sciencewise
EXPERT RESOURCE CENTRE

The road ahead

Public Dialogue on Science and Technology

Edited by Dr Jack Stilgoe

BIS | Department for Business Innovation & Skills

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Chris Caswill & Steve Rayner

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Andrew Acland

Andrew Acland has worked as a mediator, facilitator and trainer for nearly twenty years. He specialises in designing and facilitating dialogue in complex, multi-party, multi-issue contexts. He was a founding member of The Environment Council's innovative stakeholder dialogue practice and training programmes and a founding Director of Dialogue by Design.

Dame Deirdre Hutton

Dame Deirdre Hutton is Chair of the Food Standards Agency. For five years, until 2005, she was Chair of the National Consumer Council, having formerly chaired the Scottish Consumer Council. Before joining the Food Standards Agency, she was a member of the Better Regulation Task Force.

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Richard Jones is Professor of Physics at Sheffield University. He is currently the Senior Strategic Advisor for Nanotechnology for the UK's Engineering and Physical Sciences Research Council. Between 2005 and 2007, he was chair of the Nanotechnology Engagement Group, and he currently sits on the EPSRC's Societal Issues Panel. In 2006 he was elected a Fellow of the Royal Society.

Debbie Perry & Laura Bowater

Debbie Perry is a PA working in the City of London. She was a participant in the first of the Sciencewise funded Nanodialogues.

Laura Bowater is a scientist at the John Innes Centre in Norwich. She took part in the British Science Association led community x-change Sciencewise funded project.

Charles Leadbeater

Charles Leadbeater is a leading authority on innovation and creativity. He has advised companies, cities and governments around the world on innovation strategy and drawn on that experience in writing his latest book, 'We-think: mass innovation not mass production'. He is a visiting senior fellow at the National Endowment for Science, Technology and the Arts (NESTA), a Demos associate and a visiting fellow at Oxford University's Saïd Business School.

Lord Robert Winston

Robert Winston (Lord Winston) is Professor of Science and Society and Emeritus Professor of Fertility Studies at Imperial College, London. He is Chancellor of Sheffield Hallam University and has recently been appointed as Chairman of Council of the Royal College of Music.

He was Director of NHS Research and Development at the Hammersmith Hospitals Trust until 2005. He was President of the British Association for the Advancement of Science in 2005. He is currently a member of Council and Chairman of the Societal Issues Panel at the Engineering and Physical Sciences Research Council.

A little more conversation

Jack Stilgoe and Kathy Sykes

UK public engagement with science has come a long way. Twenty-five years ago, scientists diagnosed a persistent problem in the way that science relates to the rest of society.[1] This problem has not gone away, but the prescription and the treatment have changed dramatically.

Scientific progress in stem cell research, energy generation, nanotechnology, neuroscience and countless other fields poses some difficult social and ethical questions. But where the reaction of scientists, politicians and civil servants would once have been just to broadcast the facts of science more loudly, there is now an awareness of the need to listen and to talk openly about what such things mean for our collective future.

As science becomes both more important and more problematic for society, it is rediscovering the art of conversation.

The last decade has witnessed conversations of all shapes and sizes between scientists and members of the public throughout the UK. In schools, at science festivals, at national debates and everywhere in between, dialogue is taking place. The UK was once seen as a place where decisions about science were taken in smoke-filled rooms.

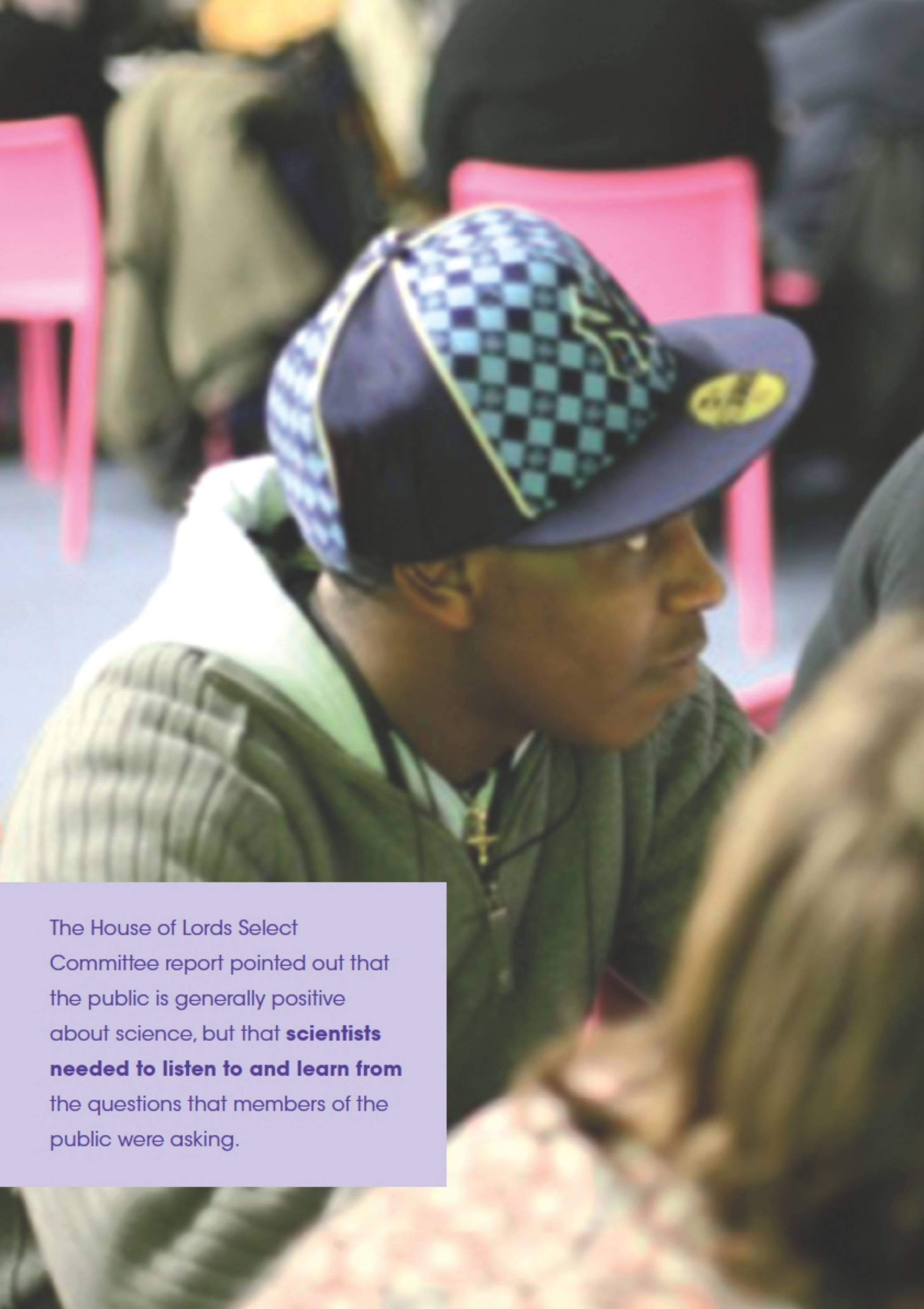
This collection brings together some of the UK's leading thinkers and practitioners in science and society to ask where we have got to, how we have got here, why we are doing what we are doing and what we should do next.

From PUS to PES

The science communication movement was kick-started by the Bodmer report, published by the Royal Society in 1985.[2] The report argued that Public Understanding of Science (PUS) was essential for the UK to make the most of its scientific potential. A huge range of initiatives and support organisations was spawned across the country. Numbers of science journalists increased, as did the numbers of science centres, festivals, and popular science books. Science became a core subject in the national curriculum.

Ten years later, the then Office of Science and Technology published its Wolfendale report, calling for universities to recognise and build PUS skills among their staff and students.[3] Research funders asked scientists to consider how they would communicate their work and its importance to the public. Scientists were being encouraged to talk; little thought was given to whether they should also listen.

By the time the House of Lords Select Committee report on 'Science and Society' came out in 2000, public controversies centring on genetic modification of crops, BSE ('mad cow disease') and nuclear power had rocked public confidence in scientific advice. The Lords clearly articulated the need for 'dialogue' with the public. 'Understanding' was replaced with 'engagement'; PUS became PES. The report pointed out that the public is generally positive about science, but that scientists needed to listen to and learn from the questions that members of the public were asking. In particular they argued that dialogue needed to become embedded in policy-making and in science.



The House of Lords Select Committee report pointed out that the public is generally positive about science, but that **scientists needed to listen to and learn from** the questions that members of the public were asking.

'Direct dialogue with the public should move from being an optional add-on to science-based policy-making and to the activities of research organisations and learned institutions, and should become a normal and integral part of the process.'

And they made a call on individual scientists too:

'Science is conducted by individuals (who) must have morality and values, and must be allowed, indeed expected, to apply them to their work… By declaring the values which underpin their work, and by engaging with the values and attitudes of the public, they are far more likely to command public support.'[4]

Scientists weren't expected to conjure debate from nowhere, however. There was an identified need for people and organisations to act as go-betweens, generating and lubricating dialogue. The science communication community became increasingly aware of the need to help scientists and policy makers listen to the public.

There had been relatively little progress with the Wolfendale recommendations for embedding science communication. It was largely regarded as a 'fluffy' thing, attached to the side of science. Some scientists enjoyed doing it, and they were tolerated by their institutions to varying degrees. The science communication community enjoyed its diversity, but recognised that there was a need for organisations to connect and share good practice. The voluntary nature of the endeavour meant that there were often insufficient resources to make activities really slick or professional.

The move towards public dialogue is not one of fashion. As the House of Lords explained, the rationale for dialogue is rooted in experience and research that has demonstrated the problems with old assumptions about how science and society relate to one another.

But since 2000, many in science, policy and science communication have been grappling with what 'dialogue' actually means, how to embed it and how to situate it within a broader range of activities that have come to be known as 'public engagement with science'.

Funders of science, science communication organisations, Government departments and other agencies have recently been experimenting with dialogue in different ways. Lectures have become debates, exhibitions have become interactive and where policy makers would once have tackled a contentious issue with a public relations campaign, they are now more likely to ask for a citizens' jury.

These encouraging developments constitute a step change in taking public dialogue seriously. The innovations taking place in various organisations are starting to link up. Research Councils have embedded the need to consider social and ethical issues when making decisions about research and they are encouraging their research communities to do the same.

Several funders have worked together to establish 'The Beacons for Public Engagement', aimed at culture change in universities, across all subjects including science. The Science Learning Centres, the DCSF/DIUS (now BIS), STEM (science, technology, engineering and mathematics) framework and Programme and the Association of Science and Discover Centres all represent greater efforts to join up activity.

Sciencewise was set up in 2005. It is trying to change the culture in Government, across all departments and agencies, so that when policy makers tackle difficult issues involving science and technology, good practice in public dialogue becomes second nature. Sciencewise is rooted in the 10 year Science and Innovation Investment Framework 2004-2014 Treasury commitment to 'upstream' engagement with the public, discussing upcoming issues and areas of science before technologies hit markets.[5] According to the Treasury, talking with the public is a vital way of framing the development of science – to increase social benefit, to make governance and regulation more robust and to reduce the possibility of later misunderstandings.

The Council for Science and Technology, the Government's top science advisory panel, wrote in its 'Policy Through Dialogue' report in 2005, that Government should develop a 'corporate memory' about how to do dialogue well.[6] Sciencewise, in its new guise as the 'Expert Resource Centre', was established to deliver this, and is talking to new audiences. The earlier programme focused on policy makers, but the Sciencewise-ERC is now also looking to the science

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community, funders and science communicators to share good practice.

All of these initiatives are making reasonable progress. However, neither Government nor the science community is known for an ability to change culture rapidly. It will of course take time and long-term commitment. Sciencewise-ERC has had some notable successes. According to external evaluation reports, it has helped departments and agencies to carry out good public dialogue and the dialogue has helped to inform decisions being made.

Scientists and policy makers who get involved remark again and again about the level of sophistication of the public's understanding of complex issues around science, once they have had time to deliberate over the topic. However, with a focus on upstream activity, the scale and impact of Sciencewise-ERC has so far been somewhat limited. The question now is whether Government can make the most of this 'corporate memory' when tackling old issues like nuclear power or genetically-modified foods and those on the horizon such as synthetic biology.

The advantages of good dialogue are becoming clear. Done well, we know that public dialogue can help policy makers, by:

- widening their thinking about an issue, exploring it from different perspectives
- identifying areas of potential concern or opportunity
- providing new approaches to regulating or framing an emerging area
- exploring the grey areas of public opinion, away from polarised discussion and media sensationalism
- identifying actions that could make more equitable use of the technologies
- considering longer-term impacts and opportunities
- helping them to be more courageous about difficult issues

It is also becoming clear that public dialogue is not:

- a way of getting public permission for things that have already been decided upon
- the public making decisions instead of policy makers
- a consultation exercise
- a stakeholder exercise
- an opinion poll[7]

Dialogue is more than just a friendly conversation. It should not be entered into lightly. Doing dialogue well means taking some new risks. New perspectives might not always be welcome, but proper dialogue brings them to the surface, which is useful in the construction of a policy response. And there is little alternative. If public dialogue is done badly, done for the wrong reasons or avoided, it can seriously risk public trust in the governance of science.

As the lessons from the UK's short history of public dialogue on science and technology become clearer, so does the need to embed dialogue in the culture of science. The science communication community and the organisations that support science have committed to two-way public engagement. Among scientists in universities, progress has been slower. Many scientists still assume that the public just needs to understand the science better. The need for scientists to listen to new views and reflect on their own work is not taught sufficiently. Where scientists do engage with the public, their efforts still tend to go unrecognised and unrewarded.

The changes asked for in the Wolfendale report, over 13 years ago, are really only just beginning. Some universities are starting to recognise communication skills or engagement activity in their appointments and promotions. In some subject disciplines teaching these skills comes more naturally than others. For many students studying physical sciences in

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particular, thoughtful discussion of ethical and social issues is still a rarity.

Public engagement, in different formats and sizes, needs to take place at all levels and in all places where science matters. We need to continue to encourage scientists and the science communication community to create new forms of engagement as part of building an innovative UK science base. And we need to link these conversations with the formal dialogue that is becoming more commonplace in the policy world. There is little point having a dialogue exercise on synthetic biology or nanotechnology if scientists then retreat to research-as-usual.

With controversial issues such as stem cell research, scientists have become more and more comfortable reflecting on their work in public. In such a situation, policy decisions sit on a bedrock of broad public discussion. Making these connections in other areas will be more difficult. The UK has travelled quickly on the road towards genuine dialogue, but the hard work still lies ahead.

The chapters

This collection hopes to advance the debate about public dialogue. It brings together insights from leading thinkers and practitioners who have been involved in dialogue activities over the last five years. These authors offer their thoughts ranging across the *why*, the *where*, the *what*, the *who* and the *how* of public dialogue with science.

In his chapter, Andrew Acland argues that too often, public dialogue takes place without sufficient clarity about its purpose.

Taking Acland's point, the collection starts with the *why* of public dialogue. Andy Stirling argues in the first chapter that, in different situations and different perspectives, there are many different possible *whys*. Stirling is interested in how we connect dialogue to policy-making. He wants us to get away from the Manichean view that science is either good or bad and have a dialogue about the different possibilities science presents. He draws a distinction between processes that close down debate and those that open it up to these new possibilities.

2 In chapter two, Steve Rayner and Chris Caswill take a sceptical look at public dialogue and ask some difficult questions about power and politics. They suggest that, even if public dialogue is as open and empowering as it claims to be, which is far from clear, there is still more to do in thinking through the connection between deliberation and representative democracy.

3 Turning to the *how* of dialogue, Andrew Acland argues that, rather than pulling participation processes off the shelf, we must design our dialogue with clarity about *purpose, people, products, context* and *resources*. These factors might conflict, leading to compromises, but we need to be clear why we are doing what we are doing.

4 Created soon after the BSE crisis, the Food Standards Agency has had to develop a sophisticated system of dialogue with members of the public. It is at the forefront of thinking through how dialogue connects to the decisions public bodies have to make. In her chapter, Dame Deirdre Hutton, the chair of the FSA, describes its approach, earning public trust rather than assuming it. The FSA uses public dialogue to think through its decisions, recognising the frequent tensions between public and scientific priorities.

5 Richard Jones offers his conceptual and personal thoughts on the public debate about nanotechnology. Jones personifies the transition towards an open-minded model of science.

He is an experimental nanoscientist who has in the last five years started to engage with experiments of a different sort. He has been involved in numerous public engagement activities, most recently prompting the Engineering and Physical Sciences Research Council to engage in a public dialogue process that was directly connected to its funding strategy.

Governments across the world are trying to encourage scientists to think beyond science for science's sake and consider possible societal and economic implications. Jones's opinion is that, '*if the agenda of science is to be set by the demands of societal needs, it is important to ask who defines those needs.*'

6 It is easy to talk about dialogue in the abstract, forgetting that there are people at its core. The next chapter brings together two participants, Laura Bowater and Debbie Perry, both of whom have taken part in Sciencewise-ERC processes.

Laura Bowater calls herself '*a member of the public who just happens to be a scientist*' and she recounts the lessons she learnt hearing from people whose voices it would otherwise have been easy to ignore.

Debbie Perry describes the surprise of being asked to discuss and give opinions on an issue that was initially obscure but revealed as highly relevant.

7 Charles Leadbeater broadens our gaze by putting public dialogue in the context of a trend towards greater openness within and around science. He argues that in old fields such as astronomy and new ones such as synthetic biology, scientists are increasingly doing science *with* people rather than *for* them. If dialogue is not sufficiently meaningful, members of the public will get tired of it, Leadbeater says: '*they will want to contribute, not just to comment.*' Leadbeater suggests we should concentrate on '*greater involvement of citizens, not just in debating what science should do, but enacting it, trying it out, testing and adapting new applications and technologies.*'

8 Processes of opening up science need to go beyond formal public dialogue, into the hearts and minds of scientists themselves. Robert Winston concludes the collection by arguing that scientists themselves should be encouraged to listen to the public and talk more confidently about the things they think are important.

We need to continue to encourage scientists and the science communication community to create new forms of engagement as part of building an innovative UK science base.

1 We use the term ‘science’ loosely to encapsulate the hugely diverse activity across science, technology, engineering, medicine and associated innovation.

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3 A. Wolfendale, E. Hassall, I.R. Murray, R. Paul, G. Thomas, J. Thurston, D. Whitehouse, T. Wilkie and M. Winstanley, ‘Report of the committee to review the contribution of scientists and engineers to the public understanding of science, engineering and technology’, Office of Science and Technology, October 1995

4 House of Lords, (2000) Science and Society - Third report of the Science and Technology Committee, Session 1999-2000., House of Lords, 23rd February 2000. Available [16 December 2008] at www.parliament.the-stationery-office.co.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm

5 HM Treasury/DTI/DfES, Science and Innovation Investment Framework 2004–2014 (London: HM Treasury, July 2004)

6 Policy through dialogue: informing policies based on science and technology – A report from the Council for Science and Technology, March 2005

7 Council for Science and Technology, Policy Through Dialogue Review, forthcoming

1

Engaging futures

Opening up choices on science and technology

Andy Stirling

Why engage?

Why should leaders 'engage' with those they lead? The question is as relevant in late industrial democracies as it has ever been, and particularly so with questions of science and innovation.

Across all parts of Government, business and civil society, diverse forms of 'public engagement' are now burgeoning. Champions arise well beyond the 'usual suspects' – practitioners and social scientists. They emerge in places as diverse as the European Commission,[1] Greenpeace, the House of Lords,[2] the Royal Commission on Environmental Pollution,[3] Government departments such as BIS[4] and Defra[5] and large corporations like Unilever,[6] as well as within established institutions of science, engineering and medicine from the Royal Society[7] and the Wellcome Trust to the Research Councils.[8]

Yet attention typically focuses more on *how* engagement takes place rather than *why*. This is especially true with political choices over the directions taken by science, technology and innovation.[9]

Public engagement here has many faces. Variously pursued as 'citizen participation', 'inclusive deliberation' or 'stakeholder dialogue', it takes place both 'in' and 'with' contrasting 'publics'. Specific approaches include citizens' juries, focus groups, consensus conferences, interactive websites, strategic commissions and stakeholder panels.

Yet amidst the clamouring particularities, this basic question of 'why?' has no single answer. It prompts a variety of equally reasonable but contending responses. Is public engagement about enriching and invigorating our democracy? Is it about fostering trust and acceptance? Or does it try to build better, more 'robust' pathways for science and technology? Under different circumstances and from different perspectives, different points are emphasised. The question gets more complex – and more intrinsically political.

The realities of progress

Central here are some neglected realities of scientific and technological progress. Whether in agriculture, energy, ICT, materials or public health: technical and institutional innovations may unfold in a variety of directions.

Low-carbon energy strategies may focus on efficient use, smart grids, carbon capture, nuclear fission, centralised renewables, distributed renewables or nuclear power. Pathways to 'sustainable agriculture' are variously claimed by organic farming, advanced cultivation, GM crops and non-GM biotechnologies.

Responses to the shortage of human organs are promised by embryonic or adult stem cells, xenotransplantation, countless medical technologies or preventive public health.

In all these areas protagonists typically disagree over which direction offers the best prospects. Different scientific disciplines and powerful industrial interests back progress along alternative paths.

There will always be some diversity, but we cannot equally realise the full potential of all viable directions. With scarce resources, choices have to be made. Those alternatives that benefit from early support may 'lock-in' or 'crowd out' others, even if they later turn out not to have held such promise. We see this in even the most competitive of consumer markets and in large infrastructures. Familiar

'lock-ins' arise in media standards, computer software, transport networks, electricity systems, and nuclear reactor designs.

The persistently awkward Victorian QWERTY keyboard is a classic example. Globalising markets amplify these pressures to concentrate and standardise. Assertive early expectations over which pathway will be followed can be self-fulfilling. Investors, suppliers, regulators and customers will often 'pick winners' on the grounds of perceived inevitability, rather than judgements of superiority. Expectations can thus be self-reinforcing, foreclosing even what all agree to offer preferable long-run options.[10]

In high-stakes, hotly-contested arenas around food, energy, resources, transport and health innovation, advocates of contending pathways understand this dynamic well. This is why we hear so often – at the highest levels – the rhetoric that 'there is no alternative.' Sceptics over a specific technology are routinely branded as generally 'anti-technology' and questions about incumbent prioritisations in science are labelled 'anti-science'.

Ironically, such accusations themselves diminish the genius and creativity of science and technology. They deny the reality of choice. They are like calling opposition to particular policies in other areas of politics (like justice, education or health), generally 'anti-policy'.

The potential of science and technology is thereby reduced to an impoverished 'race' along some pre-ordained track. Open questions over 'which way?', 'who says?' and 'why?' are replaced by narrow preoccupations with 'how fast?', 'how far?' and 'who leads?'[11]

Motivations for engagement

Against this backdrop we can revisit the question: 'why engage on science and technology?' Alternative answers hold contrasting practical implications for the ways public engagement is perceived, designed, implemented and evaluated.[12]

First, a dominant view among many academics, commentators and practitioners is that public engagement is about enhancing our *democracy*. This rationale would hold even if the choices that arise are agreed to be less effective, efficient

or timely than they might otherwise have been. As long as the *process* itself is more enriching, empowering or fair, then this aim remains satisfied. The design (and evaluation) of engagement is geared to counter undue influence from vested interests and ensure qualities like accessibility, transparency, equity and legitimacy in the course of decision-making.[13]

This interest in process is less pronounced in the more outcome-focused world of policy-making. Here, public engagement is a means to an end, fostering outcomes like trust, credibility and acceptance (for existing institutions and interests) or blame management and strategic intelligence (supporting favoured policies). This is a second, more *instrumental*, rationale. It hinges on relatively narrow institutional aims concerning political *justification*, rather than on the qualities of the engagement process. This kind of engagement is a way to substitute – rather than support – vigorous political debate.[14]

There may often be flexibility over which precise outcome is favoured – as long as it is effectively justified. Like conventional consultation, expert committees or risk assessments, public engagement can help in the vital political tasks of maintaining consent and managing conflict. But in other cases, there will be a clear idea of the particular outcome to be justified.

Even without overt manipulation, there are many ways in which engagement can – like expert analysis – be framed so as to favour the 'right' answer. By subtle shifts in process design, particular sites can be selected, specific products approved, or individual policies legitimated. Again, this is not a partisan point. It applies as much to a radical NGO looking for changes to energy or transport policies as to powerful industrial interests defending the *status quo*. Whether such an instrumental motivation is judged good or bad depends on the point of view. Either way, the design (and evaluation) of engagement is focused not on process, but on privately favoured outcomes (like trust, acceptance or blame avoidance).[15]

The third general motivation also hinges more on outcomes than process. Here, though, the merits are not judged in terms of narrow

sectional interests. Instead, they appeal to widely-recognised *substantive* qualities – reducing impacts, protecting health, enhancing 'precaution' or promoting social wellbeing.

Though details differ, all agree as to the overall desirability. For instance, a corporation may be open-minded about which products to develop, but simply wish to understand the needs and values of potential customers and wider society.

Similarly, bodies like the Department for Business Innovation & Skills, the Royal Commission on Environmental Pollution, The Royal Society and the European Commission all agree that broad engagement at the earliest stages in the development of a technology can help gather relevant knowledge and so provide early warnings of possible problems.

Without being romantic, public engagement can draw on relevant knowledges of users, consumers or local communities and test and integrate these rigorously with expert perspectives. Specialist expertise is essential, but it is not sufficient definitively to compare, prioritise or distribute different forms of benefit or harm. Subjective judgements remain unavoidable, over issues like the relative importance of avoiding injuries or disease, or harm to workers or children, or impacts on biodiversity or jobs.

If the primary motivation is a substantive one, design and evaluation of public engagement is not primarily about processual 'fairness' or 'legitimacy', but about ensuring better validated (and more complete and accountable) treatment of relevant options, issues, uncertainties and values – so fostering better decisions.[16]

Opening up directions for choice

There can be no single final or definitive answer to the question of 'why engage?' Responses vary by circumstance, perspective and timing. We may wish simultaneously to nurture democratic process, foster general substantive qualities and promote more specific instrumental ends on the lines outlined above. But these motives have different implications for the ways we view and do public engagement.

There are particularly serious implications for the evaluation of engagement. Since they vary with

motivation, evaluation criteria may display odd contradictions and circularities. In the Government's GM Nation dialogue exercise in 2003,[17] one of the evaluation criteria was impact on decision-making.[18] Since the outcome was rather sceptical about GM, it failed to justify more positive Government policy. As a result, it was not particularly influential. This contributed to under-performance in the official evaluation, which was in turn cited as a (circular) reason for Government caution over the exercise in the first place. To include 'policy influence' as an evaluative criterion for well-conducted public engagement (rather than for wider governance) is a sure sign of instrumental motivations.

Despite these complexities, we can draw a distinction between initiatives that try to 'open up' decisions on science and technology and those that 'close down'.[19] Conventional approaches tend to assume that the most desirable general outcome of engagement is the achievement of closure and consensus. This appears simultaneously to fulfil the functions of democratic process, practical justification and the identification of substantively 'best' options.

Yet it is just this kind of 'closing down' that presents some of the most acute problems. If closure takes place invisibly within a specific engagement process, what then is the role of democratic institutions? How representative, legitimate or accountable are the included participants or procedures? Might a similar exercise have arrived at different conclusions if it were structured or informed in a different way? What was the opaque (possibly inadvertent) influence of power?

Instead, we may use a range of different approaches to achieve a complementary role for public engagement. Rather than aiming at 'closing down' around a single recommendation to policy-making, approaches like open space, deliberative mapping, interactive modelling, multicriteria mapping, scenario workshops and dissensus groups instead transparently 'open up' implications of different possible choices. They explore ways in which alternative viable directions for science and technology appear favourable under contrasting assumptions, conditions or perspectives.

Approaches like open space, deliberative mapping, interactive modelling, multicriteria mapping, scenario workshops and dissensus groups transparently **'open up'** implications of different possible choices.

They offer richly detailed information concerning interactions between options, values and knowledges. The resulting 'plural and conditional' recommendations provide a more authentic reflection of the irreducible political complexities. Such recommendations are 'plural' because, whilst ruling out some, they outline a range of potentially justifiable actions. They are 'conditional' because each recommendation is qualified by associated values, assumptions or contexts.

Although possibly inexpedient to officials attempting to prescribe decisions, responsible politicians may actually welcome this deeper information. For every senior civil servant insisting that practical advice must take the form of a single sentence in a one-page briefing, there is a beleaguered Minister wondering how much their latitude for choice has been constrained (and vice versa). Despite the apparently greater humility and caution of this 'opening up' approach, it can – by clearly identifying pathways that appear unfavourable under all viewpoints – also add to the robustness of decisions. Where engagement highlights alternatives, the resulting justification is also more credible. Decisions are still made, but are better informed and at the right level.

An 'opening up' approach to public engagement can help nurture a richer, more vibrant and mature politics of technology choice. It recognises that different knowledges, values and interests favour different, equally feasible, directions for innovation.

This is not postmodern 'anti-science'. Just because a number of directions are viable does not mean 'anything goes'. In fact, this approach is more realistic about science and technology – celebrating its many possibilities Just as what Robert Merton called 'organised scepticism' is recognised as a fundamental quality in science, so pluralism and scepticism in public engagement can help build more rational social discourse over science and technology. And by making processes of closure more transparent, systematic 'opening up' is also more consistent with existing procedures for democratic political accountability.

Public engagement can help enable – rather than suppress – a more healthy politics of choice. Only by engaging openly with our multiple possible futures, may we hope truly to realise the unbounded, intertwined promise of science, technology and wider human aspirations.

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2

Empowered or reduced?

Reflections on the citizen and the push for participation

Chris Caswill and Steve Rayner

The push for public participation in the governance of science has many and varied supporters, not least among social scientists, who act both as analysts and facilitators of participation processes.

In this they have assumed a variety of roles – not only as friendly critics but also as intermediary experts,[1] as illuminators of localised ordinary knowledge,[2] as guides for the public's empowerment and participation, as technicians of instruments for participation and as supporters of increased democracy.

As advocates of deliberative democracy, many will see the need to act as assistants in the creation of space for public deliberation and in the social distribution of knowledge.[3]

This has led in practice to an unlikely alliance between social scientists and enthusiasts who see science, technology and innovation as the engine of economic growth.

Underpinning this increasingly powerful consensus is an idealised conception of the actual or potential influence that the individual citizen can exert on science and science policy through deliberation and organised exchanges of views. The outcomes of such processes are imagined to be in some way 'better' as well as more legitimate. Citizens are provided with new tools and new information to go with those tools.

As participants they are encouraged to expect some direct influence on scientific and policy outcomes. These ambitions are implicitly (and sometimes explicitly) set in sharp (and favourable) contrast to the institutionalised processes by which decisions are delegated to others – experts, scientists, and, not least, elected politicians. There has been little reflection on these processes and the role played by social science. In this chapter, we turn up the volume on the challenges of participation.[4]

Some question marks

a) Questioning the outcomes

Independent evaluation of the effects of public participation in the governance of science is problematic. There are limited examples of outcome-based evaluations that have established that public participation has led to an outcome that would not otherwise have been reached.

There are examples of self-evaluation performed by the organisers of the consultation or engagement activity or sympathetic evaluation by social scientists known to be committed to the principle and techniques being employed. Even these assessments express concern about efficacy and outcomes.

Based on a study of eight countries, Hagendijk and Irwin[5] find that '*rhetoric is running well ahead of practice*' and the experiments are isolated and limited in scope. Hansen observed that none of the participation

processes he studied in Denmark, Germany and the UK brought any closure on the various controversies.[6]

Bora and Hausendorf suggest that direct public participation, badly handled, may provoke exclusion and conflict rather than the intended outcome. What they call '*participatory euphoria*' may well have negative consequences.[7] It seems that the positive impact of public participation in science remains, at best, a matter of faith.

b) Questioning the validity

It is equally the case that few, if any, of the tools and techniques developed by social scientist and think tankers to help the public participate in discussions about the future of science and technology have been rigorously evaluated. Carson & Martin claim that sample bias can be overcome by random selection of participants.[8] However, close examination of their methodology reveals that their citizen juries were far from fully random. The pool from which they were drawn was self-selected from an initial random mailing and the actual juries were then selected to conform to a predetermined socio-demographic profile of the population in question. While this method may be considered to have produced panels that were representative in a sampling sense, the authors also claim legitimacy for them in that they performed well by process criteria. However, these juries were also heavily mediated by the researchers, which suggests that their conformance to deliberative norms of ideal free speech may have little to do with their representativeness.

c) Defective deliberation

A key element of participation is the search for deliberation where citizens can not only influence outcomes but also shape the way issues are framed for discussion.[9] Participation tends to emphasise deliberation and building consensus, but it depends on a standardised model of the citizen who is:

- socially embedded in a community
- locally knowledgeable and intuitively reflexive about society and nature
- focuses on common good as a core value of public life
- relies on inclusionary deliberation to reveal truth

A key element of participation is the search for deliberation where citizens can not only influence outcomes but also **shape the way issues are framed for discussion.**

Public participation all too often offers citizens the opportunity to select from among a limited array of options, but not to play a significant role in setting policy agendas.

We want to argue that the diversity of citizens' interests and motivations, and their reactions to the specific circumstances are all too often not captured in artificially created deliberative mechanisms. Others have drawn attention to the ways in which participation masks politics. Questions of power, differential resources, ownership of issues and conflict over outcomes are overlooked or excluded.

Drawing on studies of courtroom juries, Sanders shows how deliberation is constrained by existing structures and relationships.[10] Participants in deliberation will inevitably have very different resources and power, and be connected to different networks. Sanders shows how well-educated white males have emerged as the leading voices in American juries.

In her critique, Mouffe reminds us that the push for participation has its roots in the Habermasian 'project'[11] of reconciling rationality with legitimacy, creating an 'ideal speech' which allows articulation of the common good, communicating free of constraints and arriving at a consensus by means of rational arguments.[12]

For her, these ambitions, however worthy, are fatally flawed. Many voices will have been left out from the start or silenced by the existing moral consensus. Legitimate conflicts will be silenced or airbrushed out. Although attempts can be made to take power and 'the political' out of politics, power will continue to be constituted in the identities of the participants, and in their social relations.

d) The absence of context

The commitment to finding neutral space for public participation means that it generally happens out of context. Wider political and economic issues are rarely in view, let alone on the table for citizens to absorb and debate.

Public participation all too often offers citizens the opportunity to select from among a limited array of options, but not to play a significant role in setting policy agendas.[13] The underlying interests of powerful governments, business and science establishments are all too rarely debated.[14] Critics of deliberative democracy can legitimately question its capacity to handle (or ability to exclude) questions of politics, economic ideology and industrial influence.

e) Benefits and costs of performative social science

Deliberative democracy needs to be organised, sometimes by the state, sometimes by think-tanks but very often by social scientists. One of the most remarkable features of the push for participation has been their prominent performative role as advocates and designers of increasingly sophisticated techniques for non-experts to take part in scientific, environmental, and technological decision-making.[15] These include focus groups, citizens' juries, community advisory boards, consensus conferences and participatory integrated assessment.

All of these social-science-based techniques attempt to equip groups of citizens to make informed decisions about issues involving complex science or technology. The assumptions underlying all of these approaches to public participation are that it leads to better decisions and that expertise can and should be harnessed through the exercise of popular will. However these techniques bring with them their own problems. In her empirical analysis of deliberative procedures in Denmark, France, the UK and the USA, Tucker (2008) argues that these activities are top-down '*oligarchic practices*', and highlights the ways in which they are structured and used by elite actors, pursuing their own particular interests rather than giving voice and authority to citizens' views. There is at least a question as to whether participatory decision processes devised by social scientists are a path to increased democracy or just another layer of technocracy in decision-making.

f) The absent polity

Participation often ignores the existing extensive apparatus of science advice and its role in representative democracies. The European Union's recent Science in Society programme expressed its wish to assess '*the functioning of policy making processes in Europe and major industrialised countries worldwide.*' But the actual projects funded by the programme were almost all small-scale experiments in public participation.

Reviewers of the programme found that '*The pervasive networks of governmental advisory processes consisting of expert committees, academic advisors, professional associations, government and university scientists, and civil servants who actually inform key decisions from local to transnational levels of European government have largely eluded the programme's attention.*'[16]

In our view, one of the biggest question marks against the push for participation is its paradoxical relationship to the democratic state. Public participation in science is often championed by state institutions and actors. But there is a tension between deliberative and representative democracy. Advocates of deliberation and participation see themselves as compensating for weaknesses in the democratic system and, either implicitly or explicitly, set themselves up in opposition to it.

As a result, the messy world of politics is left to one side, and representative democracy is the ghost at the participation feast. Where 'democracy' is discussed, it is normally in terms of vague abstractions such as 'networks', 'collectives', and 'governance systems'.

Yet consideration of decisions about science should not exclude the democratic state, for at least two reasons. First, the state decides on the funding, steering, regulation, and infrastructure of scientific research. It plays a major part in the high-

In our view, one of the biggest question marks against the push for participation is its paradoxical relationship to the democratic state.

level shaping of science policy, currently placing heavy emphasis on the relationship between science, technology and innovation, for example. Secondly, citizens of democratic states act within, and interact with, the institutions of representative democracy, and it is to those interactions that we turn, in order to propose a fresh way of thinking about public participation in the governance of science.

Participation within representative democracy

In recent years, one strand of political science, using principal-agent frameworks has sought to reconceptualise the democratic state as a chain of delegation from the individual citizen.[17] Here the citizen re-emerges at the heart of democratic processes, as principal, rather than the occasional, beneficiary of powerful government.

Agency loss along the chain of delegation then becomes the central problem, and the institutions that reduce or permit that loss become significant actors in the process. We believe this model can be used to embed our understanding of the push for participation within a more politically-informed enquiry into public involvement in the governance of science. Deliberative participation can be seen as just one way to cope with perceived weaknesses in the delegation chain, but there will be other solutions to explore as well, some of which may be better connected to underlying political realities.

Looking to the future, we propose that locating public participation in science governance within a larger set of questions about citizens' relations with the institutions of representative democracy could restore the citizen to a central role, as an everyday actor and not just an occasional contributor summoned up by social science. This would provide a richer framework for debating, investigating and, in due course, resolving the challenges we have outlined.

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3

Designing and delivering public engagement with science

Andrew Acland

“In questions of science the authority of a thousand is not worth the humble reasoning of a single individual.”

Galileo Galilei (1564-1642)

Galileo was half right. It may still be the single individual who does the reasoning, but in the modern world it is the authority of the metaphorical thousand that can determine whether that reasoning grows beyond an idea.

The purpose of public engagement is to weigh and measure that authority and through it to deliver the legitimacy and the funding that enables questions of science to be answered. Scientists today think with envy of Galileo and his contemporaries, funded largely through private patronage.

The reality now is that science and innovation are so expensive that it means tapping the pockets either of taxpayers or shareholders for support, and this in turn means some degree of accountability to others.

Those who design and deliver public engagement around science and technology, whether they are civil servants or professional engagement practitioners, have a particular responsibility to ensure that in enabling this accountability they neither inhibit the scientists nor short change the public. The way they can do this is by tailoring dialogue processes to fit the specific issues and circumstances. The purpose of this essay is to describe the different forms that such processes can take, the considerations that go into process design and the methods that deliver the results.

Types of engagement process

Practitioners generally recognise a spectrum of types of contact between scientists and the public. At one end of the spectrum there is research and data-gathering on public attitudes to particular issues; at the other, complex, iterative dialogue exploring, for example, the profound moral implications of new medical advances.

The main difference between the processes along this spectrum is the amount of interaction they involve. Data-gathering methods such as surveys and questionnaires, for example, involve little interaction and many practitioners are unwilling to describe them as 'dialogue'. A lecture by a scientist involving a question and answer session, or a day-long workshop in which scientists and public meet to discuss an issue are both more interactive.

The language used to describe the processes along this spectrum is still evolving. Some practitioners use 'engagement' as it is used here: as a generic term for all such interaction. Other words commonly used to describe different types of processes along the spectrum are 'consultation', 'involvement' and 'participation'.

'Consultation' generally refers to the formal publication of a consultation paper and the request for comments or responses to specific questions. 'Participation' and 'involvement', meanwhile, tend to be reserved for the rarer occasions where the participants have some say over the shape of the process, the scope of its content and even the decisions that result from it, if these are not the sole prerogative of legislators. These processes can unfold over months or even years, and tend to be conducted through professionally designed and facilitated meetings and workshops.[1]

The word 'dialogue' is reserved by some practitioners to denote the most intense forms of interaction designed to establish a shared and deep understanding of an issue in all its complexity. Such processes explore the commercial, social, ethical, philosophical or psychological implications and consequences of scientific issues. As science raises increasingly arcane questions about our world, our species, our composition and our prospects so, it is argued, we need more demanding dialogue processes to ensure that decision-making in our collective names takes as rigorous and holistic an approach as possible.

There are also some types of process that many practitioners feel should not be described as 'engagement'. Chief among these are public relations processes that have as their sole purpose the intention to sway the minds of those at whom they are directed. The minimum requirement for any process to be defined as 'engagement' is its sponsor's intention to listen and willingness to be influenced. Minds may be swayed as well, but it will be through their owners' free choice and as a consequence of the process - not as its guiding purpose.[2]

Newcomers to the field can find it daunting to step into this semantic minefield. The best advice is always to check what people mean by the words they use, and to be careful about the expectations that may inadvertently be created. It may not be helpful, for example, to talk about public 'participation' if the intention is just to send out a consultation document, or about 'dialogue' if the process involves no more than a focus group or a one-day workshop.

Key variables and process design

As will be clear from the above, there is a relationship between different types of engagement and the methods used to deliver them. Choice of method is not, though, determined solely by mode of engagement. In the real and messy world there are six key variables that need to be taken into account, all of which are inter-related. They are:

- the overall *purpose(s)* of the process
- the *product(s)* required of it
- the *people* to be involved or at whom the process is targeted
- the *context* in which it is conducted
- the *time* available
- the *money* available

Defining the *purpose* of an engagement process is important for reasons both of principle and pragmatism. Of principle, because it is one way to fill the inevitable cracks in a democracy: to enable the voice of the electorate to be heard in the long periods between elections, and to ensure that politicians and policy makers are alert to the interests and concerns of those they serve. Of pragmatism, because experience teaches that many sponsors remain confused, or internally divided, about what they expect public engagement to deliver.

It is for this reason that the first thing every public engagement practitioner does, on meeting a sponsor, is to ask the purpose of a process and go on asking until it is unambiguously clear. Sometimes the question is reduced to the almost childishly simple: *'What do you want to be different as a result of this process?'*

The answers, likewise, may be simple *('we will be able to make a better decision')*, or they may be more complex *('we will understand better what people like or dislike about this innovative area of science, and we will be able to re-draft our policy proposals to take account of a wide range of technical, commercial and ethical interests and concerns before initiating a further round of engagement to fine tune our proposals')*.

Once the purposes have been teased out, the practitioner usually asks about specific products from the process. These, again, may range from the relatively straightforward *('representative and quantitative survey results that tell us what people think of this idea')* to the subtle and multiple *('relationships with key stakeholders on whom we can call in the future to help guide the implementation of our policy proposals; some resolution of previous conflict around this issue; and some means by which we can decide which source of expert advice is most reliable')*.

The next major variable is the people to be involved. Engagement processes can involve anything from a few key stakeholders to several thousand people chosen to be representative of the population as a whole. Who is involved depends on the purpose of the process and the products required. If the purpose is to discover public opinion about something, then it makes sense to use a method that involves a

demographically representative sample; if the purpose is to gather detailed guidance on a technically complex issue then it may be better to involve a relatively small number of people carefully chosen for their expertise and to judge their contributions on their merits, not on whether more experts argue in one direction or another.

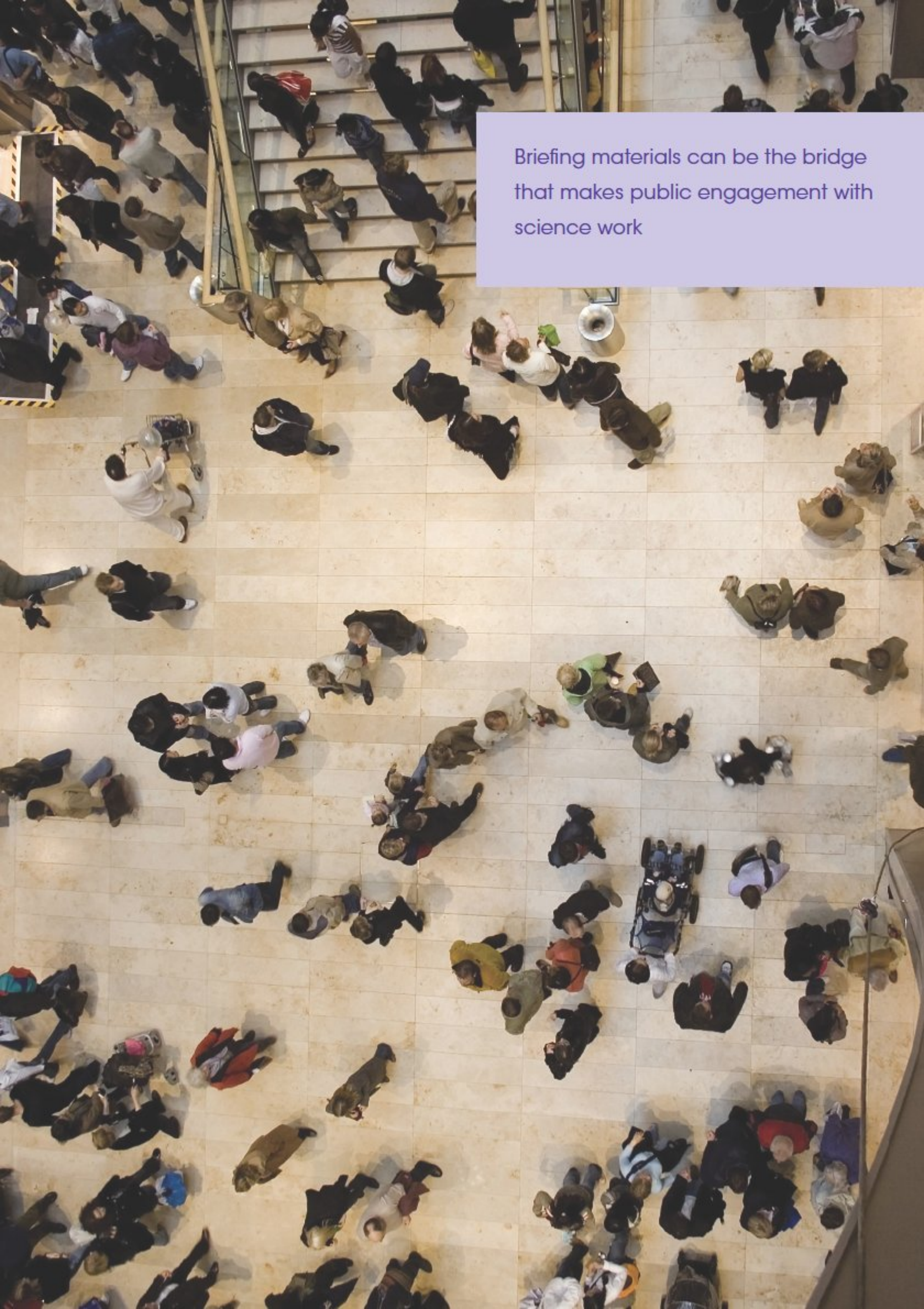
So one of the early design decisions to be made is whether the process should be primarily *quantitative* or *qualitative*: whether the number of people who think one way or another is significant, or whether it is their comments or ideas that are of interest. The confusion of quantitative and qualitative processes leads to one of the common forms of bad practice in engagement: running a qualitative, non-representative process and then trying to base conclusions on the numbers responding.

The fourth variable is *context*. In the case of public engagement with science the major context factor, from the point of view of process design, is the background information that non-scientists need to absorb in order to be able to engage meaningfully. The two final variables are *time* and *money*. The equations are very simple: quantitative data-gathering processes using surveys and polls are relatively quick and cheap; qualitative, deliberative processes using face-to-face meetings take longer to prepare and cost more to deliver. This can all too easily lead to policy makers making decisions about methods that are driven more by considerations of time and money than by the purposes of the process, the products required, and the people who should properly be involved.

Choosing engagement methods

Choosing the right method is a question of reconciling the sometimes competing demands of purpose, product, people, context, time and money and it is extremely unwise to choose an engagement method without considering each of these and how they relate to each other.

This is why practitioners talk about process design, and deplore tenders for engagement, for example, that specify the method to be used without references to these variables, and are wary of methods being preferred because they are either familiar or fashionable rather than because they are – all things considered - the right tool for the job.



Briefing materials can be the bridge that makes public engagement with science work

There is one particular difference between using public engagement to explore everyday issues and public engagement with science that also affects choice of method. With science, public engagement processes often need to provide briefing materials that enable non-scientists to understand the science and its possible implications without either over-simplifying the issues or 'leading' their conclusions. The materials developed for the Sciencehorizons project in 2007 aimed to find this balance; the subsequent evaluation has been helpful in identifying where they did not get it right, and where they did.[3]

Experience has led practitioners to three conclusions about choosing methods in this context. First, time and effort invested in getting briefing materials right pays off in terms of quality of results; secondly, the process, including the method(s) used, must be designed around the use of these materials; and thirdly, that with the right briefing materials, non-scientists are much more able to engage with complex issues and reach useful conclusions than many policy makers may believe.

Briefing materials can be the bridge that makes public engagement with science work. Treading the fine line between the accessible and the patronising is perhaps the greatest challenge we face, especially at a time when scientific education is, arguably, failing to keep pace with what science is delivering.

Ultimately our education system will determine whether Galileo could believe that the authority of thousands is up to at least following, if not duplicating, the reasoning of the single scientific genius. In the meantime public engagement with science must ensure that science proceeds with the blessings and the cautions of those it aims to benefit.

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1 A recent example is the work that took place under the umbrella of the Nanotechnology Engagement Group, www.involve.org.uk/neg

2 Deliberative public engagement: nine principles (http://www.involve.org.uk/deliberative_principles) is a useful guide to the principles that practitioners routinely use to ensure engagement is genuine.

3 www.sciencehorizons.org.uk

4

An appetite for public dialogue

Using public engagement to inform policy decisions in emerging areas of science and technology

Dame Deirdre Hutton

Public dialogue is on the calling card of every public body these days, but in the case of the Food Standards Agency it's at the heart of its business. The FSA was set up in the wake of the BSE crisis, at a time when public confidence over food issues was at an all-time low and trust in Government bodies fragile.

So the Agency was created as a fundamentally different animal, an independent Government body set up '*to protect the public health from risks…which may arise in connection with the consumption of food and otherwise to protect the interest of consumers in relation to food*'.[1] Putting consumers first is one of our core values: it's in our DNA.[2]

In our latest survey of people's attitudes to the Agency, 60% of the public who had heard of the Agency rate the FSA as an organisation they can trust.[3] But that trust is earned, and public engagement is vital in helping us earn it. We have always been clear that our policies are informed by the best science. But without earning that trust, the public will not accept the science that supports our advice on food.

What do we mean by engagement?

Our understanding of engagement is perhaps different from that of other Government departments – we know the real value of carrying out research and consulting people at the same time (see case study below) and we strive for two-way dialogue. The FSA, like all regulatory bodies, has to strike a delicate balance between basing its decisions on expert advice and sound science, while considering consumer knowledge, values and attitudes.[4]

Why do we use public engagement?

Public engagement is essentially a democratic activity. It gives a citizen the opportunity to shape the state and community in which they live. The democratic principles of social equality and respect for the individual are intrinsic to our three key reasons for engaging with consumers:

- Develop effective policy and communication strategies. Good policy is based on a genuine understanding of consumers – their lives, desires and constraints
- Increase trust and legitimacy by being open to public scrutiny and increasing public awareness of our work
- Develop ongoing dialogue with consumers, and others, which enables us to build alliances for positive change

Being accessible, transparent and having the public's trust is conducive to a fluid dialogue, and helps dialogue continue during difficult times.

Our scientific base has grown and developed during the Agency's existence, especially in the physical and natural sciences. But we know we need to increase use of social science to give the physical and natural sciences a social context and, more critically, understand people's behaviour better and how to influence it. Why are we, as individuals, reluctant to change, even in the face of compelling evidence?[5]

We use dialogue as one of the ways to help us understand what drives behaviour, so we can influence it. Our independent scientific advisory committees assess risk using scientific evidence.[6] Public dialogue captures the public's appetite for risk – information that is used for risk management by the FSA Board to calibrate the impact of policy.[7]

What forms of engagement do we use?

The FSA is a thoughtful organisation, keen to use new technologies such as social media to facilitate public dialogue. We use wide-ranging methods to engage with as many people as possible, because not everyone can be reached in the same way – not everyone has access to a mobile phone or the internet and not everyone speaks English as a first language.

We use traditional forms of engagement such as public meetings, written consultations and focus groups. But our full spectrum of engagement methods ranges from quantitative research, involving no deliberation (evidence reviews, opinion polls and surveys), through qualitative depth interviews, reconvened discussion groups, online consultations and online discussion forums, right the way to citizens' forums, deliberative polling, citizens' summits, consensus building workshops (which are almost entirely built on deliberation and interaction) and citizen's juries, where deliberation dominates.[8]

We also use the web to engage by making our website accessible and usable. We use it to issue press releases and news stories, so the public, directly or via the media, is kept informed early on about policy decisions and new advice. We sometimes undertake research to make sure our messages are understood by the public before we issue them.

Across the UK, ten citizens' forums on Food each meet three times a year to develop a deeper, richer conversation with the public to understand some of the current concerns that consumers have about food issues, and to gain their input into the earliest stages of policy development.[9]

For each open Board meeting, we provide live webcasts and podcasts. The public can also listen free on the phone and text questions and comments to the Board. During the annual British Science Festival, formerly the BA Festival of Science, we provided real time online voting during a live webcast. This event at the BA festival was an extension of the work we've been doing to engage the public in our scientific work.

One aspect of this has been our Chief Scientist Andrew Wadge's blog, which has been running for two years, and initially formed part of the

Hansard Society's Digital Dialogues project.[10] Andrew is trying to reach out to people who are interested in the science behind the story and encourages them to access the depth of evidence and analysis that drive the Board's public discussions of policy.

This has triggered useful debates around science and food safety, such as with raw milk.[11] The blog is seen as a friendly face of the Agency, which may also encourage people into engaging with us in other ways, and useful for gauging the impact of our work.

When it comes to issues of science and emerging technologies, our approach to public engagement

Case study:

Animal cloning and implications for the food chain[12]

Animal cloning is an emerging technology in the European Union and is more developed in the US. If its use becomes economically possible, there is the potential for food produced from cloned animals to enter the market.

The FSA researched the UK public's views about cloning animals, and cloned animals, their offspring and their products (such as milk and meat) entering the food chain. The research was just one part of the engagement process. It not only informed the FSA policy position in this area but also informed the communications strategy, another key part of public engagement.

To overcome the challenge of how to ask people about a complex subject about which they would have little knowledge, a deliberative approach was adopted, based on reconvened workshops. Participants

took part in two three-hour sessions, as well as carrying out their own background reading and research. The FSA provided reading material, as well as links to other sources of information, that needed to give sufficient depth but also be understandable to people from a wide range of socio-demographic backgrounds.

The first workshop focused on current livestock breeding methods, gave explanations of how clones are produced, how this technique can be applied to animal livestock breeding and the implications of this for the food chain. Participants then had a week to reflect on the information they had received and to do their own research. At the second workshop, we focused on participants' views on buying and eating food derived from clones and their offspring, as well as the steps they thought should be taken if such food went on sale in the UK.

FSA scientists were present to answer questions and engage in dialogue directly. To allow a wide range of views to be expressed, everyone was given the space to express their views at breakout groups and during a mixture of exercises.

Some participants were sceptical about the purpose of the research, holding the view that perhaps the FSA had a hidden agenda to persuade them of the benefits of cloning. Participants' key areas of concern were the safety of food derived from clones, standards of animal welfare, the lack of tangible consumer benefits, and a mistrust in the motives of the main players involved.

(More information about the process can be found at food.gov.uk/news/newsarchive/2008/jun/clone)

is perhaps best summed up with an example:

What have we learnt about engagement?

Our experience of doing and using public dialogue within the Agency has taught us some important lessons:

- Get scientists and the public in the same room. And get them talking on the same level. This is gold
- Scientists and the public can communicate on complex issues about emerging food technologies – if the public is given time and resources to learn and understand. In future, people will be grappling with more complex science and they'll need help unravelling the issues
- Don't assume the public's reaction. Giving workshop participants more information might change their view. In the animal cloning case, at the reconvened workshops, we heard that concern increased for many as they learnt more, particularly about the current low efficiency rates of Somatic Cell Nuclear Transfer (SCNT)
- Give feedback. Let people know how their input has made a difference. This need not be more complicated than sending an email or updating your website. This is more complicated when views have been considered but not taken forward, requiring careful communication about how a balance of views is used
- Do something that includes a mix of groups in the population – include views from groups of people who are hard to reach and/or vulnerable
- Make the subject relevant. Some issues, such as nanotechnology, are not on everyone's radar or not part of their everyday life. Make sure you make them relevant to people's lives before trying to engage
- Government structure does not reflect the public's understanding of an issue. For example, with animal cloning, the FSA is concerned with food safety and consumer benefits and The Department for Environment, Food and Rural Affairs deals with animal welfare concerns. Care is needed if you are engaging on issues outside your remit, to get a wider evidence base and help develop, implement and assess the social impact of advice and policies. Don't lead people to expect you to deliver in an area where you have no remit or authority

to do so. Think about working with other departments when dealing with cross-cutting issues. We involved Defra in the animal cloning project. They contributed to the background material that was given to participants and they had the opportunity to attend the workshops

- Dialogue can be too easy.
  Quality of consultation responses might not be meaningful or well considered if it's too easy to reply at the press of a button. Be clear that responses need to be qualified

- Simple forms of engagement may need more input than you think.
  For example, if you're running a blog, people may expect a response to their postings each time. There is a risk they will become annoyed if there is no response and become sceptical about your intentions. Resources are needed to maintain engagement.

The future

People are complicated. What matters to an individual might be different to what matters to the wider world, and the difficulty in differentiating between the two will continue to be a challenge which we must bear in mind.

Clearly the challenges of food policy and technology are here to stay. The World Bank estimates that the global demand for food will rise by 50% by 2030.[13] Such a threat to food security may well impact on the public's attitude to emerging areas of food science and technologies that might improve the efficiency of food production – such as GM, cloned animals and nanotechnology – if these methods are perceived or proven to be a sustainable solution for future generations.

But technological advances in communication can help us with this engagement as well as presenting us with issues that we need to tackle. So we will continue to experiment with developments in online and digital technology, to help us increase the range of people with whom we engage.

And at the same time we will continue to work with our staff, our committees and our stakeholders to enmesh our public engagement in our policy-making process – to knit together old methods with new technologies to achieve the FSA vision of safe food and healthy eating for all.

1 Food Standards Act 1999, www.opsi.gov.uk/acts/acts1999/ukpga_19990028_en_1

2 Consumers comprise three groups: individual consumers (the general public); vulnerable consumers (these sections of the population might include the young, elderly, those on low or no incomes, etc); consumer stakeholders (organisations, groups and networks who represent the views of a particular constituency).

3 Food Standards Agency's eighth annual Consumer Attitudes to Food Survey food.gov.uk/science/socsci/surveys/foodsafety-nutrition-diet/eighthcas2007

4 'Engagement, evidence and expertise' discussion paper for FSA Board (Demos, September 2006): food.gov.uk/multimedia/pdfs/fsa061004b.pdf

5 To give one example, currently no food is irradiated in the UK, although decades of research have shown that the irradiation of food is safe. National regulations allow for the irradiation of seven categories of food: fruit, vegetables, cereals, bulbs and tubers, spices and condiments, fish and shellfish, and poultry. However, only one UK licence, for a few herbs and spices, has so far been granted and hasn't been recently used.

6 food.gov.uk/science/ouradvisors/

7 How the Agency approaches risk: food.gov.uk/aboutus/how_we_work/107441

8 The FSA's GM food debate 2003 included a three-day citizen's jury to independently assess people's views on GM food and how it relates to consumer choice: food.gov.uk/gmdebate/?view=GM+Microsite

9 food.gov.uk/multimedia/pdfs/board/fsa080503.pdf

10 FSA Chief Scientist Andrew Wadge's blog: food.gov.uk/scienceblog

11 'Pasteurised is best' blog: www.fsascience.net/2007/11/07/pasteurised_em_is_em_best

12 The current regulatory position is that no cloned animals, their offspring or their products can enter the food chain. The research was carried out in advance of the FSA being asked by any company wanting authorisation to sell food produced using cloned animals. The FSA is the UK body responsible for assessing the safety of foods that do not have a history of significant consumption within the EU before May 1997 and giving the go ahead, or otherwise, for them to be sold.

13 Global Trends 2025: National Intelligence Council 2025 Project, pp.51 www.dni.gov/nic/NIC_2025_project.html

5

Public engagement and nanotechnology

The UK experience

Richard Jones

From public understanding to public engagement

Nanotechnology emerged as a focus of UK public concern in 2003, prompted not least by a high profile intervention on the subject from the Prince of Wales.[1] This was an interesting time for the evolution of thinking about public engagement with science. A consensus about the public understanding of science (PUS) movement, dating back to the Bodmer report in 1985,[2] had begun to unravel. The proposed alternative was for the scientific community to reflexively engage the public in a genuine upstream dialogue.[3]

My own personal involvement in science communication has followed a path that mirrors this shift in emphasis. As a nanoscientist, I was keen to correct what I perceived as serious misconceptions in the way nanotechnology was being presented in the wider media, so I wrote a book about nanotechnology for the general reader.[4] In connection with this, I have since lectured extensively to non-scientific audiences, and run a widely read blog.

My introduction to public engagement, rather than public understanding, came through my participation in a citizens' jury about nanotechnology. Following this challenging but rewarding initial experience, I have participated in a number of other public dialogue events and, through my role as chair of the Nanotechnology Engagement Group, developed a good overview of the area. Most recently, through my advisory role with the Engineering and Physical Sciences Research Council (EPSRC), I have been able to see the potential relevance of public engagement to the practicalities of science policy.

Enter nanotechnology

In response to the growing media profile of nanotechnology, the Government commissioned the Royal Society and the Royal Academy of Engineering to carry out a wide-ranging study on nanotechnology and the health and safety, environmental, ethical and social issues that might stem from it. The working group included, in addition to distinguished scientists, a philosopher, a social scientist and a representative of an environmental NGO. The process of producing the report itself involved public engagement, with two in-depth workshops exploring the potential hopes and concerns that members of the public might have about nanotechnology.

The report – 'Nanoscience and nanotechnologies: opportunities and uncertainties'[5] - was published in 2004, and amongst its recommendations was a whole-hearted endorsement of the upstream public engagement approach: *'a constructive and proactive debate*

A constructive and proactive debate about the future of nanotechnologies should be undertaken now – at a stage when it can inform key decisions about their development and before deeply entrenched or polarised positions appear.

about the future of nanotechnologies should be undertaken now – at a stage when it can inform key decisions about their development and before deeply entrenched or polarised positions appear.'

Following this recommendation, a number of public engagement activities around nanotechnology have taken place in the UK. Two notable examples were Nanojury UK, a citizens' jury which took place in Halifax in the summer of 2005, and Nanodialogues, a more substantial project which linked four separate engagement exercises carried out in 2006 and 2007.

Nanojury UK was sponsored jointly by the Cambridge University Nanoscience Centre and Greenpeace UK, with the Guardian as a media partner, and Newcastle University's Policy, Ethics and Life Sciences Research Centre running the sessions. It was carried out in Halifax over eight evening sessions, with six witnesses drawn from academic science, industry and campaigning groups, considering a wide variety of potential applications of nanotechnology. The Nanodialogues, funded by Sciencewise and led by Demos, took a more focused approach.[6] Each of its four exercises, described as 'experiments', considered a single aspect or application area of nanotechnology. These included a concrete example of a proposed use for nanotechnology – a scheme to use nanoparticles to remediate polluted groundwater – and the application of nanoscience in the context of a large corporation.

The Nanotechnology Engagement Group, which I was asked to chair, provided a wider forum to consider the lessons to be learnt from these and other public engagement exercises both in the UK and abroad.[7] This revealed a rather consistent message from public engagement. Broadly speaking, there was considerable excitement from the public about possible beneficial outcomes from nanotechnology, particularly in potential applications such as renewable energy, and medical applications. The more general value of such technologies in promoting jobs and economic growth was also recognised.

There were concerns, too. The questions that have been raised about potential safety and toxicity issues associated with some nanoparticles caused disquiet, and there were more

general anxieties (probably not wholly specific to nanotechnology) about who controls and regulates new technology.

Reviewing a number of public engagement activities related to nanotechnology also highlighted some practical and conceptual difficulties. There was sometimes a lack of clarity about the purpose and role of public engagement; this leaves space for the cynical view that such exercises are intended, not to have a real influence on genuinely open decisions, but simply to add a gloss of legitimacy to decisions that have already been made. Related to this is the fact that bodies that might benefit from public engagement may lack the institutional capacity to make the most of it.

There are some more practical problems associated with the very idea of moving engagement 'upstream' – the further the science is away from potential applications, the more difficult it can be both to communicate what can be complex issues, whose impact and implications may be subject to considerable disagreement amongst experts.

Connecting public engagement to policy

The big question to be asked about any public engagement exercise is *'what difference has it made?'* – has there been any impact on policy? For this to take place there needs to be careful choice of the subject for the public engagement, as well as commitment and capacity on behalf of the sponsoring body or agency to use the results in a constructive way. A recent example from the EPSRC offers an illuminating case study. Here, a public dialogue on the potential applications of nanotechnology to medicine and healthcare was explicitly coupled to a decision about where to target a research funding initiative, providing valuable insights that had a significant impact on the decision.

This initiative was part of a new approach to science funding at EPSRC, where I act as Senior Strategic Adviser for nanotechnology. 'Grand Challenge' projects are large, goal-oriented interdisciplinary activities in areas of societal need. One of these was in the area of applications of nanotechnology to healthcare and medicine, within the £50m strategic Cross-Council Nanotechnology Initiative. This is a potentially huge area, so it was felt

necessary to narrow the scope of the programme before asking the scientific community for research proposals. EPSRC drew on its Strategic Advisory Team – an advisory committee with about a dozen experts on nanotechnology, drawn from academia and industry, and including international representation. There was also a wider consultation with academics and potential research 'users', defined here as clinicians and representatives of the pharmaceutical and healthcare industries, and a 'Town Hall Meeting' open to research and user communities.

This is a fairly standard approach to soliciting expert opinion for a decision about science funding priorities. Given the public engagement around nanotechnology up to this point, it seemed natural to ask whether EPSRC should seek public views as well. EPSRC's Societal Issues Panel – a committee providing high-level advice on the societal and ethical context for research – enthusiastically endorsed the proposal for a public engagement exercise on nanotechnology for medicine and healthcare as an explicit part of the consultation leading up to the decision on the scope of the Grand Challenge in nanotechnology for medicine and healthcare.

In the spring of 2008, BMRB, led by Darren Bhattachary, ran a public dialogue on nanotechnology for healthcare. This took the form of a pair of reconvened workshops in each of four locations – London, Sheffield, Glasgow and Swansea. Each workshop involved 22 lay-participants, with care taken to ensure a demographic balance. The workshops were informed by written materials, approved by an expert Steering Committee; there was expert participation in each workshop from both scientists and social scientists. Research Council staff also attended, which was taken by many participants as a signal of how seriously the organisation was taking the exercise.

...Here, a public dialogue on the potential applications of nanotechnology to medicine and healthcare was explicitly coupled to a decision about where to target a research funding initiative.

The dialogues produced a number of rich insights that proved very useful in defining the scope of the final call.[8] In general, there was very strong support for medicine and healthcare as a priority area for the application of nanotechnology, and explicit rejection of an unduly precautionary approach. On the other hand, there were concerns about who benefits from the expenditure of public funds on science, and about issues of risk and the governance of technology. One overarching theme that emerged was a strong preference for new technologies that were felt to empower people to take control of their own health and lives.

One advantage of connecting a public dialogue with a concrete issue of funding priorities is that some very specific potential applications of nanotechnology could be discussed. As a result of the consultation with academics, clinicians and industry representatives, six topics had been identified for consideration. In each case, people at the workshops could identify both positive and negative aspects, but overall some clear preferences emerged. The use of nanotechnology to permit the early diagnosis of disease received strong support, as it was felt that this would provide information that would enable people to make changes to the way they live. The promise of nanotechnology to help treat serious diseases with fewer side effects by more effective targeting of drugs was also received with enthusiasm.

On the other hand, the idea of devices that combine the ability to diagnose a condition with the means to treat it, via releasing therapeutic agents, caused some disquiet. This was seen as potentially disempowering. Lower down the list of priorities were applications of nanotechnology to control pathogens, for example

One overarching theme that emerged was a strong preference for new technologies that were felt to empower people to take control of their own health and lives.

through nanostructured surfaces with intrinsic anti-microbial or anti-viral properties, nanostructured materials to help facilitate regenerative medicine, and the use of nanotechnology to help develop new drugs.

It was always anticipated that the results of this public dialogue would be used in two ways. Their most obvious role was as an input to the final decision on the scope of the Grand Challenge call, together with the outcomes of the consultations with the expert communities. It was the nanotechnology Strategic Advisory Team that made the final recommendation about the call's scope. Its recommendation was that the call should be in the two areas most favoured in the public dialogue – nanotechnology for early diagnosis and nanotechnology for drug delivery. In addition to this immediate impact, the projects funded through the Grand Challenge will be expected to reflect these findings in how they are carried out.

Public engagement in an evolving science policy landscape

The current interest in public engagement takes place at a time when the science policy landscape is undergoing wider changes, in the UK and elsewhere. We are seeing considerable pressure from governments for publicly funded science to deliver clearer economic and societal benefits. There is a growing emphasis on goal-oriented, intrinsically interdisciplinary science, with an agenda set by a societal and economic context rather than by an academic discipline – 'mode II knowledge production' – in the phrase of Gibbons and colleagues.[9]

The 'linear model' of innovation – in which pure, academic science, unconstrained by any issues of societal or economic context, is held to lead inexorably through applied science and technological development to new products and services and thus increased prosperity, is widely recognised to be simplistic at best, neglecting the many feedbacks and hybridisations at every stage of this process.

These newer conceptions of 'technoscience' or 'mode II science' lead to problems of their own. If the agenda of science is to be set by the demands of societal needs, it is important to ask who defines those needs. While it is easy to identify the location of expertise for narrowly constrained areas of science defined

by well-established disciplinary boundaries, it is much less easy to see who has the expertise to define the technically possible in strongly multidisciplinary projects. And as the societal and economic contexts of research become more important in making decisions about science priorities, we need to consider how to scrutinise the social theories of scientists. These are all issues which public engagement could be valuable in resolving.

The enthusiasm for involving the public more closely in decisions about science policy may not be universally shared, however. In some parts of the academic community, it may be perceived as an assault on academic autonomy. Indeed, in the current climate, with demands for science to have greater and more immediate economic impact, an insistence on more public involvement might be taken as part of a two-pronged assault on pure science values.

As traditional gatekeepers between the experts and the public, media might not be sympathetic to such new forms of engagement. Then there are some who consider public engagement more generally as incompatible with the principles of representative democracy. Their view would be that the Science Minister is responsible for the science budget and he answers to Parliament, not to a small group of people in a citizens' jury. It is also clear that public engagement, done properly, is expensive and time-consuming.

Many of the scientists (me included) who have been involved with public engagement, however, have reported that the experience is very positive. In addition to being reminded of the generally high standing of scientists and scientific enterprise in our society, they are prompted to re-examine unspoken assumptions and clarify their aims and objectives.

There are strong arguments that public deliberation and interaction can lead to more robust science policy, particularly in areas that are intrinsically interdisciplinary and explicitly coupled to meeting societal goals. What will be interesting to consider as more experience is gained is whether embedding public engagement more closely in the scientific process actually helps to produce better science.

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6

Reflections from participants

Debbie Perry and Laura Bowater

Debbie Perry

This is an edited version of a talk given by Debbie Perry at the launch of the Nanodialogues report in June 2007.

As someone who enjoys voicing their opinions on various topics, I was delighted to be invited to engage in the Nanodialogue on nanoparticles and the environment. Bar the impending Olympics, there aren't many plus points to living in E17 but, on this occasion, the location enabled me to become part of an interesting group of people from East London asked to take part in this public debate.

As a humble member of the general public, to be given the opportunity to participate in discussions with university lecturers, representatives of key organisations such as Greenpeace and key scientists on a subject hitherto hidden away from public view was a great honour.

I'm a PA in the City working predominantly in banking. Other members of our group included a retired financier, a mature student, a full time mum and a specialist nurse at St Mary's Hospital.

As part of our discussions we would split up into sub-groups and then re-assemble as part of the main group of 13 to discuss and share our findings. Our group saw two areas as particularly important – health and the environment.

A popular moisturiser widely advertised in magazines and on TV was passed around the group and we were asked to rub it into our skin as it contained 'nanoparticles' which were claimed to make our skin softer and wrinkle-free. We were prepared not to question the safety aspect of putting a cream containing an unknown substance onto our skin just because the power of advertising and attractive packaging said it was OK to do so. Would we be so gullible if we had access to more in-depth information on nanoparticles and the potential risks to our health?

In healthcare, the pros appear to relate to the apparent precision of using nanotechnology in medical research. Apparently, nanotechnologies could enable us to grow body tissue both inside and outside the body. Damaged body parts could be replaced by stronger and lighter implants coated with nanomaterials which could prevent the body from rejecting them.

The cons relate to potential toxicity of nanoparticles within the human body. We discussed the implication of natural versus manufactured nanoparticles. There was concern that the injection of loose nanoparticles into the human body and the environment as opposed to those that were fixed could cause unseen damage over a period of time, although no specific conclusions could currently be drawn as studies are still in their relative infancy.

For the environment, nanotechnology seemed to provide better ways to generate energy and new ways to clean up an extremely polluted planet. But we were concerned about how potentially damaging eating or breathing in millions of nanoparticles could prove to be, even though nanoparticles currently exist in nature in volcanic ash, ocean spray, clouds and forest fire smoke. (All that information was gleaned from the Science Museum website by the way!)

I found it an inspiring and rewarding experience - a once-in-a-lifetime opportunity to engage in discussions to make me aware of a subject **which affects me, my family and future generations to come.**

Since the actual series of discussions took place, I am disappointed not to have seen articles in the press referring to nanotechnology. I feel the broadsheets would be best placed to tackle this subject, providing the information was presented in a comprehensive format. I fear The Daily Mail would present a 'the end of the world is nigh' scenario which would hardly be ideal PR for such a sensitive and still relatively unknown topic!

I caught a 30 minute Open University programme on BBC2 at midnight one evening (thanks to a bout of insomnia!) which, as expected, focused on the Patrick Moore aspect of nanotechnology and its molecular structure as opposed to how it relates to people in everyday life.

Some months later, the chance for a mini representation to visit Defra arose to give us the opportunity to register our concerns with civil servants. This proved challenging as any Government meeting would! We wanted to address the lack of information available to the public and requested that the team made the necessary findings available via a variety of sources like their website.

In conclusion, I found it an inspiring and rewarding experience – a once-in-a-lifetime opportunity to engage in discussions to make me aware of a subject which affects me, my family and future generations to come. I sincerely hope, as a result, that a great deal more information is made widely available to the man, woman and child in the street. Nanotechnology exists here and it exists now.

Laura Bowater

When I became involved in the *community x-change* project, I had been working as a microbiologist at the John Innes Centre for eight years. Like all career scientists I was a specialist in my own specific research area, but unlike a lot of scientists I had always been interested in talking to the public about research that my colleagues and I were doing.

The idea behind community x-change is that members of the public help design the process of dialogue. Our project focussed on the environment, trying in particular to get the views of under-represented people. I was

keen to be involved. I felt that the environment was a hugely important issue that should be discussed in a public forum. As a society we have an obligation to take decisions that will have a positive outcome to our global environment. I entered the dialogue believing that this fundamental issue needs everyone within our society to work together. The x-change project was one opportunity to listen to less well-represented groups' thoughts and concerns.

I really connected with the idea that this project was an opportunity to get our voices heard. I feel that the concerns of the public should be listened to and addressed by policy makers or people who influence decision-making. Creating a video recording of the process provided the opportunity to make our thoughts and concerns known to policy makers, giving us a real feeling of empowerment.

The project was keen to involve scientists but I was initially concerned that I wasn't an environmental scientist and would not be able to enter the project as an expert on environmental issues. Taking part would mean leaving my specialisation behind. I was becoming a member of the public who just happened to be a scientist.

I realised that taking part in this type of forum would be a very different experience to any public engagement activities that I had done in the past. I had done one-way engagement where I shared my enthusiasm and my interest in science and research with the public. The community x-change programme would introduce me to the concept of dialogue.

What I learnt from taking part

The project took place over four days in the summer of 2006 in a Norwich community centre. It involved 39 local participants from all parts of the community, including homeless young men, ethnic minorities and people who could not speak English. I was one of eight scientists. Six young people who had taken part in the Peterborough Living Lens Community project created a series of short videos to report on the project.

I quickly realised that this was a completely different experience from any public engagement event that I had done before. The community x-change brought together people from different cultures and communities who would otherwise never have come in to contact with each other. I became aware that we spend huge amounts of our lives in

I became aware that we spend huge amounts of our lives in tiny parts of society and we each have very strong preconceived ideas about other parts.

tiny parts of society and we each have very strong preconceived ideas about other parts. These ideas are, for the most part, based on a lack of information, misinformation and a reluctance to step outside our comfort zone. Working in small groups, this project was designed to break down barriers and encourage the exchange of everyone's views and concerns.

Through taking part in this process it became apparent that my perception of issues of environmental change was sometimes very different from that of others. To me, environmental issues are synonymous with the global issues attached to future climate change. Working with others in these group sessions made me aware that environmental issues for many people are much closer to home and are impacting on their lives in the present. These impacts included lack of local facilities, lack of a transport infrastructure, concerns about crime and the feeling of isolation that many people feel within our society.

Within a small group setting we were encouraged to turn these issues into questions and suggest candidates who would be able to provide us with more information.

As a group we spent the final day of the workshop talking to these local information providers who had been recruited to the project – a councillor, an MP, environmental businesses and others. This seemed really empowering for the group. We had people who had taken the time to talk to us but importantly we had people who listened to us too. This was the first time that this had happened to most of the people there, including me, within the programme, and it was a hugely positive experience.

What I have taken away from the experience

Projects like this require a lot of time, energy, money and research to ensure that people within under-represented communities can be reached and given an opportunity and a forum to

discuss science. Participating within this forum brought home to me that I live in a bubble of 'middleclassity' and I share this bubble with my colleagues, my family and my friends. I live a privileged life in which I am able to have concerns about future global issues.

For many people, because of their circumstances, their issues and concerns are centred on the local environment where they live, work and they raise their children. Their environment is completely different to my own. As a science communicator, I realised that the people that I had tended to interact with shared this 'middleclassity' bubble. Most of them already have an interest in science and research.

Participation processes such as the community x-change are hugely valuable and can be empowering. I felt empowered to change my role from a scientist who communicates science to a scientist who discusses science with a more diverse public. I am keen to begin to engage with less well-represented members of my community. I see it as a very real way to break down the preconceptions that many people have of what a scientist is. I hope that I can become someone who seems less removed from society and can help science become more accessible.

Finally, I believe that upstream, participatory dialogue workshops are the standard we should strive for. But if we offer people empowerment and we encourage communities to participate and to find a voice, we have to listen, even if it is not what we want to hear, and we have to act. We cannot feel content just facilitating the process of dialogue. If nothing changes, I feel we will end up with a society that feels less valued, more blatantly ignored and increasingly disenfranchised.

7

Science and the web

Charles Leadbeater

Imagine for a moment that the world is like a beach that is divided into just two kinds of organisations: some that are boulders and others that are pebbles.

In many industries, especially those like science that depend on the orderly publication of information, until very recently the world was dominated by boulders.

Boulders came into being because media had high fixed costs such as print plants for newspapers and studios for television. Resources, like broadcast spectrum, were scarce. All that created high barriers to entry. Rolling a new boulder onto the beach took lots of people, money and machinery. You could be seen coming from a long way off.

In science – which depends on a cycle of research, peer review, publication, citation and critique – the boulders meant everything remained reasonably orderly. Authors submitted reports of their results to a publication for peer review. Once their article was accepted it was published in a journal and stored by a library.

Now imagine the scene on this information rich beach in five years time. A few very big boulders are showing. But many have been drowned by **a rising tide of pebbles.**

Now imagine the scene on this information rich beach in five years time. A few very big boulders are showing. But many have been drowned by a rising tide of pebbles. Every minute hundreds of thousands of people come to drop a pebble on the beach. Some of the pebbles are very small: a blog post or a comment on YouTube. Others are larger: a piece of code for a complex open source software programme like Linux. A bewildering array of pebbles in different sizes, shapes and colours are being laid down the whole time, in no particular order, as people feel like it. Many of these pebbles will be pieces of scientific research, data, half formed ideas, simulations still in progress, observations recently made, results just in.

All media and information businesses in future will be based on organising pebbles to some extent. Google and other intelligent search engines offer to help us find the pebble we are looking for. Wikipedia is a vast collection of factual pebbles. YouTube is a collection of video pebbles; Flickr of photographic pebbles. Social networking sites such as Twitter, Facebook, MySpace and LinkedIn allow us to connect with pebbles who are friends or people with shared interests.

Will something like this happen to the way scientific research and publishing is organised? And what will that mean for the way science is debated, understood, challenged and even enacted by citizens as well as the professionals?

Science is one of the oldest publishing businesses. The boulders of scientific publishing will continue to be important for some time yet, just as millions of people still listen to radio, watch television and read newspapers. But even within the world of the boulders there will be change. Thanks to the web, professional science is likely to become ever more collaborative and as a result probably more open as well.

To understand why, just take a brief glimpse at the working practices of young scientists, especially in emerging fields like bioinformatics, where traditions and hierarchies are less entrenched. They often start their research not with a hypothesis but with a target gene or a condition to explore.

They begin by drawing in data from hundreds of public databases, held in multiple institutions and scour for relevant information using a variety of highly sophisticated, open source

search engines, which will become available to ordinary users of the web in due course. Before these scientists conduct any real experiments they will simulate experiments using powerful computers and open source simulation programmes to narrow down their field of inquiry.

The research will be done by highly collaborative teams, almost certainly international in reach and probably crossing several disciplines. Many of the researchers will exchange ideas and information using wikis and social networks akin to Facebook and LinkedIn. Results will be published to the web daily using electronic web notebooks and when the research is complete it will be published in an online, open access journal, along with all the data and the software tools used to analyse it.

The science boulders of the future – big research efforts, university departments, funding councils, scientific publishers – will have to be reorganised to promote this kind of highly collaborative, open science. This will mean change even for the very biggest and best of the boulders. For publishers it will mean focussing less on the publication of information and more on the provision of the kinds of tools, forums, networks and software that will allow new forms of collaborative science. For research funders it will mean new ways to fund scientific collaboration that stretches across borders and disciplines.

In time, perhaps, even new kinds of multidisciplinary scientists and research institutes might develop. Even the boulders that survive the rising tide of the pebbles will do so only because they have mutated so that in some respects they resemble the pebbles that seem to threaten them. That is bound to make science, even as it is practised in traditional scientific institutions, more open. Efforts to open up science to more public involvement and scrutiny will be more likely to succeed if they take account of and use these trends to their advantage.

The other big change, however, and one that is much more difficult to predict the course of, will be the growth of science among the pebbles. The citizens, consumers and workforce of the near future will have grown up using the social web to search for and share ideas with one another. They will bring with them the web's culture of lateral, semi-structured free association.

...in the future, aspects of astronomy will depend on dedicated **amateurs working in tandem with professionals**, motivated by a shared sense of excitement about exploring the universe.

They will not just want information about science and the opportunity to debate. They may also want to enact aspects of science, just as YouTube has brought to millions the opportunity to become broadcasters and performers. They will want to contribute not just to comment.

More sciences will acquire a following of citizen scientists who will work alongside the professionals. Astronomy is a prime example. Like most sciences, astronomy started with amateurs. When Copernicus moved the sun to the centre of the universe he was only a part-time astronomer. Johannes Kepler, who discovered that planets orbit in ellipses, made most of his money from horoscopes.

Yet by the 20th century the pendulum had swung decisively in favour of professional astronomers who had access to huge telescopes, like Jodrell Bank in the UK or the Mt Wilson Observatory near Pasadena where Edwin Hubble determined that the galaxies are being carried away from one another. Professionals probed the outer depths of space; amateurs concentrated on brighter, closer objects they could see with their puny telescopes.

That all changed with three linked innovations that gave pro-am astronomers cheap and powerful tools: digital telescopes; light sensitive computer chips that could record faint starlight much more clearly than a traditional photograph; the internet, which vastly amplified this distributed capacity for exploration by helping pro-ams to work together.

Global research networks have sprung up, linking professionals and amateurs with shared interests in flare stars, comets and asteroids. Groups of pro-am astronomers tracked the weather on Jupiter, found craters on Mars and detected echoes from colliding galaxies as accurately as professionals.

Amateurs may not be able to produce new theories of astrophysics and sometimes do not know how to make sense of the data they have collected. An amateur did not write A 'Brief History of Time'. Yet in the future, aspects of astronomy will depend on dedicated amateurs working in tandem with professionals, motivated by a shared sense of excitement about exploring the universe. More scientists may find themselves motivated to go down the same path.

Biology may be a prime and potentially troubling one. The 20th century was dominated by what physicist Freeman Dyson calls 'gray sciences' which created machines that made us more powerful: the car, the plane, the steel mill, the generator.

In this century the focus for funding and research will shift to living, complex systems. Dyson argues it will not take long for the tools of biotechnology to spread from the laboratory into people's homes, giving millions of amateur plant and animal breeders new tools to work with. Gardeners will be able to breed their own roses or orchids by splicing gene sequences together. Pet breeders will be able create their own kinds of dogs and cats. Farmers will be able to make their crops more resistant to local conditions and more productive.

That is all the more likely if biotechnology becomes a branch of the software industry. Programmes for synthetic biology could easily be shared as software is now. Drew Endy, a professor at MIT, is already teaching his students how to build custom made bacteria by clicking together a set of 'bio-bricks' that are available open source through his BioBrick Foundation. The equipment for a DNA lab can be bought on eBay and fitted into an average garage. 'Make' magazine, the bible for America's home inventors, has already shown its readers how to do what it calls 'backyard biology'.

Many will be alarmed at the prospect of engineering new biological parts and system and putting new power to create and destroy life into the hands of rogue scientists and madcap amateurs. Software programmes with bugs can be recalled and rewritten; real world viruses cannot. Yet synthetic biology also offers the prospect of huge advances: carbon-free fuels made from biomass, cheaper drugs manufactured in cells.

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Whether more open, collaborative sciences like synthetic biology turn out to be mainly creative or destructive will depend not just on the science, but on our social organisation, on how the knowledge is owned and controlled. In the long run, open and collaborative approaches, with effective self-regulation and the involvement and review of peers and citizens, will be better for good science and our security than either state control or private ownership.

The big challenge of the future will not be to apply the techniques of citizen review to traditional, closed forms of professional science. The big challenge will be the control and use of highly distributed forms of scientific knowledge as it flows out of scientific institutions into society.

The big opportunities may not be either in remaking the boulders or trying to gather up the pebbles to create mass. The big opportunities may lie in creating new relationships between boulders and pebbles. Schools and universities are boulders that increasingly deal with students who want to be in the pebble business, drawing information from a variety of sources, sharing with their peers, learning from one another.

Barack Obama made it to the White House thanks to a campaign that took organising the pebbles to new heights.

The biggest opportunities in science may be in the same area between the boulders and the pebbles, in the interaction that combines collaboration among cross-disciplinary teams of professionals with greater involvement of citizens, not just in debating what science should do, but enacting it, trying it out, testing and adapting new applications and technologies. The field of knowledge will be much more chaotic and in some ways unruly. But it will also be far richer and more productive.

The culture the web is creating and the kinds of organisations that will emerge from that culture can be reduced to a single, simple design principle: call it the principle of With.

The web invites us to think and act *with* people, rather than *for* them, on their behalf or doing things to them. The web is an invitation to connect to other people with whom we can share, exchange and create new knowledge and ideas.

These common and widespread experiences of being done *to* and *for* stem from deeply rooted assumptions that: knowledge and learning flows from specially designated experts to people in need; organisational hierarchies are based on the power and the knowledge to make decisions; centralised authority is exercised top-down. Knowledge is largely instrumental and rational: it allows us to master, plan and control our environment.

The web is creating a world that works to the logic of With – an unstructured, lateral, free association of people and ideas. The principle of doing things *with* people rather than to or for them will breed very different organisations, services, ways of working, cultural artefacts and experiences in virtually every field, including science.

The underlying principles of With are quite different from those of To and For. Knowledge and learning can be co-created, come from many sources, often from committed pro-ams. Organisations will increasingly resemble networks, partnerships and collaborations. This includes science, which is naturally collaborative, cross disciplinary, international and open.

The next few decades in field after field, from politics to science, commerce to culture, public and private, we will witness and get caught in the interplay between these two forces: the familiar but dysfunctional world in which things are done To and For us versus the emerging, elusive and potentially revolutionary world in which we think and work With one another. Science will find itself caught right in the middle of this struggle.

8

Why turning out brilliant scientists isn't enough

Lord Robert Winston

2009 sees the 50th anniversary of C. P. Snow's influential Rede lecture on the 'two cultures', in which he argued that the breakdown of communication between the sciences and the humanities was a major hindrance to solving the world's problems. One of his premises - that those problems would be solved by better science - now seems a little naive. However, his point that the sciences and humanities need to learn to communicate better, and people to understand each other better across the divide, is as pertinent as ever.

In the UK, the issue of how scientists engage with - and, crucially, listen to - the public has become increasingly prominent since the House of Lords' 'Science and Society' report. Before this, many believed that for people to trust more in the value of science, it would be enough for scientists simply to educate the public. These days it is widely understood that fostering public engagement - rather than just mere public understanding - is of key importance. This makes sense. Most scientific research in the UK is paid for by the taxpayer, and when technologies have a negative impact the consequences can be profound for everyone.

The scientific knowledge we pursue is public property. We scientists have a duty not merely to tell people what we are doing (a skill not taught as well as it should be in most universities), but also to listen to people's fears and hopes and respond to them, even when we feel their antagonism to be ill-founded. Being open in this way has been shown to have real advantages.

A good example is the success of the Sciencewise-ERC initiative, which uses public dialogue to help policy makers reach better decisions about science and technology issues. A two-way dialogue - communication in the fullest sense - seems more likely than a one-way lecture to lead to a maturing of views and resolution of conflict. It can help scientists to accept that some public concerns may be justified, and that recognising them can improve their science; and it makes the public aware of the good intentions of scientists. If we show that we care about the ethical implications of our work, people are likely to be more sympathetic.

Dialogue has been shown to be a much more constructive and valuable process than the consultations and opinion polls that policy makers previously relied on, and has been very successful in public discussions about embryology and nanotechnology. If we show we care as scientists about the ethical implications of our work, people are likely to be more sympathetic.

The science community as a whole is starting to acknowledge that it must interact with the public more fully. When I started making science television programmes, I was frequently accused of dumbing down. After the BBC transmitted my television series 'The Human

Too few science undergraduates explore the ethical issues of their subject, and **young scientists often seem to think that they deal in certainty and 'the truth'.**

Body' ten years ago, I was painfully ostracised at scientific meetings and at the Royal Society, even though the programme was seen by about 19 million people in its first weeks and widely used as teaching material in schools.

Now it is a delight that TV science programmes by colleagues such as Jim Al-Khalili, Marcus du Sautoy and Kathy Sykes are seen by many scientists as valuable contributions to public engagement. We need to do much more. We have a duty to conduct research to ensure that the ways we attempt to engage really do have an impact, yet there is still no consensus on the best way to conduct such studies. In the UK we must make certain that the increasing sums of money that bodies such as the Research Councils and the Wellcome Trust are prepared to spend on public engagement are not wasted.

University science education also needs to improve. We turn out excellent scientists and engineers, but their education is not always well-rounded. Too few science undergraduates explore the ethical issues of their subject, and young scientists often seem to think they deal in certainty and 'the truth'. The nature of science is much more complex. In this respect, the Beacons for Public Engagement initiative (funded by UK Higher Education Funding Councils, Research Councils UK and the Wellcome Trust) should be valuable, encouraging university students to be more involved with societal issues and researchers more open about their science and its implications. C. P. Snow may have been right in arguing for better connection between science and the arts, but not necessarily right about identifying two distinct cultures.

The remarkable creativity of science is an integral part of human culture and it needs to be thought of in this way. We scientists can help bring this about by engaging with the wider world about what we do and its implications for society. We need to show that we too have human values. Snow would surely have approved.

This is an edited version of an article that originally appeared in 'New Scientist' magazine, February 2009.

This collection looks to the future of public dialogue with science. It brings together some of the UK's leading thinkers and practitioners in the space between science and society to ask where we have got to, how we have got here, why we are doing what we are doing and what we should do next.

www.sciencewise-erc.org.uk