‘We don’t get asked what we want, do we?’ . . . ‘But would we know if we were asked?’ . . . ‘Well, no one’s asked us.’

‘I object to the fact that we’re called consumers. We’re not humans anymore. We’re consumers.’

‘It’s not nanoparticles we need to govern, it’s the people that are making them and using them.’

‘I feel lucky. I feel like we can make some nanoscule contribution to society.’

Nanodialogues

Experiments in public engagement with science

Jack Stilgoe

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My hope is that this pamphlet does justice to the countless conversations that have formed the Nanodialogues. But the views within this pamphlet are my own and do not necessarily represent those of others involved in the project.

Jack Stilgoe
June 2007

About the author

Jack Stilgoe is a senior researcher at Demos, where his work focuses on science and innovation. Since 2005, he has coordinated the Nanodialogues project. He is co-author of *The Received Wisdom* (Demos, 2006) and *The Public Value of Science* (Demos, 2005). Previously, he was a research fellow in the science and technology studies department at University College, London, where he looked at debates between experts and the public about the possible health risks of mobile phones. He has a degree in economics, an MSc in science policy and a PhD in the sociology of science. He is an honorary research fellow of University College, London (jack.stilgoe@demos.co.uk).

1. Manufacturing consensus

On a late spring evening in 2006, an odd sort of policy meeting is in progress. The evening sun bounces off the rain-drenched pavements of Victoria Street and into a civil servant's corner office. Outside, people are stepping over puddles on their way home to a hosepipe ban. Inside, three members of the nanotechnology team at the Department for Environment, Food and Rural Affairs (Defra) are talking to four public participants of a recent 'People's Inquiry' into nanotechnology. Six months before, none of these members of the public had heard of nanotechnology. Now they are offering their advice to the government.

The civil servants explain what government is doing in relation to nanotechnology. They are at the stage of trying to find out what is going on here and abroad, before deciding whether regulation is required. And they are still working out what questions to ask. 'I'm sorry to keep saying "we don't know",' one of the team concedes. But the four representatives of the People's Inquiry – David, Santosh, Debbie and Steve – have questions of their own. David wants to know: 'What safety measures are in place? Who's in charge? If someone wants to use nanoparticles in the environment, how do you stop them?' Steve, in particular, is worried. He tells the policy-makers that, given the level of uncertainty, 'you need to look for the things you might not be looking for'.

Then it is the turn of the nanotechnology team to ask questions.

Did the panellists think the public engagement experiment in which they had been involved was valuable? Debbie is enthusiastic. She reckons the People's Inquiry was well worth the investment of time and money. 'I feel lucky…' she says, 'I feel like we can make some nanoscule contribution to society.'

What's in a name?

Conversations such as this, unthinkable a few years ago, have been made possible by a growing openness in science and technology policy. The short history of nanotechnology has coincided with a move towards greater public participation in decision-making, particularly but by no means exclusively in the UK. Against the backdrop of past failures, the move towards broader public engagement in science has gathered momentum.

With nanotechnology, the story begins in 2004, when a group of scientific heavyweights from the Royal Society and Royal Academy of Engineering (RS/RAE) set out to explore an exciting area of science in the context of an increasingly sceptical society.[1] In the sea of recent reports on nanotechnology, the RS/RAE report remains the high-water mark. The report provided a workable definition that focused on the novelty of science and technology at very small scales (less than 100 nanometres). It pointed to the empty spaces in our scientific knowledge, and it began sketching out some of the social uncertainties – the questions we need to ask about where nano might be heading and the impact it may have on society. The report set the agenda for subsequent discussions of nano.

In its response to the RS/RAE report, published in February 2005, the UK government acknowledged some of the immediate policy challenges and created a cross-departmental 'Issues Dialogue Group', to address them.[2] At the same time, a 'Research Co-ordination Group' began re-reviewing the research needs identified by the RS/RAE. And a 'Nanotechnology Engagement Group' was set up to oversee public engagement, through projects such as the Nanodialogues. Some of the trickier issues were kicked into the long grass to be revisited later. Meanwhile, 'nano' started to become a more visible part of our lives.

Smoke and mirrors

For the past couple of years, the Woodrow Wilson Center in the USA has been taking an inventory of nano as it appears on our supermarket shelves. Measured against the hype and hubris of some of nanotechnology's proponents, the list of products is rather mundane. Nano-enhanced golf clubs, tennis balls and stain-proof shirts have now been joined by incrementally improved cosmetics, antibacterial washing machines and a 'nano-silver foam condom'.[3]

Investment analysts Lux Research tell us that more is now spent globally on nano-enabled products ($50 billion) than on nano research ($12 billion).[4] But the connections between the research and the products are not at all clear. Researchers in labs around the world, only some of whom would label themselves nanoscientists, are busy working at the nanoscale without obvious applications in mind. Most would agree that the really interesting nano developments are still some way off.

As the science unfolds, for some pressure groups, nanotechnology has created a rare opportunity to raise questions at an early stage – to encourage a 'frontlash' more than a backlash. Reports, publicity stunts and, in France, a protest against Europe's largest nano centre have helped to keep the issues that the RS/RAE raised on the policy agenda.[5] Much of this activity has not been about nano *per se*, but has used nano as a way of drawing attention to patterns that are repeated with each new technological wave. Looking to past experience for analogies, much of the nano debate has taken place in the language of 'risk'.

Nanotechnology has also been dragged into its first health scare. In March 2006, six people were hospitalised after using a bathroom cleaner called 'Magic Nano'. A German company, Kleinmann, announced that it was recalling the product, days after its release. It was a false start for one of the few nano-products and there were fears that it would spark wider alarm. Except, as far as we can tell, there was nothing nano about Magic Nano.[6]

For scientists, companies and policy-makers, the case highlighted

three things. First, that the nano brand is fragile and easily tainted. Second, that there is no fixed definition of what is and isn't nanotechnology. And third, that regulation has very little idea of where nano is and isn't being used in products. In Germany, the UK and elsewhere, it seems that regulators are still working out the rules.

Taming nanotechnology

In March 2007, the publication of a report from the Council for Science and Technology brought the science minister, Malcolm Wicks, onto Radio 4's *Today* programme. Three years on from the RS/RAE report, the Council was not happy with the government's response. They complained that it had spent only a tenth of the money it should have done on nano-related risk research.

Wicks tried to defend himself: 'We need more research and I recognise that. . . . But this is not about money. The research councils . . . have never been better funded. . . . What's happened is that they haven't had, and this is what the MRC tell us, sufficiently high quality research applications to award the grants.'

The presenter Ed Stourton fired back: 'So it's the scientists' fault, not your fault at all?' And the minister replied: 'Look, it wouldn't be right for a minister to say, "you scientists do this".'[7]

From behind the scenes, it was clear that central government should have paid for more research into the toxicological uncertainties surrounding nanotechnology. Yet despite the science community's insistence that normal modes of research funding were inadequate for this sort of science, the buck was passed back to them by government. Lines of responsibility and accountability have become very confused.[8]

What we see is policy-in-the-making designed to accommodate science-in-the-making. Nanotechnology, as with many of the policy challenges posed by advances in science and technology, falls into something of an institutional void. In such a void, according to the political theorist Maarten Hajer, there are 'no generally accepted rules and norms according to which politics is to be conducted and policy measures are to be agreed upon'.[9] So a policy response needs to be

built from scratch, and those grappling with nanotechnology have attempted to fill the void with structures adapted from past experience.

While regulators were considering their options, the deputy head of the Confederation of British Industry (CBI) complained that 'overly cautious regulations by the Department for Environment, Food and Rural Affairs have tied hands and limited options'.[10] In reality, companies were crying out for the regulatory signals that could guide innovation. At one meeting, a nano-businessman expressed his frustration that they were trying to create 'a business, an industry and a regulatory framework all at the same time'.[11]

In the US, chemicals company DuPont teamed up with Environmental Defense to create a 'Nano Risk Framework' aiming to 'promote responsible development of nanotechnology products, facilitate public acceptance, and support the formulation of a practical model for reasonable government policy on nanotechnology safety'.[12] But a loose coalition of civil society groups smelt a rat. In a press release, Friends of the Earth, Greenpeace and others described the move as 'fundamentally flawed', 'a public relations campaign' and insisted they would 'strongly object to any process in which broad public participation in government oversight of nanotech policy is usurped by industry and its allies'.[13]

In Europe, an attempt by the Swiss-based International Risk Governance Council (IRGC) to advise the world on how to deal with nanotechnology has met with similar criticism.[14] By offering us their own interpretations of the key issues and questions at stake in nanotechnology, Dupont, the IRGC and others inevitably invite counter-examples and possibilities that don't fit neatly into their frameworks. By trying to narrow the discussion into something more manageable, parts of the conversation that are squeezed out get louder rather than falling silent.

How new is nano?

In the UK, Defra's first step towards regulation is a voluntary reporting scheme, through which companies can tell the government

what they are up to. But by February 2007, Defra had received just five submissions from those involved in nano-research. The scheme appears to have become stuck in a 'novelty trap' – as technologies that are presented as new and exciting for funding or marketing purposes are rapidly re-imagined as mundane whenever the regulators come looking.[15] Voluntary regulation has turned nanotechnology back into standard industrial chemistry.

Whenever policy-makers discuss nanotechnology, the first thing they usually talk about is definitions. Are we talking about natural nanoparticles, as in soot or milk, or manufactured ones? Is it about things that are stuck down or those that are free to float about? Plenty of organisations are 'staking claims at the nanoscale' as the German philosopher Alfred Nordmann puts it.[16] Others argue that it is not so new, and that we should stop focusing so much attention on the nano label.[17]

The history of technologies tells us that they are never just things. They are systems, which tend to impose certain 'technological trajectories', crowding out alternatives.[18] We are starting to see these dynamics taking shape around nanotechnology, but despite certain groups pushing in certain directions its future is still very unclear.[19]

Almost every nanotechnology conference now includes a 'society bit' on its agenda. Social and ethical concerns have become an obligatory footnote to nanotechnology's technological promise. Public engagement has become part of the orthodoxy of twenty-first-century science policy, and nanotechnology has arrived at precisely the moment to make it a test case for this new type of governance.[20] So we have seen a new set of conversations between nanotechnology's main players, and we have seen these starting to reach out to the wider public.

The search for analogy

Depending who you ask, nanotechnology might be the Next Big Thing, but it may also be the Next Asbestos, the Next GM or the Next Thalidomide. But what if nano is something else altogether? Alfred Nordmann suggests that it might be more helpful to think of

nanotechnology as the Next Plastics.[21] Nano is an 'enabling technology . . . [which] cannot be tied to any particular social or economic agenda . . . an amorphous technology that promises to change everything, but nothing in particular'.[22] So it is hard to say what the impacts may be, and what form and focus public engagement should take.

Why is Demos – like the many other NGOs, think tanks and social scientists working in this area – so interested in nanotechnology? The scientific and technological possibilities are fascinating in themselves, but more exciting still is the prospect that nanotechnologies could open up new sorts of conversation between scientists, policy-makers and wider society. Rather than simply becoming the Next Controversy, could nano become an arena in which relationships between science, innovation and democracy are redesigned?

For the last two years, a team from Demos, Practical Action and the Universities of Lancaster and Durham have tried to contribute to this goal, by facilitating a series of conversations that we called 'The Nanodialogues'. These have been deliberately modest and experimental. We have run four dialogues, each with an organisational partner. The first was with the Environment Agency. The second was with both the Engineering and Physical Sciences Research Council (EPSRC) and the Biotechnology and Biological Sciences Research Council. The third was with Practical Action. And the fourth was with Unilever.

The roots of the project are in academic thinking that stretches back more than two decades about how science relates to society. Demos's more recent series of reports, from *See-Through Science* onwards, has tried to develop these arguments in a policy context.[23] Throughout this three-year programme of work, we have described a positive public agenda for science and technology, strengthened and deepened through new forms of social deliberation and accountability. The 'Nanodialogues' represents our most systematic attempt to test these ideas and connect them to decision-making.

In scientific terminology, the 'Nanodialogues' are a 'proof of concept' – that public engagement can make a positive difference. By

running our four experiments with partner organisations, all of whom were thinking through what nano means for them, we were able to flex and test systems of innovation and regulation.

As the project was in part government-funded, it carried a certain weight of expectation. This has placed us in an odd situation: while making the case for radical change in the governance of science and technology, we have also become part of the government's response to the RS/RAE report.[24] Our work has been explicitly experimental, but was also intended to contribute to the development of a coherent policy response to the challenges of nanotechnology.

We have had to negotiate these expectations with our partners, but we are grateful that we have been given plenty of freedom to experiment. At the end of the project, we would still be reluctant to say in definitive terms what public engagement is, and how it should be conducted. We feel clearer about what it *isn't*, and more able to contribute to discussions of what might work, but there are no easy answers. The project has been one small step along the road towards a new model of science and society. Our hope is that it informs the next steps that others need to take.

Beyond risk management

The experiments that form the 'Nanodialogues' have taken us behind the scenes of science policy. The view from backstage has been fascinating. Our conclusion is that, while policy-makers have been worrying about whether nanotechnology will be the New Asbestos or the Next GM, they have stopped thinking about what else it could be. They are governing nervously, seeing the public as a problem rather than as a potential resource. So public engagement has become risk management, designed to ensure that nanotechnology does the least possible damage.

Our argument is that by unlocking the politics of science, public engagement can contribute more than this: it can help to derive greater public benefit from new technologies.

In the past few years, public engagement has moved from being a radical idea to a comfortable one. Things have gone quiet – some

might say, too quiet. Yet the argument is still far from won. As one policy-maker told us, when it comes to public engagement, 'we've got to be seen to be doing it'. Those in government who pay it any attention at all still tend to regard it is a way of building legitimacy, or predicting and mitigating public concerns. The idea that it might help us to shape innovation trajectories, strengthen the public value of technologies and open up new spaces for political leadership is still met with a blank stare.

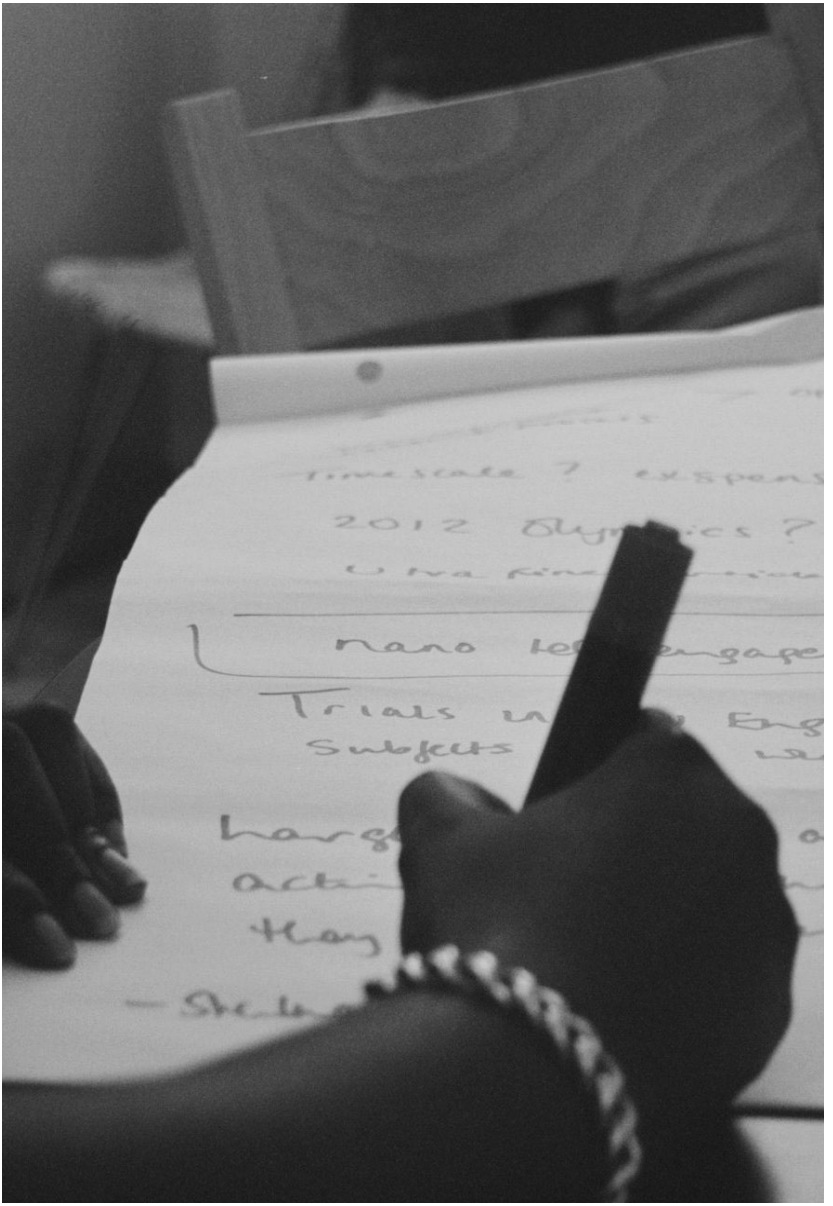
Some social scientists, more comfortable with the lessons of history than the challenges of the future, have reinforced the government's view of upstream public engagement. One attempt at definition restricts it to: 'Dialogue and deliberation amongst affected parties about a *potentially controversial risk issue* at an early stage of the Research & Development process and in advance of significant applications or controversy.'[25] From this perspective, engagement is about fears, not hopes; it is about regulation, not innovation. The participants of the nanodialogues project – scientists, members of the public, organisers, evaluators and partners – would disagree. If public engagement is worth doing, it is worth doing with constructive ends in mind.

Beneath a prosaic discussion of risk sits a far more vital one about science, values and what we expect and want from technology-based innovation. Reflecting on the various conversations that have made up the 'Nanodialogues', we feel that an opportunity is still being lost. While science continues to take us to new and potentially exciting places, government's nervous desperation to avoid bad choices means that it is sometimes failing to make good choices. Nanotechnology still represents a fantastic opportunity to re-imagine the relationship between science, technology and society. These debates are crying out for leadership and imagination, not yet more defensive risk management.

This pamphlet describes our series of experiments, on a two-year journey that took us to Liverpool, via Swindon, to Harare and back to London. It draws out what we feel are the important lessons and tries to give a sense of what it was like in the room when dialogue was

taking place. It complements and builds on a number of earlier reports that we have published from the individual experiments.[26] More information about the project, including methodological reflections and evaluations can be found in these reports and on the project blog (www.demos.co.uk/projects/thenanodialogues/blog).

In the next chapter, we explore the connections between public engagement and public policy as they developed through our work with the Environment Agency. Chapter 3 looks at the needs of one particular community and describes the bumpy ride from human need to innovation. Chapter 4 examines the imagination of research agendas by scientists, and suggests that the public can still have a role in contributing and helping to shape them. Chapter 5 is set in the research labs of Unilever, where nanotechnology is one of many pathways for future product development. The final chapter draws together these strands into an agenda for the future of public engagement with science.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2. Connecting people to policy

Six months before their meeting with Defra, David, Santosh, Debbie and Steve had, along with nine other people from East London, been participants in our first experiment. Over three Saturdays, the 13 members of our 'people's panel' explored the promise and uncertainty of nanotechnology. The first day had not begun well. An initial discussion, while friendly, had been peppered with confusion and crossed purposes. Two hours in, David admitted, 'We don't know. We don't do science.' Finding out about the promise others held for nanotechnology, Debbie shrugged: 'I feel like a nano-person.'

A month later, after 15 hours' deliberation involving 11 expert visitors, the panel produced a set of recommendations to address a policy question that at first glance appeared rather esoteric: How should we regulate the release of nanoparticles for land remediation? One of the visiting scientists told the panellists that they had joined a group of about only 100 people in the UK who knew anything about this issue.

Experiment 1 at a glance – The Environment Agency

What?	A 'People's Inquiry' on nanotechnology and the environment
When?	January/February 2006
Where?	London

Why?	To see how members of the public understand novelty, uncertainty and regulation; to give a small group of the public the opportunity to contribute to shaping policy on new technologies
How?	Three days of public dialogue with visiting perspectives
Who?	13 people from East London
	Twelve 'very important perspectives' Steve Killeen, Environment Agency Nicole Grobert, Oxford University Olaf Bayer, Corporate Watch Kristen Kulinowski, Rice University, Texas Graham Norris, formerly of Golder Associates Steven Banwart, University of Sheffield Brian Bone, Environment Agency Mike Raco, King's College London Nick Christofi, Napier University Julia Black, London School of Economics Andy Stirling, University of Sussex Doug Parr, Greenpeace

What's new?

Nanoparticles of iron and other metals have been tested in a number of countries to clean up pollution in the ground.[27] Nanoparticles are more reactive than their bigger equivalents and their size allows them to reach the parts of contaminated land that other particles cannot. Yet tests so far have looked at how effective they are, rather than how dangerous they might be.

The UK has taken a more precautionary line. Nanoparticles have not yet been used in land remediation, following the RS/RAE recommendation that:

> *Until more is known about the environmental impacts of nanoparticles and nanotubes, we recommend that the release of*

> *manufactured nanoparticles and nanotubes into the environment be avoided as far as possible.*[28]

Our experiment took place in this context of scientific uncertainty. There was a regulatory vacuum, and the Environment Agency had been charged with finding some answers. Through the People's Inquiry, they decided to invite some members of the public to help them.

Discussions of new technologies and risk frequently turn on the question of novelty – How similar is the technology to what has gone before? What new uncertainties does it present? What new regulatory questions does it ask? The Environment Agency had learnt the lessons of biotechnology, where industry had claimed that genetically modified (GM) crops were just an incremental step up from conventional plant breeding.[29] There are already people arguing the same thing about nanoparticles of iron: that they are no different from the iron powder we have been eating for years on our corn flakes.[30] But in the last two years, we have heard more people providing the counter-argument – that novel nanoparticles present novel uncertainties and should be controlled. In 2006, Berkeley, California, became the first place to put in place legislation to deal with nanomaterials.

In taking nanoparticles as a focus, we helped to reinforce the idea that their novelty brought new challenges. But this presumption of novelty created the space for an open conversation about innovation and regulation. By the end of the experiment, the participants had produced a set of recommendations that are wide-ranging and balanced.

The conclusions of the People's Inquiry

For three Saturdays, we have deliberated on the issue of nanotechnology and the environment. We have heard from leading experts with a range of perspectives. We have made these conclusions and recommendations:

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 using nanotechnology in the environment should be obliged to conduct 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 It should be mandatory to publicly declare the results of tests, good or bad. 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 containing specialists and lay people to oversee research, monitoring, regulation and communication of issues around 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 managing 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.

Written and agreed by the participants, March 2006

Questions and answers

Our experiment was based on the mechanics of a citizens' jury, which provides a forum for deliberation with experts. But we were keen to move away from the antagonistic jury language, with a 'charge' presented, 'witnesses' called and a 'verdict' agreed. Our experiment was more of a collective exploration by members of the public and scientists, of the content and context of a new scientific issue. The phrase 'People's Inquiry' is a metaphorical extension of the 'public inquiry', which is conducted *in* public, but not *by* the public. Whereas a public inquiry usually takes place after the event, our People's Inquiry set out to explore an issue as it was emerging.

Our panellists produced a set of self-authored recommendations – a tangible, legitimate end-point to a discussion. But it would miss the point to think that these represented the discussion. More important than the answers provided by public engagement are the questions that it asks. In the course of our experiment, our participants asked countless questions, mapping the territory of their concerns.

Some of these were factual:

> *How do things actually stick to these nanoparticles? Is it that it's actually physically sticky or has it got little things like Velcro on it, or has it got sucky things that suck the contaminant out, or is it a gluey thing? Is the process of using nanoparticles for land remediation a quicker process than other methods?*

Other questions echoed those of current scientific concern:

> *How far can the nanoparticles travel? Presumably nobody's actually looked at whether the things could be made to break down in cells?*

But most were open questions with no easy answers. They highlighted the areas of concern that were likely to define the future public context of nanoparticle use:

> *Will there be any unanticipated effects? Who has a say? Would the fact that it's a quicker process mean that the safety issues may be overlooked? What's the rush? What about irresponsible companies? Is information-sharing too informal?*

An important theme of both questions and recommendations was *openness*. Our participants, realising that they would never be able to know everything about the issue, demanded that a policy response should be accountable. They wanted a more open approach to the application and governance of technologies. They argued that regulation should be proactive, but also responsive to the changing

social and economic context of technology, including the emergence of new concerns.

The over-riding theme of our experiment was *uncertainty*. Uncertainty is a feature of almost all discussions of technology and policy. But it is often hidden. Unlike other public engagement initiatives, our experiment began with an admission of uncertainty from all sides. The Environment Agency didn't know enough about nanoparticles, and they wanted to know what to do. The participants knew nothing before they walked through the door. The shape of the conversation was experimental. And we, as facilitators and researchers, had no idea what would happen.

This allowed for a constructive series of exchanges, exploring how different people define and describe the uncertainties they see as relevant. It became clear that scientists currently know very little about where nanoparticles go and what happens to them in the environment. But the panel was critical of the suggestion that these uncertainties would be easy to resolve through more research. The paradox is that tests need to take place in real environments to be credible, so nature becomes the laboratory, and we have what Sheila Jasanoff has called 'experiments without borders'.[31] There was a real concern that regulatory research was being sidelined in innovation:

> *We're still not aware of what the risks are and there still haven't been safeguards put in. So we're the guinea pigs for this at the moment.*
>
> *What's happening to them? Because we don't know how it breaks down, if it breaks down, whatever. So it's a little bit scary there, everybody knows that testing's inconclusive, but they've still gone ahead.*
>
> *When you give us an example of something like a nano-iron particle to do something to remove a contaminant from the soil, that's fine, right, 'cos you've probably done some work on a nano-iron particle to see what, the way it works and things. What's probably frightening is if you don't use a nano-iron*

particle but you use something else, will the same research and studies have been done on that particle, if that's being used to remove a contaminant?

The resolution of uncertainty is complicated, as is deciding which uncertainties are most relevant. Certainly, there are scientific questions about the fate and transport of nanoparticles. But the problem is a collective one rather than just a scientific one. We need to ask questions such as: How transferable is knowledge of one nanoparticle to others? How can we apply knowledge across different environments? How should we take account of unintended consequences? Then there is the question of what we should do despite our uncertainty. Our panellists insisted on a precautionary approach – that we should wait until we knew more. But the nuances within this recommendation prompted further policy discussion. When the Environment Agency presented their view of nanotechnology to the Council for Science and Technology (CST) in September 2006, their argument was that, although they would work to prevent release of nanoparticles, they could not ban them as they had no evidence of harm. A member of the CST responded that this missed the point of the precautionary principle, which was to act despite a lack of evidence of harm rather than waiting for it to emerge.[32]

The Environment Agency were keen to gather intelligence on the recent policy trend towards 'risk-based regulation' – moving away from command-and-control, uniform procedures. By highlighting the troubles and uncertainties behind risk assessment, the panel exposed the limits of the model. But they recognised the need to regulate the system rather than the specific application:

It's not nanoparticles we need to govern, it's the people that are making them and using them . . . say to them, OK, we're going to govern you – until you can show us basically X amount of tests have gone on over X amount of time, and show us some conclusive report, result; basically, only then can you continue.

Taking the people to power

As is often the case with public engagement, the People's Inquiry provided more questions than answers.[33] To its credit, the Environment Agency responded positively:

> *Our experiment showed that it is possible to develop a dialogue about a complex environmental issue with a group of people who initially know very little about it. The nature of the questions asked by the panel and their focus on uncertainties and risks, the need for contextual research, openness, accountability and education shows that their input has been not only meaningful, but valuable. This 'socially framed' evidence adds weight to the existing government position on the use of nanoparticles in environmental clean-up. . . . Our participants started from a very different place to the experts who worked on the RS/RAE report, yet they came up with similar recommendations that are, for the most part, already being addressed.*[34]

They took on the task of responding in full to the panel's recommendations. And though they are an incomplete record of the discussion, the act of responding has forced the agency to reflect – in the light of public scrutiny – on its role in the regulation of new technologies.[35]

The experiment's evaluators provided us with another angle on the deliberation. They were interested in the way the experiment was constructed, the way discussions took place and the connections that could be drawn to decision-making:

> *This engagement has shown that, given adequate resources and access to expertise, publics can not only take on difficult issues, but work with them in ways which provide meaningful contributions to governance.*

> *The conclusions put forward by the panel offer much more than specific regulatory measures concerning the use of nanotechnology and land remediation. . . . This level of contextual understanding has allowed the 'people's inquiry' to offer a much more honest picture of the regulatory dilemmas facing government and society than a more limited discussion might have.*
>
> *The participants we spoke with conveyed a sense of importance about what they were doing.*[36]

Our people's panel left enthused but concerned. Having invested so much of their energy in the discussion, they wanted reassurance that what they were doing was not, in the words of one, 'a paper exercise'. They realised that their conclusions were not the final word on the matter. But they were convinced the things they had to say were the sorts of things that the government rarely heard.

The evaluators point out that, while our experiment claimed to be an example of upstream engagement, it was taking place downstream. The conversation piece was a technology that had been trialled in many countries and used in a few. This is an important point. Our response would be that debates about technologies are not just debates about *things* and they do not stop when things leave laboratories. They are debates about the systems around the things – the contexts of use, regulation and further innovation. So while some of our discussion concerned technology-in-the-making, most of it was about policy-in-the-making.

Talking into an institutional void

Of all the Nanodialogues, our first experiment was most clearly framed by a policy context. Had it taken place a year earlier or a year later, it would have made less sense to the people who supported it. The experiment was prompted by an open-minded organisation, eager for fresh thinking on a new policy challenge. While in progress, it generated real excitement, drew people together and challenged the

preconceptions of those involved. But now the dust has settled, what can we say about the changes that it made?

Public engagement initiatives are frequently met with questions about 'impact'. Organisations ask if it is really worth paying for; policy-makers ask how they can make use of the recommendations; sceptics insist that it hasn't told them anything they didn't already know; and academic critics argue that is just another way for institutions to varnish business as usual. Advocates of public engagement have sometimes made it hard for themselves. They have sold engagement on a critique of past policies, such as GM, BSE and nuclear power. With intelligent hindsight, problems are clear. Upstream, where policy options have not been laid out, let alone chosen, engagement provides no easy answers. But it can ask some deep questions about how we do policy and who we involve.

In the last ten years, talk of 'evidence-based policy' has become a maxim of justification for decisions. At the same time, policy-makers have tried to strengthen their advice with various forms of consultation.[37] Public engagement tends not to fit neatly into either of these frames of reference. As a way to get to either 'evidence' or 'consultation', our People's Inquiry was limited by the selection of 13 people who had no prior interest in the issue.

Instead, it provided a lens through which policy-makers could see an issue differently, focusing on contexts, uncertainties, alternatives and local concerns. This often leads to further debate and opens up new areas of policy. Another obvious impact of public engagement is personal – being involved in deliberation changes people's views. Scientists and policy-makers who get involved are self-selected by a degree of open-mindedness. But as others join in, they are likely to recognise the value of the conversation.

Of course, if public engagement is going to make a difference, invigorating the 30 or 40 people who are involved in a particular process will not take us very far. The Defra civil servants who spoke to our participants have now moved out of nanotechnology policy, taking whatever enthusiasms and insights they have gained with them. The space opened up by our discussion is closing again as

everyday challenges take hold. The next step for public engagement is to turn personal impact into systemic impact. As we will see in the final chapter, for engagement to make a difference, institutions need to innovate in the light of public values.

3. The politics of new technologies

Epworth is a suburb of Harare, but it feels rural. It is just outside the Harare city limits, which means it is cut loose from the support of the city. In 2005 it was the scene of some of the harshest of the slum clearances that formed Robert Mugabe's 'Operation Murambatsvina' ('Drive Out Trash'), which left thousands homeless. It is framed by outcrops of rock that have been worn away to resemble meticulously stacked balls. The balancing rocks are famous – they appear on the 10,000 dollar banknote. In the distance, you can see the electricity pylons of Harare's suburbs. But the telegraph poles around Epworth carry no cables. Plans for electricity and telephone lines were abandoned before completion.

Epworth gets its water from a combination of shallow wells and springs. The water brought up from the well looks clean enough, but with the pollution from the city, it's impossible to tell what it contains. 'We're supposed to check' shrugs our guide, who acts as one of the community leaders.

Nearby, a new well is being created. At the bottom of a six-metre pit, a man is filling a bucket with wet sand. His colleagues pull up the bucket and pile the sand around the pit's edge. It has taken two days so far, and will take another three. Then they need to seal it and put a lid on it. The well is next door to a pit latrine. It is far from ideal, which is why new sanitation methods are so important. Though

Epworth is cut off, it is near enough to the city to be cramped. There is little space, and the well needs to be dug where there is water.

Any conversation about technology in Epworth has to start from here. In Zimbabwe, there is a headline context – a failing state and an economy that is both shrinking and sliding out of control – and there is an everyday context. In this everyday context, the idea of nanotechnology is not on its own likely to generate excitement. Ask what technologies people would like to see to help them get clean water and they mention rope-and-washer pumps, which replace disease-ridden open wells, and can be made and fixed using old tyres.[38]

Nanokutaurirana

People in the developing world don't have much of a voice in science and technology. They are less likely to enjoy the benefits of new technologies and more likely to suffer from their downsides.[39] The RS/RAE report took issue with the sweeteners often offered to the developing world by nano-marketeers:

> *Much of the 'visionary' literature . . . contains repeated claims about the major long-term impacts of nanotechnologies upon global society: for example, that it will provide cheap sustainable energy, environmental remediation, radical advances in medical diagnosis and treatment, more powerful IT capabilities, and improved consumer products. . . . However, it is equally legitimate to ask who will benefit and, more crucially, who might lose out? . . . Concerns have been raised over the potential for nanotechnologies to intensify the gap between rich and poor countries because of their different capacities to develop and exploit nanotechnologies, leading to a so-called 'nano-divide'.*[40]

Other contributions, such as the Meridian Institute's 'Global dialogue on nanotechnology and the poor', have stimulated wider discussion about possible benefits.[41] One academic study, collecting the insights of people thinking about nano and development, concluded that the

top three applications are energy, agriculture and water.[42] For our second experiment, we chose to explore the relevance of nanotechnology in the provision of clean water. Demos worked with Practical Action, the development NGO, which for the past 40 years (under its former name of the Intermediate Technology Development Group) has been making technology work for people in poor countries. Its vision is of appropriate, usable, sustainable technologies, driven by human needs rather than markets.

In Harare, we put together a three-day workshop with local mushroom farmers, brick makers and water scientists. The non-scientists were representatives of communities that work with Practical Action. Three were from Epworth and three were from Chakohwa, a rural community near Chimanimani, in the mountains of eastern Zimbabwe. The scientists were from government agencies, universities and charities. The participants named our workshop Nanokutaurirana, a Shona neologism meaning 'Nanodialogue'. But for the first day and a half, the word nanotechnology was not mentioned. We wanted people first to define what the problem was.

Experiment 2 at a glance – Practical Action

What?	'Nanokutaurirana'
When?	July 2006
Where?	Harare, Zimbabwe
Why?	To understand the problem of getting clean water in two Zimbabwean communities; to identify the conditions under which nanotechnology might work for these communities
How?	A three-day stakeholder workshop
Who?	Seven scientists, six community representatives: Sibekile Mtetwa, Zimbabwe National Water Authority Herold Sibanda, Water and Sanitation Development Crispen Mutsvangwa, National University of Science & Technology

Cleophas Musara, Mvuramanzi Trust
Amatus Rwazemba, Mvuramanzi Trust
Sthabile Tirivarombo, Chinhoyi University of Technology
David Love, WaterNet
Gift Matembudze, Talkmore Mukundu and Rosemary Muchini from Chakohwa
Grace Bwanya, Tsitsi Mafuta, Zhuwawo Mugwagwa from Epworth
Facilitators from Practical Action, Demos and an independent Harare consultancy

Observers

Their description of the problem had multiple roots. Water is a market commodity, it is unaffordable, it is scarce, it is a long way away and the responsibility for collecting it normally falls to women and girls. Where wells exist, they are crammed next to latrines and difficult to seal off from contamination. Near Harare, in addition to a recent cholera outbreak, there is chemical pollution from factories. Away from the city, the rural community reported that water was contaminated by natural salt deposits. By the end of day one, we had a rough map of the issues and the connections between their social, technical and political dimensions.

The politics of technology

The more the problem came into view, the further removed nanotechnology seemed as a solution. The community representatives had been let down in the past by well-intentioned technologies. Water pumps had arrived with instructions in English or German. When handles had broken or filters had clogged, they had been unable to find the parts or the expertise to fix them. As one of the community representatives asked, 'When the NGO goes away, who has the knowledge to run and maintain their technology?'

For these communities, local technology was not a matter of pride,

it was a matter of what worked. The system that shapes the problem needs to map onto the system that provides the solution. So the rope-and-washer pump makes sense. It is not so much a thing as a system. It is not owned or sold by any one company and it is flexible enough to fit different societies. The participants were well aware that, as one put it: 'All these new technologies are old in other countries.'

As the historian David Edgerton describes, while the West obsesses about the increasing 'pace of innovation . . . most change is taking place by the transfer of techniques from place to place'.[43] Technological systems – the way things are used, abused and controlled – are political.[44] There are reasons why they end up the way they do, and there are ways in which we can talk about better or worse technologies. We can judge new technologies according to the extent to which they lock people into certain systems (as, for example, GM crops and centralised nuclear power do) or provide an open platform for new sorts of use (for example, Linux or micro-renewable energy).

In our first experiment, with the Environment Agency, our participants exposed the politics of technology by talking about issues of detectability (whether we will be able to find nanoparticles once we release them) and reversibility (whether we will be able to backtrack). They realised that, even once we understand the effects of nanoparticles in a lab, when we release them, we will know much less about their impacts. So innovation becomes experimentation as technological systems become bigger and more complicated. Technologies carry with them some definition of social need and some promise of a technical fix. They define both a problem and a solution. And the systems of research, innovation and regulation of which they are a part can harden this definition. So while in the UK we may take the system – transport, maintenance, markets and a stable economy – for granted, in Epworth, this needs close scrutiny. Rather than starting from the technology, we need to start from the local context and think about alternatives.

Alternative technologies

Edgerton argues that the politics of new technologies have tended to narrow down consideration of alternatives. 'Alternatives are everywhere, though they are often invisible.'[45] Public discussion reveals these alternatives. Technologies do not force people to do things, but as they open new doors, there is a danger that old ones can close. While good intentions are focused on nano and development, they may lose sight of what else can more easily benefit poor people.

In the course of our public engagement work, as we have reflected the public context of nanotechnology back to institutions, we are often asked whether public concerns are specific to nanotechnology or more general. Our response has usually been that nanotechnology is currently a good place to start the conversation, but that the sentiments speak way beyond this. In Zimbabwe, the issue of whether we should be talking about nano at all never seemed more pressing.

Halfway through our workshop's second day, we introduced nanotechnology. Luckily, a few weeks before, the Meridian Institute had provided some examples of nano-products working in developing countries.[46] Their report was careful to point out that the diffusion of these technologies was some way off, but it provided some examples of nano-scale water filters working in South Africa. Our participants understandably shared little of the West's excitement for nanotechnology. Even for the scientists there was little prospect of riding nanotechnology's funding wave. So the group asked about applicability, alternatives, environmental impact, cost, maintenance and the capacity to manufacture and maintain the technology locally. They asked whether these technologies were fixed or adaptable for local needs, whether they would mean an increase in employment for Zimbabwean scientists, or greater reliance on the West. And they asked at what scale these could be used. Were they the sorts of filters that would be used centrally, at government treatment plants, or could they be put in schools and controlled by communities? The experiment revealed the huge gulf between research and diffusion. We

began to see the steps that need to be taken to connect innovation to human need in a place like Epworth.

Systems of science

The temptation is to see the problem as intractable, to say that science has nothing to offer and that the solution is for Zimbabwe to provide solutions to Zimbabwean problems. But this would deny the huge potential that exists for constructive collaboration. Around the world, there are efforts under way to direct emerging technologies towards pressing human needs. A more positive approach might ask how these efforts might yield greater benefits.

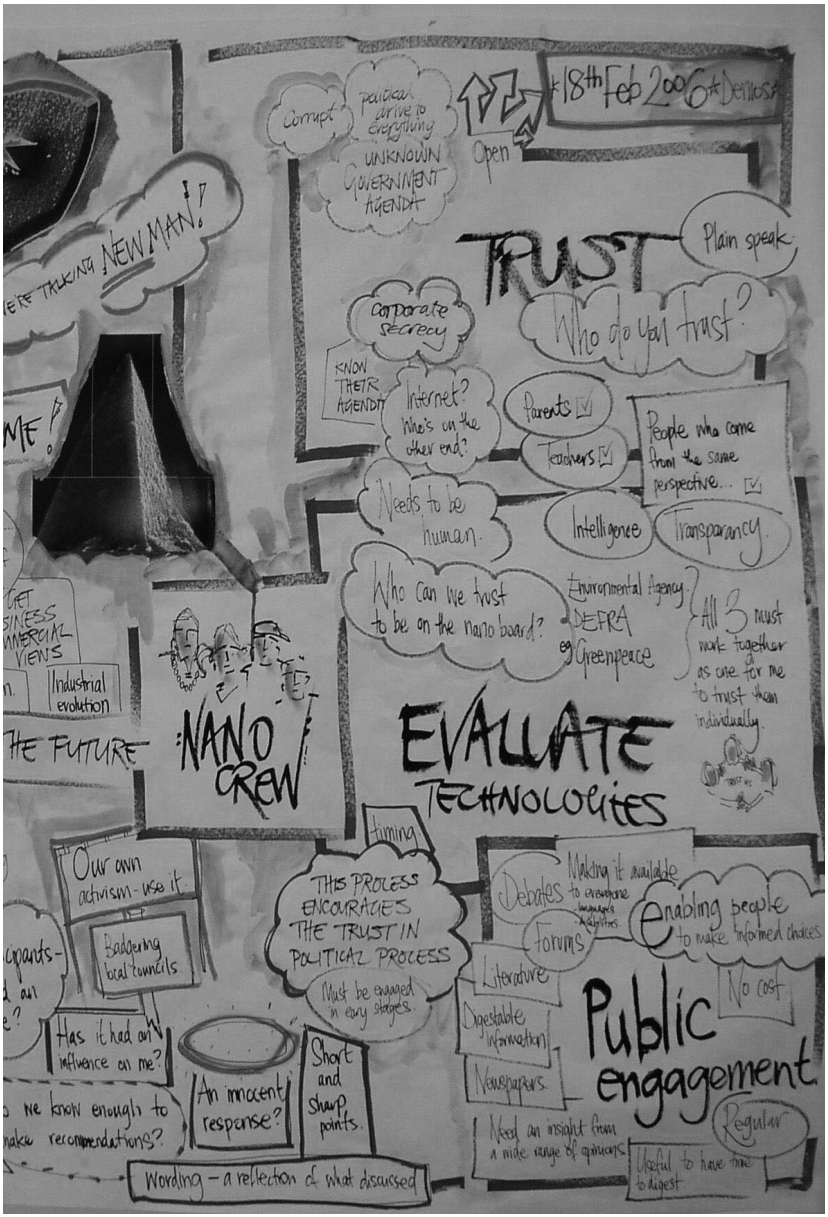
As a step towards this, we asked our Zimbabwean participants to produce a set of recommendations for UK scientists. They concluded that innovation does need to point in a different direction, but collaboration can be hugely positive 'when there is a story to tell' – that is, when it starts with some concrete benefit in mind. The Zimbabwean scientists recognised that in many cases, given the asymmetry of resources, Western scientists would have to lead research, but this research should recognise the value of local knowledge and work to empower Southern scientists and build their capacity. They also recommended immediate steps that could be taken, such as opening up access to all scientific journals.

Back in the UK, we went to visit Mark Welland in Cambridge. We were keen to see what lines could be drawn between the needs of people and the science, to stretch the connection back to the research base. Welland runs Cambridge University's Nanoscience Centre, but he is also co-director of the Yousef Jameel Science and Technology Research Center at the American University in Cairo. His research team is driven by scientific curiosity, but he encourages his colleagues to reflect on public value as part of their work.[47] At one of his centre's nanoscience seminars, we told the scientists about our time in Zimbabwe and asked for their thoughts and questions.

In Zimbabwe, scientists saw community participation as a vital, if hugely complicated, part of what it means to do good science

and engineering. In the UK, systems work against community or public engagement.[48] Talking to the young researchers at the Interdisciplinary Research Collaboration (IRC) in Cambridge about our experiment, it became clear that many of them have an appetite to use their skills to contribute to human needs. But advancing in their scientific career often feels like a routine progression through certain stages in which they have 'no control over their own research projects, social impacts or otherwise'.

At the moment, the gravitational pull for these scientists is towards certain sorts of innovation – marketable technologies or a narrow definition of world-beating basic research. We need a broader understanding of innovation, which places greater value on the needs of people in the developing world. The young scientists in Cambridge recognised the scale of the challenge that this poses to established systems, but were unsure how to continue the conversation and change things from inside.


Corrupt
political drive to everything
UNKNOWN GOVERNMENT AGENDA
Open
18th Feb 2006 Demos
TRUST
Plain speak
Who do you trust?
Corporate secrecy
KNOW THEIR AGENDA
Internet? Who's on the other end?
Parents
Teachers
People who come from the same perspective...
Needs to be human.
Intelligence
Transparency
Who can we trust to be on the nano board?
Environmental Agency
DEFRA
eg Greenpeace
All 3 must work together as one for me to trust them individually
EVALUATE TECHNOLOGIES
NANO CREW
Industrial evolution
THE FUTURE
Our own activism - use it
Badgering local councils
Has it had an influence on me?
An innocent response?
Short and sharp points.
Wording – a reflection of what discussed
THIS PROCESS ENCOURAGES THE TRUST IN POLITICAL PROCESS
Must be engaged in every stages.
Debates
Making it available to everyone
Forums
Literature
Digestable information
Newspapers
Enabling people to make informed choices
Public engagement
No cost
Regular
Need an insight from a wide range of opinions
Useful to have time to digest

4. Democratising imagination

Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.

Albert Einstein

In January 2007, before undergraduates returned from their holidays and the routine of university life resumed, 25 scientists of various ages and backgrounds gathered in the Hampshire countryside. Over five days, their task was to come up with some radically new lines of nanotechnology research, driven by the challenge of manufacturing matter from the bottom up. The proposals they produced would be funded by the EPSRC, who had put £1.5 million on the table. For all the organisers' encouragement to 'go with curiosity rather than expertise', it took two full days to free people from their disciplinary mindsets and engage in more adventurous sorts of conversations. The week brought together computer scientists, chemists, physicists and a sculptor.

The EPSRC Ideas Factory asked scientists to extend themselves from the realm of the possible to the fanciful. Some participants found themselves embarrassed by occasional lapses into the language of Eric Drexler – nanotechnology's much-criticised godfather. This was science funding that started with ideas: imagining radical new approaches, unimpeded by everyday concerns such as intellectual

property, publications and professorships. The assumptions of senior scientists were unpicked by postdoc researchers. Gaps in experience were filled by eager collaborators. Some of the scientists arrived looking for ways to take their research one step further. Most left having headed down completely different paths, working with people they had never met, drawing on fields of knowledge they didn't know existed.

But the discussion was not contained within the walls of an English stately home. Asked to consider the question of what we should be imagining and how we should be doing so, the Ideas Factory blog (http://ideasfactory.wordpress.com) attracted more than 100 comments over the week. One science undergraduate commented on the blog:

> *I'd like to say how exciting these proposals are. It is a breath of fresh air from the constant talk of sunscreen and spill resistant clothes . . . and a step towards the concepts and possibilities that got people such as me interested in the field in the first place.*

It got the Americans particularly excited. The Center for Responsible Nanotechnology, followers of Drexler, chose to issue a press release once the factory had closed:

> *The remarkably advanced projects those scientists produced . . . suggest that the era of molecular manufacturing could arrive far more swiftly than previously imagined. . . . In a single week of intense interdisciplinary work, an 'IDEAS Factory on the Software Control of Matter' produced three ground-breaking research proposals that bring the nanofactory concept closer to reality.*[49]

One of these proposals was for an artificial ribosome, a molecular machine less than 50 nanometres long that climbs up a strand of pre-coded DNA, clicking together combinations of molecules and nanoparticles to produce radically new sorts of material.[50] The

science combines DNA nanotechnology with cutting-edge polymer chemistry and the team consists of natural scientists and computer scientists from six universities. Looking at the pictures painted by the researchers, one participant concluded: 'I don't know if it'll work, but shit it's beautiful.'

Reflecting on the conversation

The Ideas Factory was an opportunity for scientists to think differently. And it was an opportunity for me, as one of the EPSRC's 'mentors', to observe and contribute to the discussions that shape science. As sociologist Steve Epstein puts it: 'Debates *within* science are simultaneously debates *about* science and how it should be done – or who should be doing it.'[51] In the evenings over supper, discussions were fast and furious. While some imagined the potential of nanotechnology for economic or social gain, others defended the value of pure science. One echoed the toast coined at the Cavendish laboratory in Cambridge, long before the growth of the electronics industry – 'To the electron, may it never be of use to anybody.' The conversations seemed to support the argument that 'the most significant impacts of nanotechnology on society have been on the practice of science'.[52]

People can make of nanotechnology what they will – it has a high degree of what sociologists call 'interpretive flexibility'. It blurs disciplinary boundaries and enables new conversations. Far upstream, the *facts* and *things* behind these conversations soften and the space for values opens up. But at the same time, as *Nanotalk*, a book based on interviews with nanoscientists, concludes, 'where nanotechnology is leading and what impact it might have on humanity is anyone's guess'.[53]

So the Ideas Factory talked about not just *what* science should be done but *how* it should be done. It provided an opportunity for scientists to reflect on their work as citizens. Some of the computer scientists, for whom open source science is now routine, imagined what they called an 'open architecture nanofactory', which would yield both economic and social benefits. Life scientists imagined the

possibilities of being able to manufacture drugs to order with a lab-in-a-test-tube.

In the past, the imagination of scientific futures has tended to be seen as an expert activity.[54] Our work with both the EPSRC and the Biotechnology and Biological Sciences Research Council (BBSRC) explored the potential for democratising imagination. The RS/RAE report spoke about the importance of the public 'realising the potential' of nanotechnology.[55] Our aim was bigger: to involve people in *imagining* the potential of nanotechnology.

Swindon 2012

Six months before the Ideas Factory, Demos ran a public engagement experiment, the third Nanodialogue – involving scientists, members of the public and research council staff. As well as providing a forum for public participation with emerging nanotechnologies, we wanted to get a feel for what public engagement could look like this far upstream. The public forum, which stretched over three days, was preceded by interviews and group discussions with research council staff and scientists. These conversations helped build a richer picture of the context. In Swindon, we invited our members of the public, most of whom lived nearby, to consider the role they and others might play. The discussion was intelligent but problematic. It was peppered with the awkward silences and crossed purposes that characterise complicated discussions on new topics. Initially, over half of the people there were unsure that they could ever contribute something useful to the practice of university research. Meeting some practising scientists relaxed some of the tensions.

Experiment 3 at a glance – BBSRC and EPSRC

What?	'Engaging research councils' – an experiment in upstream engagement
When?	May/June 2006
Where?	Swindon
Why?	To explore the potential for public engagement with research council science

How? Two focus groups, one session of dialogue with scientists and a concluding session at the research council

Who? 14 people from Swindon and Bristol

Visiting perspectives

Philip Moriarty, Nottingham University
Jeremy Baumberg, Southampton University
Ruth Duncan, Cardiff University
Peter Fryer, Birmingham University and a BBSRC peer review committee member
Julian Kinderlerer, Sheffield University and a member of the BBSRC Bioscience for Society Strategy Panel
Two facilitators
Assorted observers

Our two physicists discussed with a pair of small groups the connection between the work they did and applications that may eventually offer social benefits. Jeremy Baumberg told one group that 'scientists don't have easy answers. . . . We have no idea what would be relevant science for Africa'. Philip Moriarty told the other: 'I could not care less whether my work leads to a new electronic device. What drives me is that there is a question that I want to answer.' The groups talked about how scientists think, and are encouraged to think, about ethics. A woman told the visitors, 'Listening to what you're saying, some of it is worrying me even more, but some of it is reassuring as you've got the same concerns as me.'

The scientists talked about the pressures on them to justify their research in terms of its usefulness and the increasing involvement of industry in university science. They also listened to the public participants' emerging opinions about science. When we asked these public participants what they felt the scientists had taken away from the experiment, they were optimistic:

Did you feel that, Philip Moriarty, his views about what he's doing changed, having spoken to you?

Yeah, I did, yeah.

Well, I'd agree as well, yeah.

Yeah, cos I think he was like, 'oh, yeah, I hadn't really thought about that' . . . he just thinks about what he's doing, he gets very excited about what he's doing. . . . So I think it was probably quite interesting for him.

At the same time, they admitted that the discussion had allowed their views to evolve. Initial scepticism about funding esoteric science faded once they had spoken to the scientists about the public value of science:

My thinking's changed, because I did say when we were in our last group, I said that perhaps the research that's going on should be of benefit to people, like you're paying tax into things. But sitting at home in the last few weeks, I felt I'd hate to stop research that's going on . . . because it's valuable in other fields rather than just beneficial to us . . .

These shifts in opinion reflect the openness of discussions about upstream science. By the end, the group concluded that scientists following their curiosity would not be able to take account of all of the broader social questions raised by their work. There was, therefore, a role for broader engagement in both science and the ethical structures that surround it. This would be complicated, as one participant reflected: 'How can you decide the ethics of something that's so far removed from what it might be used for?' But it was felt that members of the public should be able to ask. In the words of one participant, 'Have you thought about ethical issues, have you thought about this, and this and this?'

Our participants saw ethics as vital, and instinctively recognised the value of public contribution to these questions. But following

their conversations with university scientists, they also saw the potential for public contribution to the scientific imagination:

> *I still think like, when you talk about the future ten years down the line – research, we don't know what's going to come along in the next ten years, we don't really know what's going on now.*
>
> *No, but then nobody does in, well, no, I don't quite mean that. But yeah, but it's just a kind of a vision or a direction isn't it?*

The stilted conversation about 'vision' and 'direction' reflects discussions that take place constantly within the research councils and between scientists. In 2005, the final report of the Agricultural and Environmental Biotechnology Commission (AEBC) asked: 'What shapes the research agenda?' Their conclusion – that there is no one research agenda and science emerges from a range of interests and arguments – prompted recommendations of greater openness and diversity in research. The AEBC pointed to the value and challenge of public engagement this far upstream.[56] Our participants agreed. They felt there was an institutional assumption that the public would not be interested in the work of the research councils, but they wanted to play a part, even if they were not sure how:

> *In the funding process . . . we don't get asked what we want, do we?*
>
> *But would we know if we were asked?*
>
> *Well, no one's asked us.*

Both the Ideas Factory and our engagement process experimented with research agendas. They started by rejecting the idea that particular outcomes were somehow inevitable. Imagination and values were brought to the foreground. This far upstream, there is a huge opportunity and challenge for public engagement. On the one hand, imagination is easier to democratise than knowledge and there is a space for open discussions of value – what sort of world do we

want to live in? On the other hand, the sorts of discussions we invite members of the public into will be complicated and at times difficult to manage.

One recent academic paper extends the idea of upstream engagement, by arguing that rather than aiming for public 'shaping' of research trajectories, we should instead talk about a more subtle 'modulation', whereby public engagement is used to enhance valuable lines of argument within science.[57] And rather than thinking just about upstream engagement and downstream control, we should look at what goes on in the middle – between the drawing board and the end product. In terms of having real impact on the practice of science, this point is well taken. But we would suggest that the first task is to broaden the range of things scientists imagine, as early as possible. As we saw with the scientists in the Cambridge nano lab, the possibilities they consider are often limited by the quest for further funding and the pressures of career advancement. The aim is to ensure that, when new research opportunities arise, they are also seen in the light of public values. The research projects that came out of the Ideas Factory might work and they might not. But we hope that they have allowed scientists to think differently. There has been a temptation in the past to invite polite public engagement on well-defined issues – in science's dining room, to use Helga Nowotny's analogy. Now we need to start opening up the conversations that take place as science is imagined and created: 'We have to let the public into the kitchen.'[58]

Embedding engagement

Public engagement at the research councils has a long history rooted in one-way science communication. In the 1990s, an official report argued that public funding gives scientists a 'responsibility to explain to the general public what the grant is enabling, or has enabled them, to do and why it is important'.[59] In addition to this activity, which takes place on the fringes of science, the last few years have seen experimentation with new forms of deliberation at the heart of science. The EPSRC has their Ideas Factories and BBSRC has

experimented with new interdisciplinary workshops. At the same time, research councils have begun to flesh out their view of the public, through explicit dialogue exercises and the creation of new groups.

In 2006, the EPSRC, following the BBSRC's lead, created a 'Societal Issues Panel', designed to feed public values and public deliberation into the council at the highest level. This panel is made up of social scientists, scientists and philosophers. At the BBSRC, these developments are starting to have a real impact on the way science is funded. Following a recommendation from their Bioscience for Society Strategy Panel, scientists are now asked to reflect on ethical questions as part of the application process. And a recent research exercise fed public discussion about diet and health into the research council's strategy for food research.

Our participants welcomed these efforts, but saw how they could also get bogged down by institutional inertia. Letting a committee worry about 'the society bit' could also be undemocratic:

> *The strategic society panel, I don't really feel that's public. . . . They could start getting their own focus and then just keep going for that as opposed to thinking around other issues.*

Research councils and other bodies that support science are, at their most basic, investment brokers. They balance demands from scientists and policy-makers to allocate resources. Talking to scientists and research council officials, we discovered that there is still a lack of clarity about where research agendas come from. The traditional picture, in which funding is a mix of directed (telling scientists what to research) and responsive (asking scientists what they would like to research), doesn't accurately represent what is going on. What gets funded is more often the product of a subtle interaction between funder and researcher, in which each guesses at the desires of the other. Such discussions need to be made more honest and open.

Organisations that fund science need to reflect on their own role, and act not just as brokers of funding, but as *brokers of conversations*.

Public engagement with science should be as diverse as the research that research councils fund. And the various discussions that take place within and around the research councils, about funding, public value and what counts as excellent science, need to be better joined-up.

WEEK FOUR
perfection
EXCESS
ALL
AREAS
Mother Nature
BALANCE
responsible
choice!
UNSTOPPABLE
VANITY
Opti ita
Superfoods
BREAKFAST FLAKES

5. Business as unusual

Port Sunlight is a value-laden place. In 1888, William Lever began building a model village on the Wirral as a place to accommodate the workers manufacturing his Sunlight soap. It is a monument to a particularly patrician model of corporate social responsibility (CSR). With its snooker-table lawns and manicured rose gardens, it has the feel of a theme park. It is chocolate-box England, and not the sort of place you imagine as a base for cutting-edge science.

From the station, you pass the bowling green and the community theatre, turn right at the original Victorian Lever building and arrive at a shiny block that could be any modern university science department. This is the home of Unilever's Research and Development for Home and Personal Care – with more than 700 scientists. The Port Sunlight plant is responsible for a significant chunk of the one billion euros that Unilever spends each year on R&D. Behind these walls, Unilever scientists are imagining the future of nanotechnology in our everyday lives. They are thinking through the benefits that nanoscience might produce in shampoo, moisturisers, toothpastes and deodorants. They are domesticating nanotechnology.

Most of Unilever's scientists did PhDs and postdoctoral research in universities before moving to the private sector. At first glance, the environment for research could not be more different. University scientists claim to be looking for answers to scientifically interesting questions, while Unilever's scientists take their lead from priorities set

elsewhere in the company. But scratch beneath the surface and you find that, just as university scientists have plenty of demands on their energies – from government policy, academic publishing and corporate funders – industrial scientists have more freedom to interpret and explore than we might think. Unilever's scientists publish in academic journals at the cutting edge of dermatology, colloid chemistry and materials science. They work with university scientists and their company funds university science.

Unilever is promiscuous when it comes to science. It is not wedded to particular research trajectories and the possibility of alternatives is ever present. So while in Port Sunlight Unilever is looking to the benefits that nanotechnology might provide, its lab in Shanghai has teams of scientists working to combine the latest advances in synthetic chemistry with techniques from Traditional Chinese Medicine (TCM). Ya Chai, Unilever's director of research in China, proudly claims that Unilever is 'one step away from TCM-based products being launched on the global market'.[60] For a global business like Unilever, a new way to use ginseng is every bit as interesting as a titanium dioxide nanoparticle.

Visions of nanotechnology

Our fourth experiment began with a question – how should Unilever approach nanotechnology? Unilever is not a technology company. But it is a company that is constantly innovating. The social context of technology is therefore crucial. The experiment was also fuelled by a bigger challenge – how can private science engage with the public? Past thinking about public engagement has revealed the private sector to be an embarrassing lacuna. For all the conversations that have bloomed around publicly funded science, the huge resources of industrial R&D remain largely unexplored.[61]

Experiment 4 at a glance – Unilever

What?	Engaging with corporate innovation
When?	December 2006/January 2007

Where?	Port Sunlight, Newcastle and London
Why?	To assess the potential for upstream public engagement in corporate science
How?	Interviews with scientists, four public focus groups and a workshop
Who?	**10 scientists, 28 members of the public** Group 1 – 'Working mothers', 30–40 years old, BC1, mothers of at least one pre-teen child, Newcastle Group 2 – 'Metrosexuals', male/female, 25–30 years old, C1, Newcastle Group 3 – 'Aspirational women', 40–55 years old, C1/2, mothers of teenage/post-teenage children, suburban London Group 4 – 'Organic men', 45–60 years old, BC1, children left home, working full time, London

In the experiment's first stage, we interviewed a number of Port Sunlight scientists. We wanted to get a sense of their visions for the future before using public deliberation to open up those assumptions to wider scrutiny. Many of their scientists, though they would not call themselves nanotechnologists, are working at the nanoscale. In the context of their research, while nano is over-hyped, it is genuinely exciting. It may provide new ingredients or new methods to deliver those ingredients where they are needed in the human body. Our interviews tried to draw out how the scientists saw the possibilities for nanotechnology within Unilever, and how they would describe those possibilities to the wider public.

We turned these visions into nano-scenarios to prompt discussion within the four groups we put together in Newcastle and London. These groups began by talking about everyday products – moisturisers, foods, toothpastes, shampoos – things that they might buy or walk straight past in a supermarket. We asked them to reflect on the role of science in these products. We introduced the idea of

nanotechnology – what it is, what people are saying about it and why it might matter. And we presented our groups with the scenarios. By this stage, in all of our groups, the discussion hardly needed encouragement. The journey from the everyday to the cutting edge, from the mundane to the bizarre, had generated a sufficiently long list of questions to fuel the discussion twice over. Given the novelty of the topic, it was tricky to reach a resolution, so we asked our groups to produce two-part collages – visualisations of the way they imagined a nano-future and an alternative future.

Beyond safety

For a company with a reputation to protect and a CSR policy to uphold, the instinct is to see the challenge of new technologies as one of safety – how can we ensure, and convince consumers, that our products are safe? A discussion in one of our groups represented a microcosm of broader public debate:

I would assume that before it came to market, whatever product, it would have been properly tested.

> *Surely something like thalidomide was thoroughly tested and look what it did. You know, it was going to be revolutionary, safe and everything and look what it did.*

Valid point.

> *It has to be tested for a few generations just to see the impact, 30 years or so.*

So can we trust them? Obviously not.

But for the public, debates about safety are only the beginning. In 2000, a Unilever–Lancaster University research project looked at GM, which at the time was an issue characterised by arguments about risk. It showed that risk provides a surface language for talking about negative aspects of technology, but concerns run more deeply. They tend to be built around the directions of innovation and the interests behind these directions.[62] So it was with our experiment.

Safety was a sideshow. The real concern was with where companies are taking us.

Engaging with corporate innovation

A recent article in *The Economist* drew a tongue-in-cheek connection between the hi-tech and the mundane by focusing on razor blades. For 70 years, one blade was seen as plenty for a disposable razor. But since 1980, we have seen the number rise as manufacturers battle for our attention. Gillette put two, then three, blades into their razors before Wilkinson Sword produced the *Quattro*. Gillette then responded with their five-bladed *Fusion*. Plotting the pace of change, the magazine suggests a new version of Moore's Law: by 2100 our razors look set to sport 14 blades.[63]

The latest incarnation, the *Gillette Fusion Power Phantom*, is advertised as 'so advanced, you'll barely feel the blades'. The addition of '5-Blade Shaving Surface Technology' (with 'patented coating', 'Soothing Micro-Pulses' and an 'onboard microchip') to a still-disposable device apparently produces 'a shave so good the ladies will never even see you coming'. The credentials of the scientists behind the razor are beyond doubt. One article describes the lab director of Gillette's 'Advanced Technology Centre': 'The good doctor is living proof that razors are rocket science. He has a PhD in ceramics applied to fighter jet engines and also developed machine-vision software for missiles.'[64] But the apparent pointlessness of such innovation and the breathless enthusiasm of the claims are all too familiar to our public participants:

> *We always have to buy the latest, the latest, the latest . . . it keeps the people on the hamster wheel of innovation. You've always got the next, the next, the next.*

So if they think this sort of innovation is novelty for novelty's sake, what do they imagine the scientists are doing within companies?

> *That shampoo [points] . . . the CEO probably says we're going to develop a new one and we want to give women shiny hair; and*

we'll give it to scientists and say 'work on it'. Believe me, that's 5 per cent of it, the other 95 per cent is the profit margins, how are we going to sell it, how are we going to package it, what are we going to name it, what's the advertising going to be, all of those issues are the number one things on their minds. It's not what the scientist will do. In fact, when they produce the product that was supposed to give more shiny hair, it's virtually exactly the same as what was there before.

It's marketing science . . . 99 per cent of it is rubbish.

The people in our groups were deeply sceptical of the claims made by companies about their products, especially when these claims were backed up by pseudo-science. Unilever sees itself differently. It is concerned with delivering on its promises. It is wary of the expectations that are raised when a product claims to wash whiter-than-white. As a company, it sells brands rather than science. And on the whole Unilever doesn't talk about science, except to shareholders. So the science that goes into manufacturing a new sort of soap is black-boxed into a white box branded 'Dove'.

'We can live without any of that'

For all the public scepticism about the novelty of 'innovation', companies that sell everyday products have to tread very carefully. People, it seems, are acutely aware that, though much corporate science is driven by marketing, it can also have a powerful and disruptive impact. Discussion in our groups quickly turned to the more problematic consequences of innovation. There was a concern that intervening at the nanoscale might pose new dangers:

The first time they had a nuclear bomb, they didn't know for sure that it wouldn't rip the whole planet apart. They didn't know. . . . They didn't ask us about it, did they? They didn't go, 'Well, what do you all think about this?' They just went all ahead and did it.

I think what concerns me is the drive of all of this. You're going

to create better tasting dessert. There's nothing better than apples, right? Apples are great. They grow. They're natural. I mean, all the stuff that we need is already here. What is the point of this? Why are we being driven always away from just the natural free things that grow, you breathe, to things that you have to pay for? . . . It's all about just markets.

This comment does not represent a Luddite retreat to nature. Rather, it is a realisation that innovation is a way for companies to cement their positions in markets. Doubts about novelty are tied to questions about why companies are doing certain things. So concerns can't be separated from need:

I think in medicine it's great. But I think it's a bit wary when you come down to food and what have you, trying to enhance that.

Why does food need engineering?

Yeah. What is the benefit of that?

We can live without any of that.

This is the context of corporate innovation. Companies like Unilever make things that people can live without. This is not to say that the products don't have benefits. But it means that the conversation about what those benefits are and who stands to benefit has to be pretty sophisticated.

Imagining consumers, imagining citizens

Formally, Unilever's science is in the service of its products. As its website puts it: 'The common thread running through all our R&D activities is this direct connection between science and consumer need.'[65] As with many large companies, the quest for what consumers 'need' has led to the growth of teams of social and market researchers, looking for the gaps that new products might plug. Unilever is one of many companies that use increasingly sophisticated tools – at the interface of social science and market research – to understand consumers.

Innovation at Unilever is driven by consumer insight. So hair-care scientists work towards 'glossiness' or a greater degree of 'de-tangling'. But it is a myth that necessity is the mother of invention. And much of the time, in the quest for certain benefits, science points to areas of unexpected value.

Consumers are aware that, far from responding to their needs, companies are leading people down certain paths. People aren't crying out for six-bladed disposable razors. Companies are innovating on their behalf, working with an imagined idea of who consumers are and what they need.[66] The idea that people are also citizens is hard to thread into a global company for whom the accountant's unit of measurement is the rational consumer. It is far easier for a company to construct consumers in its image, reinforcing existing patterns of consumption rather than questioning them.

Problems arise when people disagree with a company's view of what they 'need'. Our groups took issue with how they were being imagined in the process of innovation.

> *Well, I object to the fact that we're called consumers. We're not humans anymore. We're consumers.*
>
> *Everybody will end up looking the same. All blond hair and blue eyes and stuff like that.*

For these groups, innovation is not following their needs; it is imagining their wants, fulfilling them and leading them somewhere. They would like to be able to ask questions about where. As nano-technology, or any other area of innovation, is domesticated by companies, there is a danger that the corporate picture of consumers is domesticated as well, to fit a particular idea of what is desirable.

Over the last decade, Unilever has been trying to paint a more sophisticated picture of the public. Before the explosion of concerns about GM, they began talking to NGOs and the public,[67] and funded some important social science at the interface of innovation and society.[68] Mirroring the growth and mobilisation of 'ethical

consumers',[69] they have begun talking about 'citizen-consumers' as a way to open the corporate mindset.

But, as we have seen with our other experiments, it is easier to assume what citizens will think than it is to ask them. So policy-makers assume that citizens will worry about the relative risks of nanoparticles or polluted soil rather than the uncertainties of the science and how these might be resolved. Policy documents assume that citizens in developing countries need clean water in the way that nanotechnology promises to provide it. And research councils have only recently stopped assuming that people won't be interested in what goes into funding university science.

For Unilever, the biggest risk with a new disruptive technology is to their reputation. Before any other considerations, they have to be able to prove and convince the public that a product is safe. Imagining citizens as worried only about safety is easy. Companies can do better tests and emphasise the credibility of these. Painting a more complete picture of citizens' concerns gives companies a harder time. Different people will want to ask different questions. One person's valuable benefit will be another's troubling development. And the only thing we can predict about the social context of nanotechnology is that it will be unpredictable.[70] For upstream engagement to work, companies need to relax their ideas of who consumers and citizens are and what they want.

The public value of private science

The final stage of our experiment took us back to Port Sunlight. What did the scientists make of the views of corporate R&D offered by our participants? They were taken aback by the response, but realised the discussions went deeper than they were expecting. The lessons were not just about ensuring products were safe, or communicating better with consumers.

The scientists shared our groups' concerns about the definition and novelty of nanotechnology: 'I'm not surprised these guys don't know what nano is; *I* don't know what nano is . . . it's everything and nothing.' One asked if, in the public eye, it had become just 'a label for

over-technologising everyday life'. But they also realised that most of the groups' discussions were not about nano specifically. In the same way as the GM controversy was not just about that particular technology, debates over nano can condense quite nebulous concerns. So the discussion turned to how a company like Unilever can take into account broader public values as part of a more balanced view of technology. The scientists talked about their own roles. Yes, they do have to respond to the demands of people in marketing. But when given suggested benefits, they 'get to interpret those benefits quite broadly'. So conversations take place within Unilever about priorities and science. And Unilever staff can see the value of listening to citizens' upstream concerns. The question is how to splice these two things together. How can we imagine new conversations between a company and its citizen-consumers?

Valuing values

In response to growing concern about the power of large corporations, business leaders have talked more loudly about CSR.[71] Done well and with integrity, CSR can be a way of opening new channels of communication that improve public accountability and corporate reflexivity.[72]

But the CSR movement arose largely in response to dilemmas of global *production*, such as labour rights, supply chain impacts and environmental protection. Corporate R&D raises its own social and ethical questions that are less well understood. And the connections between the engine room of research in many companies and the parts that deal with CSR are often weak. The challenge is to move CSR upstream, so that it becomes more than an end-of-pipe addition of values. For example, this could mean that Unilever should find new ways for its scientists to talk directly with citizens. But such moves to 'radical transparency'[73] must also be reconciled with the need to protect intellectual property, avoid prior disclosure and maintain Unilever's brands.

Companies like Unilever are now experimenting with how they can thread values through all of their work. Companies from John

Lewis ('Never knowingly undersold') to Google ('Don't be evil') and Hewlett Packard ('Invent') are increasingly realising the importance of value-laden slogans as organising principles rather than marketing exercises. Since 2004, Unilever has spoken about 'vitality' as a way of telling the world what it does and a way of thinking about itself. Unilever claims: 'Our vitality mission connects us to consumers as citizens.'[74] As part of this connection, Unilever needs to think through how its mission can be enriched, so that it represents citizen values as well as consumer benefits.

In the 1970s, the R&D department at Lucas Aerospace was getting nervous. Impending redundancies prompted some of the Lucas technologists to come up with a new plan – to diversify beyond arms manufacture to products with more obvious public value. Mike Cooley, one of the engineers behind the plan, described in a subsequent book his vision of 'a future in which masses of people, conscious of their skills in both a political and technical sense, decide they are going to be the architects of a new form of technological development'.[75] The Lucas Plan contained 150 ideas for new products the company could make, with imagined social benefits. And, in a move ahead of its time, it threaded sustainable production into its thinking.

Modern technology companies conduct cutting-edge research. And as with any cutting-edge research, what scientists *do* doesn't map perfectly onto the drawing board. So unexpected benefits that don't match corporate demands may emerge, but remain unfulfilled. Giving scientists a voice within companies and taking public values upstream raises the possibility of what we might call 'social spin-outs'. Mirroring the enthusiasm for private sector spin-outs in universities, we can imagine large companies supporting spin-out companies or social enterprises that follow alternative trajectories. At Lucas Aerospace, the engineers went ahead and built a vehicle for children with spina bifida. But the company refused to take production beyond the prototype stage. The product did not fit with the company's structure, and the potential for new forms of value was lost.[76] The challenge for the public engagement agenda within

business is to ensure that more radical visions and possibilities for corporate R&D are better supported and connected to parallel efforts within publicly funded research.

6. Making public engagement matter

Emerging from the other side of the Nanodialogues, what can we say about the future of upstream engagement? The first, rather Pollyannaish observation, is that it's good to talk. It doesn't take much to encourage a productive conversation between scientists and members of the public about emerging technologies. Upstream engagement works when it is genuinely open, an opportunity for members of the public to explore, with scientists, what the future could and should look like. By shining a public spotlight on systems of science, we can see new concerns and possibilities that would otherwise have been ignored. Some of these have been about risk, as illustrated in our first experiment. But most have been about the direction of innovation and the broader public value of science.

There already exist various typologies of the general benefits of public engagement with science.[77] The final report of the Nanotechnology Engagement Group summarises and expands on these.[78] Placing these benefits alongside the costs – in both money and time – we can conclude that public engagement is only really worth doing if it makes a substantive difference. If it is used as an instrumental attempt to build trust, it is expensive, disingenuous and likely to backfire. This does not mean that we should be able to see immediate benefits. If we take upstream engagement seriously, the difference made by deliberation may be hard to detect for some time.

Only one of our experiments – with the research councils – took as

its explicit target science-yet-to-be. And yet they were all examples of public engagement with the future. With the Environment Agency, the conversation revolved around a technology ready to be used but held back by regulatory precautions. For the provision of clean water, there are already technologies that claim to do the job but, as we have seen, the sustainable application of these in Zimbabwe is a long way off. Unilever's challenge is to make sense of new and existing technologies as they may apply to everyday products. If we see technologies as systems rather than things, all of our experiments were upstream.

Engagement in context

Public engagement needs to understand its context. It cannot take place in a vacuum. As far as possible we have tried to embed our experiments in their respective contexts. Before inviting public discussion, we worked with our partners to map the relevant scientific and policy terrain. But perhaps the most useful immediate findings of our experiments were the systemic constraints and obstacles they revealed.[79]

The Environment Agency People's Inquiry highlighted the challenges of incorporating uncertainty into policy and forcing public deliberation into an 'evidence-based' mindset. In Harare, our experiment with Practical Action revealed the complexity of technologies-as-systems and the steps that need to be taken before well-meaning technologies will work in new places. The research councils' experiment pointed to the mass of assumptions and decisions that make up research agendas and the difficulties of imbuing these with a sense of public value. And in our work with Unilever, we are left with the challenge of scaling up a conversation about citizens and public value to the level of a global company whose unit of accountancy is the one-dimensional consumer.

Public engagement needs to take place where it can reveal the need for system change. Public engagement with science is also public engagement with scien*tists*, with policy and with organisations. It asks fundamental questions about the way science is imagined and placed

within institutions. Rather than accepting assumptions about the status quo, it asks 'why?'

Democratising democracy

The UK is now seen as a leader in public engagement with science. But further progress is far from inevitable. Science policy can fall out of love with public engagement as quickly as it was smitten. In other areas, we have seen growing cynicism about eye-catching but half-hearted attempts at public involvement, such as the Labour Party's 'Big Conversation' in the run-up to the 2005 General Election. Genuine efforts at transparency can also be derailed by an increasingly sceptical public.[80]

Public engagement with science was born of critique and discontent. It has now become too comfortable. Making public engagement matter means making it uncomfortable again, looking for tension and argument as well as areas of consensus.[81] Much of the tension exists in the motivation. Just as scientists have gravitated to 'nanotechnology' without a clear idea of what it is, so people involved with 'public engagement' have a multitude of meanings and motivations for doing it. We need to ask: 'Public engagement as opposed to what?' Stakeholder engagement? Technocracy? Opacity? Authoritarianism? Public relations? Doing public engagement is fascinating, but it is not an end in itself.

Against method

Public engagement may be hard to get right but it is also hard to get wrong. There is plenty of room for experimentation and diversity. This does not mean that the methods and processes of engagement are not important. But too often in public engagement, discussions of *how* obscure discussions of *why*.

Growing interest in participation and engagement across all policy areas has seen the emergence of consultants eager to deliver democracy in neat packages. Nik Rose calls this group 'experts of community'. They come armed with 'devices and techniques to make communities real'.[82] 'Technologies of elicitation' such as focus groups,

surveys, citizens' juries and new online devices can create a new form of technocracy by disguising the politics of both science and participation.[83] We need to keep asking why engagement should take place and why it should look a certain way. Off-the-shelf processes can exacerbate the distinction between the 'science bit' and the 'society bit', leaving assumptions untouched.

In the search for legitimacy, talk of engagement often turns to evaluation: how can we discover what works? But if we are serious about engagement becoming part of the software of science, we need to avoid strangling it with evaluation. In the Nanodialogues, we have used evaluators as a valuable source of additional reflection, not as a way to tick legitimacy boxes.

One of our evaluators raised the question of whether the experiments could have been shaped more by the participants. This is an important point. Engagement runs the risk of manipulating the public, which is worse than ignoring them.[84] We need in the future to find new ways for members of the public to set the terms of debate, in negotiation with those organisations that invite engagement. We have found it hard within the Nanodialogues to put this ideal into practice. But we recognise the need to relax control of the mechanics of engagement. A key lesson of the Nanodialogues is not that 'anything goes' but that process needs to come second. The *how* of public engagement should always follow the *why*.

For public engagement to make a difference, it must become part of the normal practice of good science. This does not mean an endless stream of citizens' juries, but it requires us to think through the different forms that engagement will take at different points in the cycle of research, development and diffusion. The aim should be to create an ongoing process of what one recent report calls 'collective experimentation'.[85]

This pamphlet ends with some reflections for organisations looking to engage the public in new ways, under the headings of **social research, new political spaces, everyday engagement** and **institutional innovation**.

Social research

Often public engagement attempts to combine research and politics. It tries to find out what and how people think while inviting them into a democratic space. But the danger is that, in aiming for both targets, it hits neither. There is real value in social research on new technologies, informed by historical experience and theoretical insight. This is not a question of 'taking the public pulse', or gathering 'certified public opinion'.[86] On issues that demand upstream engagement, public opinion in those terms does not yet exist. Social science cannot speak for citizens, but it can point to issues that demand public debate.

There is room for the sort of research that reveals new issues and injects them into debate – the genuine 'ethnographic surprise' of being in Harare and finding out about a new technological context. But we have found that social research works best when it is part of an ongoing, interdisciplinary conversation with science. The Nanodialogues project has worked closely with scientists and social scientists as partners and co-researchers. This sense of collaborative exploration, carried over from previous Demos–Lancaster University work, is close to the idea of 'public sociology' discussed by Brian Wynne in a previous pamphlet.[87]

New political spaces

Public debate about science has moved a long way in the last few years, but remains stuck between the cathedral and the bazaar.[88] The Nanodialogues project has created conversations among people who do not usually get a voice. But according to one recent paper, the tendency is to see the silent majority as the true voice of the public:

> *Pericles noted that 'We alone regard the man who takes no part in politics not as someone peaceful, but as someone useless'. The opposite seems to be true in consultation exercises: the unengaged, the quiet citizens, are the most useful of publics,*

> *because they are the one authoritative source of representative opinions, and the only constituency weightless enough to be moved by the kinds of consultation exercises and deliberative process that governments and their consultants dream up.*[89]

In the search for the 'real', consensual public, more vocal interest groups are sometimes sidelined.[90] But if public engagement is to help us understand systems of science and technology, then interest groups need to be invited back in. We need to tie engagement to politics, rather than strip the politics away.

We are starting to see, especially in areas of medical science, the emergence of public groups who are neither disinterested nor uninterested in science. As we saw with debates over the MMR vaccine, animal rights and nuclear power, 'engagement' can be uninvited but impossible to ignore. Patient groups in particular have demanded a say in scientific research.[91] In the future, such groups are likely to become more vocal and powerful. The challenge for institutions is to acknowledge the diverse interests that make up 'the public'; to learn from uninvited engagement, while making the most of organised engagement.

Everyday engagement

A 2006 survey of scientists by the Royal Society reported that almost half would like to spend more time engaging with the public.[92] We have seen throughout the Nanodialogues the value of face-to-face conversation between scientists and the public, particularly when a topic is open and there is a genuine opportunity for collective exploration. In this context, experts take part as guides, bringing wisdom as well as facts.[93]

Our project has provided some limited opportunities for scientists to get involved. But the conversations have been manufactured. If science is too important to be left to scientists, then public engagement with science is far too important to be left to consultants and think tanks. As well as engaging with science's organisational arms, we need to encourage the movement of its fingers. If public

engagement is to become everyday, then scientists have to feel they are empowered to innovate with new forms of engagement.

The Royal Society survey was helpful in identifying the barriers to scientists' engagement. As we argued in *The Public Value of Science*, this often comes down to professional expectations and a narrow view of what counts as scientific excellence.[94] The Research Assessment Exercise (RAE) must also take some of the blame. But there are signs that this may be starting to change. In late 2006, Gordon Brown announced that the Higher Education Funding Council for England (HEFCE), the organisation behind the RAE, would, alongside the research councils, invest £8 million to enable a number of universities to become 'beacons for public engagement'. There were 86 applications for five pilot projects, demonstrating that enthusiasm quickly follows money and institutional support. When these 'beacons' are established, they should become places that empower public debate, and encourage scientists and other researchers to reflect on the social dimensions of their work.

Institutional innovation

Our experiments revealed the difficulty of making public engagement work for institutions. What works in one context will not make sense in another. But the first step is for institutions to put themselves into the conversation. The hubristic message we hear too often is that we need *technological* innovation to improve society. But our experiments demonstrate the opposite – that we need *social* innovation to realise the potential of technology.[95]

When public dialogue works best and is connected to policy, it is in fact a trialogue. Engagement provides a space for scientists, publics and institutions to meet with open minds, to give, take and reflect.

It is not enough for institutions to encourage the public and scientists to talk to each other. Nor is it enough to ask the public what they think of institutions. The institutions themselves must join the project of thinking through the lessons of engagement. They must throw themselves into the mix – public engagement cannot be outsourced.

The Food Standards Agency (FSA) is one example of an organisation that not only supports public engagement, but ties it to the live policy and scientific debates in which it is involved. In the FSA's case, the BSE crisis that led to its creation has been a constant reminder of the importance of opening up. Other organisations need to think through what this 'trialogue' might look like for them.

In our experiments, we have worked with a regulator, research funders, a company and an NGO. But some organisations have been harder to enthuse. Most notably, one key organisation that failed to engage in a substantive way was the Office of Science and Innovation (OSI). In one sense at least, the OSI was heavily involved – as the project's lead funder. But beyond signing a quarterly cheque, the OSI showed remarkably little enthusiasm for exploring how these activities might connect to its own policy-making and institutional reflection on nanotechnology, or what might be learnt from this domain and applied to wider debates over science and society. While Demos remains grateful for the OSI's financial support, we feel that the OSI must reconsider its own role as an institutional participant in engagement and move away from an outsourced 'purchase and provide' model.

Another focus of institutional innovation in this area should be the Technology Strategy Board (TSB). In summer 2007, the TSB will move away from government and down to Swindon. Alistair Darling has insisted it will be 'relentlessly business focussed'.[96] But the TSB must also learn the lessons of public engagement. When it arrives in Swindon, it should visit its neighbours at the research councils, to find out how they are re-imagining science and technology.

Towards a new politics of science

This pamphlet marks the end of a three-year programme of Demos work that has taken nanotechnologies as a test case for a new approach to the governance of science and innovation. But as technologies and research areas develop and converge, we need to find a way to address these issues in more general terms.[97] At the

moment, public engagement is splashing about in science's shallow end. But the challenges run deeper. If public engagement is a means to an end, what is that end?

We believe that the goal should be a renewed politics of science. In the years during and immediately after the Second World War, science was high on the political agenda. JD Bernal, Michael Polanyi and CP Snow argued about the pros and cons of state control of science and the state of our intellectual cultures. Across the Atlantic, Vannevar Bush imagined science as an 'endless frontier', cementing the idea of basic research as the source of innovation.[98]

But in the decades since, while science budgets have soared, political discussion has become strangely muted. The language and frames of reference within which science and innovation are debated are good at asking questions of scale – 'how much?' and 'how fast?' – but far less sophisticated at talking about *direction* – the outcomes to which all of this investment and activity is being directed.[99] In the global 'race' to compete in science and technology, the choice we are often presented with is faster or slower, but with no option to change course. We don't devote enough attention to considering the plurality and diversity of possible directions.

The politics of science are subtle. There are questions about the science we need and the science we want; questions about uncertainty, evidence and burdens of proof; questions about ownership, access and control. We need to learn how to open up and debate these questions in public.

Tony Blair recently argued that 'government must show leadership and courage in standing up for science and rejecting an irrational public debate around it. . . . The anti-science brigade threatens our progress and our prosperity.'[100] If Gordon Brown is to show fresh leadership in this area, he must start by ditching the assumption that anyone who asks questions of science is irrational and 'anti-science'. This is as ridiculous as labelling people 'anti-education' when they ask questions about how schools should operate.[101] Public engagement, in its many forms, can no longer be seen defensively. Blair saw science as requiring leadership in the face of public opposition. But our

experiments teach us that science can become a shared project of imagining, exploring and debating public value.

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