancement of science
BSE	Bovine spongiform encephalopathy
BBSRC	Biotechnology and Biological Sciences Research Council
CEHR	Commission for Equality and Human Rights
CIPAST	Citizen Participation in Science and Technology
DCA	Department for Constitutional Affairs (now Ministry for Justice)
DCLG	Department for Communities and Local Government
DEEPEN	Deepening Ethical Engagement and Participation in Emerging Nanotechnology
Defra	Department for the Environment, Food and Rural Affairs
Democs	DEliberative Meetings Of CitizenS (a conversation game to facilitate deliberation on complex policy issues)
DLR	Discrimination Law Review
DTI	Department for Trade and Industry
EPSRC	Engineering and Physical Sciences Research Council
ESRC	Economic and Social Research Council
ETC	GroupCanadian action group on Erosion, Technology and Concentration
EU	European Union
FSA	Food Standards Agency
GM	Genetically Modified
GNDP	Global Dialogue for Nanotechnologies and the Poor
HEFCE	Higher Education Funding Council for England
HofL	House of Lords
IPPR	Institute for Public Policy Research

IRC	Interdisciplinary Research Collaboration
KTH	Swedish Royal Institute of Technology
nef	new economics foundation
NEG	Nanotechnology Engagement Group
NGO	Non-Governmental Organisation
NIA	Nanotechnology Industry Association
NIDG	Nanotechnology Issues Dialogue Group
NISE	Nanoscale Informal Science Education
NRC	National Research Council Committee on Risk Characterisation
ODPM	Office of the Deputy Prime Minister (now DCLG)
OPPEN	Outline Programme for Public Engagement on Nanotechnologies
OSI	Office of Science and Innovation
PEALs	Policy, Ethics and Life Sciences Research Centres at the University of Newcastle
PR	Recommendation for public engagement (in this report)
R&D	Research and Development
R2BH	Right to Be Heard
RAE	Royal Academy of Engineering
RCEP	The Royal Commission on Environmental Pollution
RCUK	Research Councils UK
RS	Royal Society
RSA	Royal Society for the Encouragement of the Arts
SDC	Sustainable Development Commission
SCCSN	South Carolina Citizens' School of Nanotechnology
SR	Recommendation for science policy (in this report)
STM	Scanning Tunneling Microscopes

Appendix 1: Record of international public engagement projects

This appendix lists the public engagement on nanotechnology activities that have taken place outside the UK.

1 Bendigo Workshop on Nanotechnologies, Australia
2 Citizens' Attitudes Towards Nanotechnology survey, Denmark
3 Deepening Ethical Engagement and Participation in Emerging Nanotechnology (DEEPEN), European Union (EU)
4 The Dialogue on Nanoscience and Nanotechnology Project, Spain
5 Forums for Dialog and Deliberation, NISE Network, USA
6 Global Dialogue on Nanotechnology and the Poor, international
7 Informed Public Perceptions of Nanotechnologies and Trust in Government, USA
8 Madison Area Citizens' Conference on Nanotechnology, USA
9 Melbourne Citizens' Panel on Nanotechnologies, Australia
10 NanoBio-RAISE, EU
11 Nano Dialogue, EU
12 Nanologue, EU
13 Nanomode, France
14 Nanoviv, France
15 New Zealand Focus Groups on Nanotechnologies, New Zealand
16 Public Nano-Cafe series, USA
17 South Carolina Citizens' School of Nanotechnology, USA

1 Bendigo Workshop on Nanotechnologies, Australia

Country/Region: Australia

Organisers: Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Funder: CSIRO Minerals

Timescale: March, 2004

Purpose
- Explore social and environmental implications of nanotechnologies.
- Listen to and analyse the public participants' views in order to inform the shaping of an ethical and ecological framework for CSIRO's research decisions.

Approach: A one-day regional workshop with community members, nanotechnology specialists, CSIRO staff, and government representatives, brought together to learn about and discuss some applications and possible implications of nanotechnologies. Participants were divided into small working groups that were allocated a hypothetical scenario kit to stimulate discussions about the social, economic, and environmental implications of nanotechnology.

Findings
- Participants displayed a similar mix of optimism and concern that has emerged in other public engagement activities on nanotechnologies.
- Participants were committed to socioeconomic well-being and environmental sustainability, and supported nanotechnology initiatives that could demonstrate such benefits.
- Participants were particularly concerned with issues of regional economic development.
- Participants called for CSIRO to be more pro-active in engaging the public on decision-making in science and technology, and to demonstrate that it takes the views of the public seriously by ongoing consultations and giving of feedback.

Workshop organisers have used the data collected to draft a 'community issues checklist', reflecting the issues raised by the Bendigo participants. The list is intended to help scientists and research planners reflect on the social, environmental, and economic implications of their work.

For a full account of the findings and a copy of the checklist, see Cameron et al (2004). Nanotechnology: the Bendigo Workshop, available from CSIRO Minerals website.

Website: www.minerals.csiro.au

Contact: Roy Lovel, Social Research, CSIRO Minerals. roy.lovel@csiro.au

2 Citizens' Attitudes Towards Nanotechnology Survey

Country/Region: Denmark

Organisers: Danish Board of Technology

Funder: Danish Board of Technology

Timescale: June, 2005

Purpose: To gauge public perceptions of, and attitudes to, nanotechnologies.

Approach: 29 citizens from the Copenhagen area took part in a series of group interviews and completed a questionnaire.

Findings: Citizens were generally favourably disposed towards nanotechnologies, although there were concerns about private ownership and governance. The group called for national and international regulation to ensure that nanotechnologies are used for social and environmental benefits, and for Denmark to take a proactive role in research of risk and ethical issues. Overall, participants were sceptical of research objectives on prolonging human life and improving consumer durables.

Website: http://tekno.dk/subpage.php3?article=1093&language=uk&category=11&toppic=kategori11

Contact: Ulla Holm Vincentsen, Project Manager. uv@tekno.dk

3 Deepening Ethical Engagement and Participation in Emerging Nanotechnologies (DEEPEN)

Country/Region: EU

Organisers: Department of Geography, Durham University, UK

Funder: EU FP6

Timescale: October 2006–October 2009.

Purpose

— Deepen ethical understanding of issues on emerging nanotechnologies through an interdisciplinary approach that uses insights from philosophy, ethics, and social science.
— Instigate a programme of cross-European empirical research aimed at unravelling the 'lay ethics' and values that a diverse European public use to understand and make sense of emerging nanotechnologies.
— Organise a series of deliberative forums in which citizens, stakeholders, experts, and decision-makers can develop convergent and divergent understandings of the social and ethical ramifications of nanotechnology.
— Develop recommendations for articulation and deliberation of ethical reflection in nanoscience practice and governance processes.

Approach: DEEPEN uses a unique interdisciplinary approach that combines approaches from philosophical and ethical appraisal, qualitative social science, public engagement, and deliberative methods. The project will be delivered through nine integrated work packages over four phases:

1 Surveying of ethical and societal issues of concern
2 Integration
3 Experiments in new deliberative processes
4 Dissemination

DEEPEN will focus on two specific domains of nanotechnology research and exploitation: nanosensors and nanomedicine.

Findings: At the time of writing, none have been published.

Website: www.geography.dur.ac.uk/projects/deepen

Contact: Krysia Wozniak, IHRR, Department of Geography, University of Durham. Krysia.Wozniak@durham.ac.uk

4 The Dialogue on Nanoscience and Nanotechnology Project

Country/Region: Barcelona, Spain

Organisers: Centre Especial de Recerca en Teories i Pràctiques Superadores de Desigualtats (CREA), in collaboration with the Communication and Scientific Dissemination Department, Barcelona Science Park.

Funder: Not available

Timescale: 2003–2005

Purpose
- Open up public debate about nanotechnologies at all levels of society.
- Provide information about public attitudes to nanotechnologies.
- Provide recommendations for policy.

Approach: Three stages of activity:
1 Survey on public knowledge of nanotechnology.
2 Working groups.
3 A seminar, Dialogue on Nanoscience and Nanotechnology, held end November, 2005.

The seminar was a meeting point for researchers from nanoscience and nanotechnology. The use and development of new methods on the basis

of inclusion of social groups' opinions in analyses and dissemination of project enabled the project to have a social impact and help ensure that policy recommendations result from dialogue between scientists and other stakeholders.

Findings: NEG has been unable to access any findings from this project.

Website: http://www.cnsi.ucsb.edu/news/current/nanocafe/index.html

Contact: Marta Soler, Centre Especial de Recerca en Teories i Pràctiques Superadores de Desigualtats (CREA). crea@pcb.ub.es

5 Forums for Dialog and Deliberation, NISE (Nanoscale Informal Science Education) Network

Country/Region: USA

Organisers: Museum of Science (Boston, MA), Science Museum of Minnesota (St Paul, MN), Oregon Museum of Science and Industry (Portland, OR), Exploratorium (San Francisco, CA), and North Carolina Museum of Life and Science (Durham, NC)

Funder: National Science Foundation

Timescale: October 2005–September 2010

Purpose: To research, develop, and test various programme models aimed at engaging adults and older youth with in-depth informal educational experiences that incorporate dialogue and deliberation about societal implications of nanoscale science, engineering, and technology.

Approach: The five collaborating museums has at least three forum events per year, which are attended by 30–50 participants per event. The consortium has created models together and independently, working closely to share research and evaluation data and experiences. The focus is to engage people in an awareness of nanotechnology and its related societal and environmental

impacts, and for participants to articulate their own perspective and to hear the perspectives of others. Forums last two to three hours, and have included speaker presentations and small group discussions that have so far focused on the regulation of nanotechnology. Formats have varied, including weighing-up of alternative scenarios or asking of multiple questions for groups to consider. Some small group discussions have been facilitated by staff; others have been self-facilitated through materials given to participants. Some events are held off-site, but most take place at the museums.

Findings: Participants have reported that they have learnt about nanotechnology and have valued the ability to discuss the topic with peers, even when the latter was not the motivation for attending. In particular, participants have reported learning more about the societal and environmental risks and benefits of nanotechnology. Forums have successfully brought scientists and non-scientists together not only through expert presentations and interactions with the audience, but through representation of a variety of expertise among participants. Most survey respondents have acknowledged learning about the values of others during the course of the Forums.

A challenge of the project is to engage a more diverse audience beyond that of existing museum visitors, to include those traditionally under-represented in discussions about societal and environmental impacts of science and technology. An integral part of the project plan is to create affordable, sustainable Forum models that can be adopted easily by smaller museums and community centres with modest resources.

Website: http://www.nisenet.org/project/working.html

Contact: Larry Bell (Principal Investigator), Senior Vice President, Museum of Science, Boston, MA, USA. lbell@mos.org

6 Global Dialogue on Nanotechnology and the Poor (GDNP)

Country/Region: International

Organisers: Meridian Institute, USA

Funder: The Rockefeller Foundation (USA), International Research Centre (Canada), and Department for International Development (USA)

Timescale: 2004–2005

Purpose
- Raise awareness about the impact of nanotechnologies for the poor.
- Identify ways in which nanoscience and nanotechnology can have a positive role in international development.

Approach: A combination of research, stakeholder dialogue, and online consultation about the positive and negative implications of nanotechnologies for poor people worldwide. The first phase of the project focused on raising awareness through a series of tools and strategies, including:
- Publishing of Nanotechnology and the Poor: Opportunities and Risk—a report on the implications of nanotechnologies for poor countries.
- Holding an online consultation for people to share their views on the report and the subject, organised by Dialogue by Design (UK).
- Conducting one-on-one consultations with stakeholders.
- Convening a multi-stakeholder steering group.

Additional activities included
- Setting up a Nanotechnology and Development news service available by email and online.
- Identification and research of key opportunities and risks.
- Holding multi-stakeholder meetings and workshops on those risks.
- Building global links and networks.

Findings: For a full list of responses to the online consultation, see http://nanotech.dialoguebydesign.net/dbyd.asp

Website: www.meridian-nano.org

Contact: Todd Barker, Meridian Institute. tbarker@merid.org

7 Informed Public Perceptions of Nanotechnologies and Trust in Government

Country/Region: USA

Organisers: The Woodrow Wilson International Center for Scholars, as part of their Project on Emerging Technologies, in partnership with the Pew Charitable Trusts. Jane Macoubrie, senior advisor to the centre, led the project and authored the final report

Funders: US National Science Foundation

Timescale: May–June, 2005

Purpose: The study was done in response to a 2004 study of US citizens, which identified low levels of trust in their government's ability to manage risk associated with nanotechnologies. The aim of the 2005 study was to understand why levels of trust are so low, and to look in-depth into what US citizens know and do not know about nanotechnologies.

Approach: 12 groups of citizens gathered in three locations around the USA. 177 citizens participated, and groups were demographically representative of their area. Participants were given background material, which presented a balanced view of known and projected applications of nanotechnologies, as well as information on the roles of six regulatory agencies, Congress, and the White House in nanotechnologies oversight. Scientists and regulators reviewed the material for accuracy and ease of comprehension by lay people. The material focused on conveying of known facts and reasoning, rather than just statements of opposing positions.

Public perceptions were obtained through questionnaires that were completed before receiving background material. After reading the material, individual

responses to concerns and anticipated benefits of nanotechnologies were gathered, and participants took part in group discussions about concerns, benefits, and perceptions of regulatory agencies. Finally, participants completed a post-study questionnaire.

Findings

— Participants had low general awareness of nanotechnologies, but generally a positive attitude towards it, feeling that benefits will exceed risks.
— Participants showed little support for a nanotechnologies ban.
— Concerns centred on unknowns, potential health risks, the danger of 'playing God', long-term effects, and the risks of nanotechnologies in food and military applications.
— Participants called for effective regulation, product labelling, and more safety testing and information.
— The level of trust in US government agencies was initially low, but increased when their responsibilities were understood better. However, trust in some bodies decreased after more information (eg, that in Congress).

Website: www.wilsoncenter.org/events/docs/macoubriereport.pdf

Contact: Project on Emerging Nanotechnologies at the Woodrow Wilson Centre. nano@si.edu

8 Madison Area Citizens' Conference on Nanotechnology

Country/Region: Wisconsin, USA

Organisers: Staff at the University of Wisconsin's Center on Nanoscale Science and Engineering and the Integrated Liberal Studies Program as part of their joint Initiative on Nanotechnologies. Daniel Kleinman and Maria Powell led the project and were assisted by students from Dr Kleinman's undergraduate course on Democracy and Expertise

Funder: UW-Madison Rural Sociology, UW-Madison Nanoscale Center, UW-Madison Integrated Liberal Studies Program

Timescale: April, 2005

Purpose:
— Educate citizens about nanotechnologies.
— Raise the profiles of both nanotechnologies and citizen participation through the media.
— Gain the attention of elected officials.
— Gain an understanding of if, and how, participation in a consensus conference affects citizens' understanding of a subject and their sense of political empowerment.

The project was based on the twin premises that:
— Citizens have the right to have a say on all matters that affect their lives.
— Lay people are able to understand complex information and may have insights that specialists do not consider.

Approach: 13 demographically diverse Madison area citizens were recruited through press coverage in local newspapers, television, radio, and press releases to major newspapers. Recruitment took place over two months, and 13 participants were selected from 18 applicants on the basis of the organiser's belief that 'they could best contribute to a well-rounded citizen panel'[143].

The conference took place over three Sunday meetings, before which participants read background material on nanotechnologies. At the first meeting, participants discussed their reading and developed a list of questions about nanotechnologies. At the second meeting, seven specialists sought to address participants' questions in a public forum. This meeting was open to the public and 30 people attended. At the third meeting, participants drafted recommendations for government. The recommendations were launched in a report at a press conference for elected officials and the media on April 28, 2005. Copies were also sent to all Wisconsin legislators.

Findings: The organisers felt that citizens became educated about nanotechnologies. The profile of nanotechnologies and citizen participation increased through press coverage to some extent. However, the press was mainly local, and conference participants identified lack of sufficient media coverage of nanotechnologies as an issue. Six state-elected officials attended the conference's press event, but whether they have taken any action on the recommendations is unclear.

The panellists' recommendations covered greater health and safety testing of nanotechnologies materials, product labelling, provision of mechanisms for citizen involvement in the direction of research, greater media coverage, and increased funding for exploration of the societal and ethical impacts of nanotechnologies.

For a full list of recommendations see the Report of the Madison Area Citizen Conference on Nanotechnology, available to download from the project website.
Website: http://cdaction.org/nanotechnology_citizen_conference.html

Contact: Dr Daniel Kleinman, Department of Rural Sociology, University of Wisconsin-Madison, WI, USA. dlkleinman@wisc.edu

9 Melbourne Citizens' Panel on Nanotechnologies, Australia

Country/Region: Australia

Organisers: CSIRO

Funder: CSIRO Minerals

Timescale: December, 2004

Purpose: To explore different perspectives on the implications of nanotechnology research and development in five areas: commercialisation; ethics; regulation; environment; and social impacts. The topics were chosen on the basis of the data collected from the Bendigo workshop (see above).

Approach: A one-day Citizens' Panel focusing on five issue-areas in the context of nanotechnology: commercialisation; ethics; environmental impact; social impact; and regulation. These issues were looked at in the context of three different perspectives: industry; government; and community. The self-selected participants heard presentations by expert witnesses and took part in group-discussions. At the end of the day, they divided into groups according

to the three categories listed above, and every group formulated an answer to the hypothetical question: 'What statement will Australia make to the United Nations Forum on Nanotechnology in 2006?'

Additional research was done through a literature review and stakeholder interviews.

Findings

— The Citizens' Panel confirmed the findings of the Bendigo workshop—ie, that engagement with the public by scientific institutions such as CSIRO may assist their decision-making and reflective processes.
— Both projects found that discussions were less polarised and participants more willing to engage with different perspective than the organisers had anticipated.
— Asking participants to look at every issue from the three perspectives of industry, government, and community helped people take into account the many different considerations involved in research and development. This contributed to providing slightly more nuanced responses than those that have emerged from similar processes elsewhere.

For a full analysis of the findings of the workshop, see Katz et al (2005). Citizens Panel on Nanotechnology: Report to Participants, available from CSIRO Minerals website.

Website: www.minerals.csiro.au

Contact: Dr Evie Katz, Social Values and Sustainable Development, CSIRO Minerals. evie.katz@csiro.au

10 NanoBio-RAISE

Country/Region: EU

Organisers: TUDelft, Cambridge Biomedical Consultants (UK); Nano2Life (EU); Westfälische Wilhelms-Universität (Germany); Dechema (Germany); Europa Bio (EU), Swedish Royal Institute of Technology—KTH (Sweden); and Society, Religion, and Technology Project—Church of Scotland (UK)

Funder: EU FP6

Timescale: November 2005–ongoing

Purpose: An interdisciplinary ethics research and science communication project, bringing together nanobiotechnologists, ethicists, and communication specialists. Objectives include:
— Clarification of the potential ethical and societal issues emerging from development of nanobiotechnology.
— Use of the lessons from the GM debate to respond to potential public concerns.
— Recommendation and employment of strategies for addressing these issues.

Approach: A series of methods have been used, including:
— Horizon-scanning workshops.
— Briefing papers and lectures.
— Ethics and public communication courses for nanobiotechnologists.
— Online forum and database.
— Democs card game.
— Public-opinion focus groups, run by Swedish KTH in four different European locations.

Approach of public-opinion focus groups: The organisers used a Convergence Seminar model of engagement, which has been developed at Royal Institute of Technology, Stockholm, Sweden, to facilitate discussion and decision-making about emerging technologies. Briefly, this two and a half hour workshop session enables 6–15 participants to discuss different paths

of technological development: paths that usually represent a scale from moderate use (ie, more regulation) to more progressive use (ie, less regulation). Because these lines of development are compared explicitly, participants can assess critically the future of the technology[144]. For NanobioRAISE, the discussion in the Convergence Seminars focused on nanobiotechnology and applications. Participants discussed three scenarios that represented diverging lines of development in terms of precaution and progress, and contained different ethical themes such as justice and distribution, privacy, health, and enhancement.

The Convergence seminars were held in four different parts of Europe during 2006. The first seminar was held at the University of Gotland, Visby, Sweden, on May 4. There were eight participants, who were members of local branches of the Swedish Society for Nature Conservation and 'Fältbiologerna', a young naturalist organisation. The second seminar was held at the School of Law at Sheffield University, UK, on July 28, in cooperation with the Sheffield Institute for Biotechnological Law and Ethics. The group of twelve participants consisted of students and members of a science discussion club. The third seminar was held at the Maria Curie–Sklodowska University, Lublin, Poland, on Nov 25 in cooperation with the Nanotechnology Centre at the same University. There were thirteen participants—mainly students of linguistics, but also architecture, chemistry and there were some senior researchers in nanotechnology. The fourth seminar was held at, and in close cooperation with, the Institute for Molecular and Cell Biology in Porto, Portugal, on Dec 6. The group of seven participants consisted of students and non-academic staff at the Institute.

Findings: This project was one of the first times that the method of Convergence Seminars was used in practice, and the organisers believe that it has been successful. It provoked discussion, and participants gave much positive feedback. The participants said that the seminars gave them information about nanotechnologies and their potential impacts, and enabled important ethical discussion on nanotechnology's impacts. Many participants expressed a wish to allow other citizens to participate in similar workshops and discussions. The final report from the Convergence Seminars has not yet been published (see contact for details).

An aim of the focus-group project was to reach as diverse an audience for participation as possible. By hosting a seminar in the eastern, western, northern, and southern parts of Europe and by at every location including people of different age, gender, political orientation, and social background, the organisers consider to have met this aim to some extent. However, because all seminars were held in cooperation with other universities and in a university setting, students were over-represented as a group.

Website: www.nanobio-raise.org

Contact: Focus-group organiser: Marion Godman, KTH. mariong@infra.kth.se

11 Nano Dialogue

Country/Region: EU

Organisers: Coordinated by Citta della Scienza, Naples, Italy

Funder: EU FP6

Timescale: March 2005–February 2007

Purpose: A process of communication and social debate about nanotechnologies and nanosciences at a European level. Aims included:
— Raise awareness among the general public on the latest developments of research in nanotechnology.
— Implement social dialogue between the research community, civil society, and citizens on the ethical, social, and legal aspects of nanotechnology.
— Research perceptions and desires of people attending the events.
— Ultimately, to discuss project findings with European commission.

Approach: A series of exhibitions, local events, science demonstrations, scenario workshops, and citizens' debates held in eight participating countries over six months. Feedback collected at the exhibitions and workshops, and via three focus groups, were analysed and presented as a set of recommendations at the end of the project and at a final conference at

the European Parliament in Brussels. The next day, the Commission held a workshop to discuss the findings.

Findings: At the time of writing no findings have been published.

Website: www.nanodialogue.org

Contact: Guglielmo Maglio, Citta della Scienza, Naples, Italy. maglio@cittadellascienza.it

12 Nanologue

Country/Region: EU

Organisers: Forum for the Future (UK), Wuppertal Institute (Germany), EMPA (Switzerland), and Triple Innova (pan-European)

Funder: European Commission Framework Programme 6 (FP6)

Timescale: February 2005–October 2006

Purpose

— Map the ethical, legal, and social aspects of nanotechnologies in three fields: food, energy, and medical diagnostics.
— Facilitate dialogue among researchers, business, and civil society about the potential benefits and impacts of nanotechnologies.
— Produce a communication and dissemination strategy to help researchers, policy-makers, and business consider the long-term and short-term impacts of their activities in nanotechnology.

The dialogue part of the project involved civil-society organisations, businesses, and scientists, rather than members of the general public.

Approach: The project had three key outputs: a scenario foresight exercise used to explore possible future applications and impacts of nanotechnologies; an online interactive tool to help scientists and funders consider the ethical,

social, and legal implications of research; and a report that outlined the findings of the interviews with business, scientists, and civil-society organisations.

Findings

— There is a wide awareness both in the science community and among civil-society organisations about the need to consider the ethical, social, and legal implications of nanotechnologies and their applications. However, the nature of these implications is not understood fully or widely. Scientists were more informed about what those implications might be than were representatives from civil society.
— There was wide agreement among representatives from civil society that civil society should influence aspects of nanotechnologies that affect human health and the environment.
— There was less agreement about whether civil society should seek to influence issues of privacy, access, liability, and regulation.

The full report: Nanologue: Opinions on the Ethical, Legal and Social Aspects of Nanotechnologies is available to download from the Nanologue website.

Website: www.nanologue.net

Contact: Hugh Knowles, Forum for the Future.
H.Knowles@forumforthefuture.org.uk

13 Nanomode

Country/Region: Paris, France

Organisers: VivAgora

Funder: Conseil regional Ile de France

Timescale: January–June, 2006

Purpose
— Inform the public and generate wider awareness about nanotechnologies.
— Stimulate debate about nanotechnologies (the first series of events of its kind in France).
— Identify potential problems and solutions related to nanotechnologies.

Approach: A deliberative public debate, which took place over six meetings over 6 months; meetings were about two and a half hours long. More than 100 people attended every meeting. Public participants were invited through organisers' networks, and most who attended has an interest, or were involved, in nanotechnology. Before every debate, an information sheet was prepared to aid participants' understanding of nanotechnologies. At every meeting, scientists and other experts gave evidence on different aspects of nanotechnology (eg, technological, social, or economic); a mediator was present to facilitate discussions. A report was published on every debate, and the project concluded with a series of recommendations based on the debates.

Both the Nanomode and Nanoviv (see below) projects will be concluded with a conference in Paris, France, in June, 2007.

Findings: 17 recommendations were made, addressed specifically to politicians, industry leaders, and academics. The recommendations are available (in French) from the project organisers.

Website: www.vivagora.org/rubrique.php3?id_rubrique=31

Contact: Dorothée Benoit Browaeys. dorbro@neuf.fr

14 Nanoviv

Country/Region: Grenoble, France

Organisers: VivAgora, with assistance from the Centre for Scientific and Technical Culture

Funder: Conseil general de l'Isere, Conseil regional Rhone-Alpes, Ville deGrenoble, and Communauté d'agglomération de Grenoble

Timescale: September–December, 2006

Purpose: See Nanomode, above.

Approach: Same as that for Paris-based Nanomode (above): six meetings, all about two and a half hours, over three months. Both the Nanomode and Nanoviv projects will be concluded with a conference in Paris, France, in June, 2007.

Findings: The process ended with 18 recommendations and four so-called 'building yards' to improve nanogovernance.

Website: http://nanoviv.hautetfort.com/

Contact: Dorothée Benoit Browaeys. dorbro@neuf.fr

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15 New Zealand Focus Groups on Nanotechnologies, New Zealand

Country/Region: New Zealand

Organisers: The Agribusiness and Economics Research Unit (AERU) at Lincoln University
Funder: MacDiarmid Institute for Advanced materials and Nanotechnology

Timescale: June–November, 2005

Purpose: To inform the development of nanotechnologies and their applications through developing an understanding of public reactions and attitudes. Specific objectives included:

— To identify and compare reactions to nanotechnologies and some nanotechnology applications.
— To provide guidance for interactions between scientists, policy-makers, and the public.

Approach: A series of focus groups, who met three times between June and November, 2005. 40 adults participated. The first session focused on people's views on science and technology in general, the second session introduced nanotechnologies and some existing applications, and the third session looked at possible future developments in nanotechnology.

Findings: Participants' views reflected the attitudes and concerns expressed at similar events elsewhere:

— People were generally supportive of nanotechnology developments with apparent social, economic, and environmental benefits, but were concerned about uncertainties in health and safety and environmental sustainability.
— There were concerns about the 'hyped' and biased nature of much of the information available about nanotechnologies, and calls for more reliable information to be made available to the general public.

For a full analysis of the findings, see Cook and Fairweather (2005). Nanotechnology—Ethical and Social Issues: Results from New Zealand focus groups.

Website: www.lincoln.ac.nz/section165.htm

Contact: Dr Andrew Cook, AERU, Lincoln University. cookaj@lincoln.ac.nz

16 Public Nano-Café series

Country/Region: California, USA

Organisers: The California NanoSystems Institute (CNSI) and the Center for Nanotechnology in Society (CNS)

Funder: The California NanoSystems Institute (CNSI) and the Center for Nanotechnology in Society (CNS)

Timescale: Quarterly series of events, starting in April, 2007, lasting one hour.

Purpose: To promote and foster discussion, and earn a greater understanding about emerging nanotechnologies and their implications.
Approach: Free public event to learn about and discuss nanotechnologies and related issues.

Findings: At time of writing, no findings have been published

Website: www.cnsi.ucsb.edu/news/current/nanocafe/index.html

Contact: events@cnsi.ucsb.edu

17 South Carolina Citizens' School of Nanotechnology (SCCSN)

Country/Region: Columbia, South Carolina, USA

Organisers: USC NanoCenter, University of South Carolina, USA

Funders: University of South Carolina (USC) and the National Science Foundation

Timescale: Spring 2004–ongoing

Purpose: To improve non-scientists' knowledge of nanotechnologies, and nurture their confidence for having active and constructive voices and roles in discussions of nanotechnology policy.

Approach: A citizens' school takes place in spring and autumn of every year. Every round consists of six to eight weekly meetings, featuring a series of background readings, presentations, visits to nanotechnology laboratories, and discussions. 30–40 participants attend every school. There is an ethos of dialogue: the participants question the experts and have many opportunities to express their values and concerns.

Findings: On a modest scale, the project has been successful at nurturing participants' confidence about nanotechnologies and nanotechnology policy.

The success of the first SCCSN, which was slightly oversubscribed, has lead to the programme being offered regularly. Feedback from participants has been very positive. In response to suggestions and requests from participants, several features have been added: more material on societal and ethical issues; a tour of scientific laboratories to see Scanning Tunneling Microscopes (STMs), electron microscopes, and other instruments that make nanotechnology possible; and a concluding session in the form of a roundtable discussion that brings together all speakers and that gives participants additional opportunities to ask questions and express concerns.

Website: http://nsts.nano.sc.edu/outreach.html

Contact; Christopher Toumey, Centenary Research Associate Professor, USC NanoCenter, University of South Carolina, SC, USA. Toumey@SC.EDU

Additional links

The following websites contain information about public engagement on nanotechnology and related activities around the world:

www.cite-sciences.fr/english/ala_cite/exhibitions/nanotechnologies
information about public exhibitions and debates about nanotechnologies.

www.nanotruck.net
a travelling exhibition set up by the German Federal Ministry of Education and Research to raise awareness about nanotechnologies.

www.cafescientifique.org
a link to 'cafe scientifiques' around the world; an informal events where people can come to learn about and discuss new developments in science and technology.

www.cipast.org
Citizen Participation in Science and Technology (CIPAST)

www.nano-and-society.org
Centre on Nanotechnology and Society (Illinois Institute of Technology).

www.nanoandsociety.com
International Nanotechnology and Society network.

www.nano2hybrids.net
a three-year initiative: scientists who work on a research project will post video diaries and blogs on a public website and engage in discussions with members of the public.

www.nanoreisen.de
an explanation of microtechnologies and nanotechnologies, which allows visitors to 'shrink down' to the nanoscale on a journey through different materials.

http://cns.asu.edu
Centre for Nanotechnology and Society at Arizona State University.

143 Kleinman D. and Powell, M (2005)

144 For more information on the motivation behind the method see Sven Ove Hansson, *"Hypothetical retrospection" Ethical Theory and Moral Practice*, in press.

Appendix 2: NEG framework—practical lessons for public engagement in science and technology

This section summarises the practical lessons from NEG's study of public engagement in nanotechnologies for future public engagement in science and technology. The issues raised here focus explicitly on the practice of public engagement. Recommendations that relate to broader public engagement policy are listed in the conclusion (chapter 6).

The NEG framework has been produced to help organisations and individuals who are involved in planning and/or running public engagement in science and technology to achieve their objectives. It is also intended to help individuals or organisations who are involved in commissioning or funding public engagement activities to engage effectively with those activities. Although the projects included in this study differ in their objectives and the approaches used, NEG believes that collectively they give valuable generic lessons that can help improve public engagement in science and technology in the future.

The framework is not a comprehensive guide to public engagement. Rather, it is intended to complement other public engagement guides by highlighting a series of issues and challenges that NEG has identified as particularly relevant to public engagement on science and technology. Public engagement is a growing and constantly developing field. Substantial literature discusses different rationales for engagement with the public in policy-making and delivery, and a similarly large amount of guides and publications are available to help institutions choose the correct method of engagement[145]. NEG argues that although it is useful for organisations who are involved in commissioning or funding public engagement activities to be familiar with the main rationales and approaches,

too much emphasis on methods carries the risk that other important considerations are overlooked. In this section we list some of those considerations.

The framework is constructed around several issues and challenges that NEG's research has highlighted as central to enabling public engagement in science and technology to achieve its objectives. Every issue is addressed with advice based on individual project experiences and on Involve's own knowledge and experience.

NEG framework: practical lessons for public engagement in science and technology

Clarity of objective

Why it matters

Having a clear objective is important because it:

— Ensures the public engagement process stays focused.
— Helps manage the expectations of participants, partners, and target audiences.
— Makes it easier to evaluate the process and measure its success.

Not having a clear purpose and set of priorities carries several risks:

— Can create misunderstandings and tensions between groups involved.
— Can make the process unfocused, and can waste of time and resources.
— Confusion about objectives can lead to a loss of credibility if the activity is seen by some not to be delivering.

What it means in practice

Setting a clear objective involves instigators, organisers, funders, and other key stakeholders (which may or may not include participants) agreeing the answers to three questions:

1 What are the desired outcomes?
2 What will the outputs be?
3 What are the primary and secondary objectives?

Outcomes are the results or impacts of the process; the way it is going to make a difference (eg, informing a specific policy or decision, building learning and understanding among participants, improving future public engagement practice).

Outputs are the activities and products that will make the outcomes happen (eg, websites, surveys, reports, and different forms of meetings and workshops).

Primary objectives are the minimum results and products expected to come out of the process; the reasons it is being done in the first place. Secondary objectives are non-essential 'added bonuses'. Distinction between primary objectives and secondary objectives not only makes it easier to maintain the focus of the public engagement activity, but also helps organisers to foresee and justify any trade-offs that have to be made between objectives.

Things to keep in mind

— There are good and bad objectives. A good objective is focused, with clearly defined outputs and outcomes. It is achievable within budget, timeframe, and other resources available. It is measurable in some form (whether qualitative or quantitative). A bad objective is poorly defined, unrealistic given the resources available, or open to conflicting interpretations.
— Be as explicit as possible about what or who you are trying to influence and how it is going to happen. Avoid use of vague statements such as 'influence policy' or 'improve decision-making'.
— Avoid focusing all efforts on achievement of agreed outputs. Outputs are not ends in themselves; it is more helpful to think of them as the building blocks of the consumer-engagement process. The aim of the outputs is to help the process make a difference; whether through building relationships, stimulating debate, giving people new information or resources, or providing decision-makers with recommendations.

Institutions and public engagement organisers working together

Why it matters

For many initiatives on public engagement in science to succeed, there needs to be a meaningful relationship between the target institutions and the projects themselves.

This situation is achieved when there is a commitment on the part of the relevant institution to connect with the public engagement activity and take its findings seriously[146]. This, in turn, is more likely to happen if the organisers of the public engagement activity take care to design the activity and present its findings in a manner and at a time that enables the target institutions to make use of the findings. Importantly, public engagement organisers should be open and honest with clients and partner organisations about what public engagement can realistically deliver.

What it means in practice

Institutions that are involved in public engagement activities should:

— Be open about their reasons for engagement with the public and their expectations.
— Be clear about the constraints they face in responding to, and making use of, the findings from public engagement.
— Set aside sufficient time and resources to connect with the public engagement activity and its outputs—before, during, and after it occurs.
— Be prepared to be flexible: outputs may not be exactly what are expected, but that does not mean they are not useful.

Independent public engagement organisers who are seeking to inform decision-making with their activities have to:

— Be clear about which institutions or decision-makers they are targeting, and seek to involve them in the process early on.

— Consult the relevant decision-makers about their needs, expectations, and the constraints they work under, and seek to meet their needs (eg, in terms of the timing or style of the activity and findings) as much as possible without compromising any other priority objective.
— Be open about the objectives of their activity, particularly about any tensions that may exist between their objectives and the decision-makers' needs or expectations.

Things to keep in mind
— Do not underestimate the time it takes for civil servants to liaise with the public engagement process and respond to its outputs.
— Timing of the engagement activity is crucial: liaise with the relevant decision-makers to ensure that it fits with their timetables.
— Be honest with participants (public, scientist, and other) about what the process can realistically achieve.

Involvement of target audiences directly in public engagement activities

Why it matters
Often, public engagement projects have a specific target audience in mind for their outputs—eg, a research council, a company, or a government department. Our research has found that it is valuable to involve the target audience directly in the engagement process because it can:

— Help decision-makers understand what public engagement is and what it can deliver.
— Help civil servants and other institutional staff build their own individual and organisational capacity for engagement with the public.
— Give decision-makers insights into the nuances of discussions and the background to the discussions and findings.
— Help create a sense of ownership of the process and the findings in the target institution, thus increasing the chances that they are responded to and taken forward.

Involvement of the target audience in a public engagement activity is not always possible or desirable. However, NEG argues that the option should always be considered, because a lack of involvement by target audiences in public engagement risks undermining the effectiveness of the activities and denies the institutions and individuals in question the opportunity to build their own capacity for public engagement.

What it means in practice

Involvement of target audiences in public engagement means that organisers of activities and the target institutions must work together to involve the relevant individuals in appropriate aspects of the public engagement process. They must find agreement on:

— Why is the involvement of target audience(s) seen as desirable, and who will benefit?
— In what aspects of the public engagement activity will the involvement of decision-makers be appropriate and beneficial?
— What role is the representative(s) of the institution going to have in the process?
— What support or preparation will the individual(s) need to enable effective engagement in the process?

Things to keep in mind

— Involvement of target audiences in public engagement activities is not always appropriate. Organisers and facilitators of the process must judge whether doing so is likely to add value.
— Such involvement of target audiences does not mean allowing them to direct the process. Instead, their role should be similar to that of the scientists and other stakeholders: to listen, offer their perspectives on the discussions, and answer questions if necessary.

Clarity of roles

Why it matters

Clarity about the role of every participant (public, scientist, and other) and partner or funding organisation in a public engagement activity helps to ensure that:

— Every participant can make an informed choice about whether they want to take part.
— Participants can prepare for their role in advance.
— Participants are able to gain more from the activity.
— The public engagement process is more likely to achieve its objectives.

Not being clear about roles and any objectives relating to participants' own learning may lead to misunderstanding and tension among participants and between participants and organisers.

What it means in practice

— Consider whether there are any additional or implicit expectations on any participants or partner organisations over and above their practical role in the activity. For instance, scientists may be expected to present or contribute to discussions, but are also expected to learn from, or be influenced by, the experience.
— Ensure that organisers, partners, and funders are in agreement about the roles of, and expectations on, every group of participants.
— Explicitly explain to every group involved (eg, participants, partner organisations, and funders) their role and what is expected of them.

Things to keep in mind

Be explicit: do not assume that groups know what a particular form of public engagement entails. Explain what it means in terms of their personal contribution and how it may differ from events they have taken part in before.

Ensuring diversity of voices

Why it matters

Public engagement is increasingly being used as a complement to traditional democratic structures. It is often perceived as a means to informing or improving policy-making and delivery, to increase the transparency of government, or to build public trust in government. However, few public engagement activities themselves conform to democratic principles. Many are small-scale, unrepresentative, and ad hoc; this is the nature of a field that tends to operate under financial and time-related constraints and that often prioritises depth of discussion over the scale of the exercise.

NEG argues that the fact that public engagement activities take place outside of established democratic structures highlights the need to ensure that such activities are founded on principles of inclusion and diversity, so that no sections of society are excluded on the basis of ethnicity, religion, disability, gender, or age. Promotion of diversity and inclusion is important to ensure that different perspectives on new technologies are heard and can influence policy.

Promotion of diversity in public engagement is not only important to maintain democratic principles; it is also a legal requirement. The Race Relations (Amendment) Act 2000 makes it unlawful for any public authority (a loose definition for any institution carrying out functions of a public nature) to discriminate, directly or indirectly, against anybody on the basis of race. The Act also states that public authorities have a duty to promote equal opportunities and good relations between people of different racial groups. Similarly, the Disability Discrimination Act makes it unlawful to deny any person or group access to a service for any reason related to their disability[147].

What it means in practice

Institutions and individuals who are involved in commissioning or organising public engagement activities must actively seek to involve a diverse range of people in their processes. This requirement may mean:

— Provision of logistical support (eg, translators, disability access, separate meetings for women, financial incentives, or income remuneration) to ensure that no group is excluded on logistical grounds.
— Striving to include a representative cross-section of the relevant population when possible and appropriate to the purpose of the exercise.
— Justification of the recruitment criteria used when a public engagement activity excludes some groups or does not represent the wider population.
— Identification of which groups are less likely to participate than others, and making special efforts to target those groups when advertising open (ie, inclusive) public engagement processes (eg, socially excluded groups, ethnic minorities, non-English speakers, young professionals, or single parents).

Things to keep in mind

Statistical representativeness is not always necessary or even desirable. Sometimes, participants are recruited justifiably on the basis of other criteria such as their interest or stake in an issue, or because people of similar background tend to engage more easily in discussions with each other. The important thing is to be able to justify how participants have been selected and why certain groups are not represented.

Supporting members of the public to take part

Why it matters

Motivating people to get involved and stay involved in public engagement on science and technology can be a challenge. When the activity addresses a new, highly complex and relatively low-profile subject such as nanotechnologies, participants tend not to have a pre-set agenda that motivates them to take part. Thus, public engagement in new and emerging technologies differs from many other areas of public participation, where participants already know and care about the issue at stake.

Three types of support that need to be considered

1 Support to help people engage in discussions about scientific topics (eg, information or training).
2 Logistical support to help people who want to attend do so (eg, expenses or childcare).
3 Incentives to encourage people who are not explicitly interested in the issue to attend (eg, financial incentives).

Provision of adequate support to public participants is important for several reasons. For example, it:

— Maximises people's ability and likelihood to take part.
— Minimises the risk of people dropping out before the process ends.
— Helps public participants gain more from the experience (eg, by building skills, knowledge, or confidence).
— Can help raise the quality of the discussion.
— Ensures that public participants' needs and expectations can be taken into account in the framing of the process and discussions.

Not offering any support to public participants carries the following risks:

— Low uptake of participants.
— Participants dropping out before the process ends.
— Participants feeling unqualified to engage in discussions.

What it means in practice

Consider what support or incentives people might need to enable or encourage them to take part, including:

— Financial incentives and remuneration of income lost.
— Travel expenses.
— Childcare.
— Translators.
— The event taking place at a time or in a setting that is convenient for the group that is targeted.

Also, think through what support public participants might benefit from to help them take part in discussions about science and technology.

For example:
— Receiving detailed information about the event, including information about what will happen after the event and who will use the findings
— Having concepts and expectations explained in advance.
— Learning about the area of science or technology before discussions begin.
— The opportunity to talk through their views and expectations before meeting the scientists and policy-makers involved in the process.
— Training in how to participate effectively.

Things to keep in mind
— Do not assume that the initial brief will be enough to equip the public participants for their role in the process. At a minimum, ask members of the public about their expectations and concerns, and offer appropriate clarifications and support.
— Consider: 'What is in it for the participants?' How can the process be made as worthwhile and enjoyable as possible for public participants?

Supporting scientists to take part

Why it matters
Compared with the amount of time and effort spent preparing public participants for their role in public engagement[148], scientists tend to receive little support to help them engage effectively with the public. NEG argues that this situation needs to change: scientists, as well as members of the public and other participants, would benefit greatly from receiving more support to help them participate effectively. Many scientists are unfamiliar with the nuances of public engagement practice or the principles of social science that underpin it. Several scientists who were interviewed by NEG for this study found the experience different from what they were used to or had expected; some described it as 'unnerving' and 'out of their comfort zone'.

Support for participating scientists has potential benefits. For example, it:
— Minimises the risk of misunderstandings about scientists' roles in the activity.
— Enables scientists to gain more from the experience.
— Ensures that scientists' needs and expectations can be taken into account in the framing of the process and discussions.

Not offering any support to scientists risks:
— Causing misunderstandings and tension between organisers and participating scientists.
— Preventing participating scientists from fulfilling their role in the engagement activity.

What it means in practice
Consider what support participating scientists might benefit from. For example:
— Receiving detailed information about the event.
— Having concepts and expectations explained in advance.
— The opportunity to outline their own thoughts and expectations before meeting public participants.

Things to keep in mind
— Reflect on how much support is offered to different groups involved in the engagement activity. Are there discrepancies, and if so, why?
— Do not assume that the briefing given to the scientists or their professional background will be enough to equip them for the activity.
— Show consideration for the constraints scientists work under, such as time restrictions or unsupportive colleagues.
— At a minimum, ask participating scientists about their expectations and concerns, and offer appropriate clarifications and support.

Communications

Why it matters

Good communications are a vital part of any public engagement activity. Provision of clear and continuous communication as the activity progresses and giving feedback after it is finished is necessary to ensure that:

— All involved in the activity are aware of what is going to happen and what the objectives are.
— Participants feel that their contribution is valued.
— Participants are able to comment on, and respond to, written outputs and any formal responses generated by them.

Not providing clear communication and feedback can:

— Create frustration and tension among partners and participants.
— Make participants feel that their input is not valued. A public participant said to NEG that the lack of feedback made her feel 'a bit like being dumped by a boyfriend. We had spent 3 days doing this and suddenly we didn't hear anything more about it'.

What it means in practice

— Inform participants and partners about the project plans, objectives, and any changes that occur.
— Ensure that websites and other sources of information about the project are up to date.
— Give participants and partners the opportunity to read and comment on project reports and evaluation reports (if appropriate).
— Inform participants and partners about what happens after the project ends (ie, how findings will be disseminated and received).

Things to keep in mind

Although giving direct feedback to all participants is not always possible, particularly after public engagement activities that have involved many people, there are always ways to make the information accessible to those who want it. Keeping participants and partners in the loop does not need to be more complicated than updating the project website or sending a mass email; something is usually much better than nothing.

Dissemination of learning and outputs

Why it matters

In the end, the ability of public engagement to have an impact beyond the small group of people who are directly involved in the activity depends on the effective dissemination of the outputs and learning. Every public engagement activity involves two types of external-focused learning[149]:

1 Learning for policy.
2 Learning for future public engagement practice.

To maximise the impact of the public engagement activity, organisers need to consider how both types of learning can be shared with as broad an audience as possible.

Not disseminating the learning widely can mean that:

— Project findings only reach a small audience and are quickly forgotten.
— The same efforts or mistakes are duplicated elsewhere.
— Capacity for effective engagement with the public does not increase over time because lessons are not shared between practitioners.

What it means in practice

Disseminating learning, at a minimum, involves:

— Careful audience analysis to identify the institutions and individuals that will be, or ought to be, interested in, and affected by, the findings.
— Measures taken by project organisers to engage the priority audience in the project from the outset, to ensure that they are given opportunities to input into, and learn from, the activity other than merely reading recommendations or project report(s).
— Dissemination of project report(s) through a range of avenues, such as launch events, presentations to relevant decision-making bodies, websites, press releases, email distribution lists, and feedback to participants.

Disseminating learning for future public engagement, at a minimum, involves:

— Identification of lessons learnt. What worked particularly well? What did not work so well? What should be done differently in the future?
— Consideration of who will benefit from hearing about what has been learnt. For example, colleagues of those who organised the activity, colleagues in other organisations, the funding organisation, external contractors or facilitators, and any relevant practitioner's network.
— Dissemination of the lessons learnt as widely as possible. For instance, by circulation of the evaluation report or by sharing of learning with relevant practitioners' networks.

145 There is insufficient space here to account for the many different methods and approaches to public engagement. For a useful overview of the spectrum of public engagement approaches, see IAP2 *Public Participation Spectrum* at www.iap2.org/associations/4748/files/spectrum.pdf. For an overview of methods, theory, and resources, see Involve's new online public engagement guide www.peopleandparticipation.net, launched in June, 2007 (funded by DCLG, SDC, and Ministry for Justice)

146 This assumes a collaborative, as opposed to a confrontation, model of public engagement. There are other methods of policy impact achieved through campaigning tools that are not discussed here.

147 At the time of writing, the Commission for Equality and Human Rights (CEHR) is conducting a Discrimination Law Review (DLR) to simplify and streamline all discrimination law.

148 In particular in the more deliberative experiments included in this study: Nano Jury UK, Nanotechnology, Risk and Sustainability and Nanodialogues

149 Aside from the learning of the individuals and institutions that take part

Appendix 3: Government's principles for public dialogue on science and technology

This section is taken from the Government's OPPEN[150] *document.*

Based on theoretical understandings and practical experience, the essential elements of public dialogue on science and technology are set out below. The Government intends to adopt the approach set out in this document, but recognises that this guidance will continue to be refined as experience grows.

The key principles for public dialogue seek to ensure that:
— the conditions leading to the dialogue process are conducive to the best outcomes (Context)[151];
— the range of issues covered in the dialogue are relevant to participants' interests (Scope);
— the dialogue process itself represent best practice in design and execution (Delivery);
— the outputs of dialogue can deliver the desired outcomes (Impact); and
— the process is shown to be robust and contributes to learning (Evaluation).

In fulfilling these principles, it is recognised that the specific context of each issue will determine the relative importance of each of the following principles. However as far as practicable, public dialogue on science and technology aims to:

Context[152]
— Be clear in its purposes and objectives from the outset.
— Be well-timed in relation to public and political concerns. It will commence as early as possible in the policy/decision process.

— Feed into public policy—with commitment and buy-in from policy actors.
— Take place within a culture of openness, transparency and participation.
— Have sufficient resources in terms of time, skills and funding.
— Be governed in a way appropriate to the context and objectives.

Scope

— Cover both the aspirations and concerns held by the public, scientists in the public and private sector, and policy-makers.
— Be focused on specific issues, with clarity about the scope of the dialogue. Where appropriate we will work with participants to agree framings that focus on broad questions to encourage more in-depth discussion. For example, we might start by asking, 'How do we provide for our energy needs in the future?' rather than starting by asking 'should we build new nuclear power stations?'
— Be clear about the extent to which participants will be able to influence outcomes. Dialogue will be focussed on informing, rather than determining policy and decisions.

Delivery

— Ensure that policy-makers and experts promoting and/or participating in the dialogue process are competent in their own areas of specialisation and in the techniques and requirements of dialogue. Measures may need to be put in place to build the capacity of the public, experts and policy makers to enable effective participation.
— Employ techniques and processes appropriate to the objectives. Multiple techniques and methods may be used within a dialogue process, where the objectives require it.
— Be organised and delivered by competent bodies.
— Include specific aims and objectives for each element of the process.
— Take place between the general public and scientists (including publicly and privately funded experts) and other specialists as necessary. Policy-makers will also be involved where necessary.
— Be accessible to all who wish to take part—with special measures to access hard to reach groups. Where the objectives require it, media partners may be needed to ensure that the process reaches the wider population.

— Be conducted fairly—with no in-built bias; non-confrontational, with no faction allowed to dominate; all participants treated respectfully; and all participants enabled to understand and question experts claims and knowledge.
— Be informed—This will include providing participants with information and views from a range of perspectives, and access information from other sources. The basis on which knowledge claims are made will be open, transparent and subject to challenge (following the scientific principles of peer review).
— Be deliberative—allowing time for participants to become informed in the area; be able to reflect on their own and others' views; and explore issues in depth with other participants. The context and objectives for the process will determine whether it is desirable to seek consensus, or to map out the range of views.
— Be 'representative'—the range of participants will reflect the range of relevant interests, and pertinent socio-demographic characteristics (including geographical coverage) of the general public. At times, there may be a need to enable participants to be self-selecting. In these circumstances, there will be measures in place to take account of potential any bias this may cause.

Impact

— Ensure that participants, the scientific community and policy-makers and the wider public can easily understand the outputs across the full range of issues considered.
— Ensure that participants' views are taken into account, with clear and transparent mechanisms to show how these views have been taken into account in policy and decision-making.
— Influence the knowledge and attitudes of the public, policy-makers and the scientific community towards the issue at hand.
— Influence the knowledge and attitudes of the public, policy-makers and the scientific community towards the use of public dialogue in informing policy and decision-making.
— Encourage collaboration, networking, broader participation and co-operation in relation to public engagement in science and technology.
— Be directed towards those best placed to act upon its outputs.

Evaluation

— Be evaluated in terms of process and outcome, so that experience and learning gained can contribute to good practice.
— Ensure that evaluation commences as early as possible, and continues throughout the process.
— Ensure that evaluation addresses the objectives and expectations of all participants in the process.
— Be evaluated by independent parties (where appropriate).

150 HM Government (2005b), annex 1

151 The means by which dialogue can impact policy and decision-making will be specific to every organisation involved in the dialogue process and every issue under consideration. It is important, therefore, that organisations involved in dialogue address their institutional arrangements and working practices to ensure effective application of dialogue processes

152 It may not be advisable to embark on a dialogue process where these requirements cannot be met

Appendix 4: Research methodology

The research on which this report is based has focused on one key question: What are the uses and limits of public engagement on emerging science and technology?

We have sought to answer this question by using public engagement on nanotechnologies as a case study, and by exploring the following sub-questions:

— What are the key findings of public engagement on nanotechnologies in the UK and abroad?
— What are the impacts of public engagement on nanotechnologies on individuals (ie, scientists, members of the public, and others) who took part?
— What are the impacts of public engagement on nanotechnology decision-making institutions?

The projects included in this study are:

— NanoJury UK
— Small Talk
— Nanodialogues
— Nanotechnology, Risk, and Sustainability
— Citizen Science @ Bristol
— Democs

These projects have been based in the UK and have reported on the results of public engagement focusing on nanotechnologies. In addition, we have mapped 17 related activities taking place elsewhere worldwide.

We have conducted two different forms of research:
— A thematic analysis of the approaches and outcomes of the six projects on public engagement on nanotechnologies listed above.
— In-depth interviews with scientists, public engagement practitioners, social researchers, public participants, and policy-makers about their experiences of public engagement on nanotechnologies and their thoughts on the lessons for future public engagement on emerging science and technology that can be drawn from these projects.

Thematic analysis has incorporated an overview of existing research into public engagement on emerging science and technology, as well as a review of project reports, evaluation reports, websites, and other forms of documentation from public engagement on nanotechnologies in the UK and abroad. We have focused on identifying lessons across the projects, rather than on comparing results between them.

Interviews aimed to elicit the views and experiences of different actors who are affected directly or indirectly by public engagement on nanotechnologies. Particular attention has been paid to how participation in a public engagement activity has affected these individuals, and what they perceive to be the key lessons learnt from these projects for future public engagement on emerging science and technology.

The interviews have focused on four projects: NanoJury UK; Nanotechnology, Risk, and Responsibility; Small Talk; and Nanodialogues, because they were the only UK projects that could provide access to participants and organisers as well as project reports and other documentation. The other UK projects (Democs and Citizen Science @ Bristol) have mainly been included in the research as points of reference and comparison alongside the international initiatives on public engagement on nanotechnology.

The interviews have covered three different themes:
1 The experience of taking part.
2 What happened afterwards: personal impact and expected or perceived wider impact (eg, on policy or research).
3 Does it matter? The value and limits of public engagement in science and technology.

We interviewed 46 people from six broad categories:

Interviewees

Participants of public engagement on nanotechnologies	Target audiences for public engagement on nanotechnologies
Members of the public (11 people)	
Scientists (8 people)	Scientists (1 person)
Policy-makers, organisers, or members of commissioning institutions (13 people)	Policy-makers or members of commissioning institutions (4 people)
Industry (1 person)	Industry (3 people)
Organisers of foreign projects on public engagement on nanotechnology (5 people)[153]	

The interviews were done in three clusters:

1 Interviews with project organisers in summer and autumn 2005
2 Interviews with project organisers and participants (scientists, members of the public, and others) in spring and summer 2006.
3 Interviews with participants and target audiences in autumn and winter 2006–2007.

150 Of these five individuals, three were interviewed by email and two in person.

Democratic technologies?
The final report of the Nanotechnology Engagement Group (NEG)

In laboratories across the world, new scientific territory is being uncovered everyday; territory that offers groundbreaking opportunities for society, as well as new risks and unexpected challenges. Just as yesterday's science and technology has contributed to shaping today's world, these new technologies will help shape the world of tomorrow. The power of technology is clear, but its governance is not. Who or what makes these world-shaping decisions? And in whose interests are they made? These are the questions posed by a growing number of researchers, NGOs, citizens, politicians and scientists who seek to challenge the way that science and technology is governed and invent new ways to democratise the development of new technologies. This report documents the progress of six projects that have sought to do just that – by engaging the public in discussions about the governance and development of nanotechnologies.

In 2005, a group of pioneering projects, from various contexts and with different motivations, set off on separate voyages into this new territory. Their mission: to explore how we might ensure that future developments in nanotechnology are governed in the interests of the many, not the few. In short, to bring democracy to these new, unchartered territories. Democratic Technologies? follows the journeys of these projects, and the scientists, citizens and civil servants who took part in them.

This is the report of the Nanotechnology Engagement Group (NEG), a body convened by Involve with the support of the Office of Science and Innovation's Sciencewise scheme, and the Universities of Cambridge and Sheffield. Our role has been to observe and support the pioneers of nanotechnology public engagement and log their experiences for the benefit of future journeys into the interface between democracy and technology.

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