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Introduction

Public engagement in an evolving science policy landscape

WHY PUBLIC ENGAGEMENT WITH SCIENCE MATTERS

Many scientists think what they do is more important than anything else in the world. Science, in their view, is a system that provides an unrivalled way of thinking about the universe. They see the last five hundred years as a story of a world improved, indeed transformed, through science, and they look forward to a future defined by science's further advances. When we talk about the importance of communicating science, this enthusiasm of scientists for the intellectual, historical and practical importance of their subject is a good place to start. So, for many, it is with conveying the passion for science that science communication should begin. The Triple Helix, an undergraduate-run worldwide forum for science in society, and the Open Research Laboratory at the Munich Deutsches Museum described in other chapters of this book are perfect examples of such enthusiasm-stimulated activities.

This entirely positive view of science is, of course, not universally shared. The perception of a popular antipathy to some aspects of science means that defensiveness, as well as enthusiasm, can be seen as a motivation for communicating science to the public. This aspect of science communication comes to the fore when controversial issues hit the headlines; this gives rise to a reactive mode of science communication, in which it is seen as a tool for coping with science policy crises.

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This reaction can even occur in anticipation of crises, as we have seen with nanotechnology and synthetic biology.

But there is much more to science communication than these two extremes. There are as many motivations for becoming involved in science communication as there are scientists so involved. Certainly, the desire to share one's enthusiasm for the subject is a good reason to want to communicate it, and it is this genuine passion for the subject that marks out some of the most successful media popularisers and evangelists of science. Some science communication is about the popularisation of well-established and uncontroversial science; sometimes, though, the popular media can be used to be provocative, or to advocate a particular point of view about a branch of science which isn't universally agreed on. Some of the most lasting and successful popular works of science fall into this category, being strengthened by the commitment of the author to a single, passionately held, position. If science is to take a central place in our culture, it must be positive when substantive intellectual arguments about science are carried out in the public domain. However, this presupposes that the difference between settled opinion and legitimate controversy, if this is a distinction that it makes sense to make, is made clear to the public and policy-makers, and that they can appreciate and live with the uncertainties resulting from the latter.

The 1985 report from the Royal Society chaired by Walter Bodmer, *The Public Understanding of Science*, brought a new urgency to the question of the communication of science to the public, and stressed a new set of very instrumental motivations for doing this (Bodmer *et al*. 1985). The report stressed that, in an increasingly technological society, it was a social imperative for the public to understand science better. With more widespread scientific literacy, workers would be able to do their jobs better, managers and government would make better decisions, and industry would become more competitive. In their personal lives, people would make better choices about their lifestyles, particularly if they understood risk better.

It may be that increased public understanding of science will lead to a more prosperous country with a healthier relationship to science and technology, but this is a long-term project. In the meantime, it has been crisis management that has caused some of the most urgent thinking about science communication. The acrimony surrounding the public debates about agricultural biotechnology and the Government's handling of the bovine spongiform encephalopathy outbreak led many to diagnose a 'crisis of trust' between the public and the world of science and technology (House of Lords 2000). This led to the idea that science communication should have a central role in maintaining public trust in the science that underpins possibly controversial policy.

A final motivation for science communication with the public stresses the two-way nature of the interaction, suggesting that the scientists involved should learn from the public as well as the public learning from the scientists. This turn to two-way engagement has followed a sustained and influential critique of some of the assumptions underlying the public understanding of science movement by social scientists, particularly from the Lancaster school associated with Brian Wynne (Wynne 2001).

According to the critique of Wynne and colleagues, the idea of 'public understanding of science' was founded on a 'deficit model,' which assumed that the key problem was a public ignorance of both basic scientific facts and the fundamental process of science. If these deficits in knowledge were corrected, it was assumed that the deficit in trust would disappear. To Wynne, this was both patronising, in that it disregarded the many forms of expertise possessed by non-scientists, and highly misleading, in that it neglected the possibility that public concerns about new technologies might revolve around perceptions of the weaknesses of the human institutions that proposed to implement them, and not on technical matters at all.

The proposed alternative was for the scientific community to reflexively engage the public in a genuine dialogue. And the time and place for such dialogue was upstream in the innovation process, while there was still scope to steer its direction in ways that had broad public support. These ideas were succinctly summarised in a widely read pamphlet from the think-tank Demos: *See-Through Science* (Wilsdon & Willis 2004).

The goal of this kind of public engagement with science, then, is to explore with the public what people want from technology in the future, with the aspiration that science and society can work together to shape that future. Seen in this way, public engagement is part of an explicit process of democratising science, in which research priorities and the trajectory of technologies are steered with reference to public values. Public engagement with science, in this view, should be seen neither as simply a way of promoting public support for the inevitable forward march of science and technology, nor as a mechanism by which a concerned public can put the brakes on progress. Rather, it imagines that the future is still open, and that society can have an influence on which of the many possible forking paths science and technology may take as the future unfolds.

In this introduction I will illustrate some of these issues as they have arisen in the context of nanotechnology, which, over the last ten years, has provided an excellent case study of the shift in emphasis from public understanding to public engagement.

THE CASE OF NANOTECHNOLOGY

Nanotechnology, from its very beginnings, has been a discipline in which the relationship between the science itself and the communication of science has been complicated, and often uneasy. The word 'nanotechnology' itself first entered wide circulation as a result of a popular science book, which described it as a potentially revolutionary new technology (Drexler 1986). On the negative side, the idea that the technology might pose serious threats to humanity was crystallised by a magazine article by the computer scientist and entrepreneur Bill Joy (Joy 2000).

Meanwhile, the academic enterprise of nanotechnology gained momentum, driven, in particular, by the announcement in the USA of a National Nanotechnology Initiative beginning in the year 2000. As the science progressed, an increasing divergence became apparent between the perceptions of nanotechnology in popular culture, which derived from science popularisations such as *Engines of Creation* (Drexler 1986) and which were imaginatively developed in science fiction, films and video games, and the directions that scientists in the field were pursuing.

My own involvement in science communication began in response to this divergence. I wrote a book about nanotechnology for the general reader (Jones 2004). My aim was partly to correct what I perceived as widely held misconceptions about the subject, and partly to present my own vision of a nanotechnology inspired by biology, in contrast to the mechanical paradigm which at the time dominated popular conceptions of the subject. Further science communication activities – such as public lectures and a blog – followed.

But what really brought nanotechnology into the public eye in the UK was the fear of another science policy crisis. In 2003, the Prince of Wales made the first of a series of high-profile media interventions that raised fears about nanotechnology (Lean 2004), drawing on a highly negative report from a campaigning NGO with a previous track record of opposing agricultural biotechnology (ETC Group 2003).

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* – was published in 2004, and amongst its recommendations was a whole-hearted endorsement of the upstream public engagement approach: '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.' (Royal Society 2004).

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 (Nanojury 2005). As chair of the science advisory panel, I coordinated the science and industry based witnesses and took part in several sessions myself – thus this was my practical introduction into public engagement, as distinct to traditional science communication.

The *Nanodialogues* took a more focused approach (Stilgoe 2007). 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 (Gavelin, Wilson & Doubleday 2007). 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 UK Engineering and Physical Science Research Council (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. 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 their 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, the market research firm BMRB Ltd, 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. Staff from EPSRC also attended, which was taken by many participants as a signal of how seriously the organisation was taking the exercise.

The dialogues produced a number of rich insights that proved very useful in defining the scope of the final call (Bhattachary, Stockley & Hunter 2008). 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 through nano-structured surfaces with intrinsic antimicrobial or antiviral properties, nano-structured 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. Their 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.

WHERE NEXT?

In the case of nanotechnology, the motivation for much public engagement was the fear of a negative public reaction against what many thought was a promising, and powerful, emerging technology. We are now seeing the same pattern unfolding in the case of other emerging fields. Synthetic biology is one such area, where a series of very well-publicised results from the Craig Venter Institute have ensured a high media profile (Gibson *et al*. 2010). In anticipation of the announcement of the first synthetic organism, two UK research councils, EPSRC and the Biotechnology and Biological Sciences Research Council (BBSRC), had already begun a synthetic biology dialogue (Bhattachary *et al*. 2010).

Synthetic biology, as a topic, has an even more upstream character than nanotechnology. Not only is it very far from clear what applications will emerge from the technology, but the very definitions and underpinning philosophies of the field remain contested (Benner & Sismour 2005), and it remains possible that fundamental barriers may prevent the more optimistic projections for the technology from being realised (Kwok 2010). This has some echoes of the situation with nanotechnology. One negative feature of the nanotechnology debate was the way unlikely and implausible future projections for the technology gained undue credibility as a result of discussions of their potential societal implications. This phenomenon has been dissected by Alfred Nordmann who has criticised the kind of '*ethical discourse that constructs and validates an incredible future which it only then proceeds to endorse or critique*' (Nordmann 2007), and in his contribution to this volume calls for a 'responsible representation', which '*involves determinations of plausibility in light of ongoing trends rather than radical novelty*' and '*requires that communicators take responsibility for their representations by being prepared to defend their credibility*'.

If one danger of public engagement around technologies in their earliest stages is an excessive focus on a set of extreme, and rather unlikely, possible outcomes, another possible response is that people concentrate on wider concerns about emerging technologies in general. If one compares the outcome of the synthetic biology dialogue mentioned above with earlier dialogues about nanotechnology, there certainly seems to be a lot of common ground. The agricultural biotechnology debate which preceded these again appears to share many common characteristics. This suggests that it might be worthwhile systematically to draw out generic responses and lessons for all emerging technologies.

Perhaps the most highly charged areas of science communication arise in those fields where the results have major implications for public policy, and where those results are mediated by a wider variety of mass media with many different agendas of their own. The most important such area – arguably the most important area of science communication of all – is the debate about man-made climate change. Here the idea that simply communicating the results of consensus science to the public would lead to an informed policy debate has been tested to destruction. Instead, we have seen what are allegedly technical arguments being used as a proxy for disputes between quite profound political and ideological differences (Hulme 2009).

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 (Gibbons *et al.* 1994). 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 that 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