Engaging in innovation: towards an integrated science policy

Dr. Tom MacMillan

Executive Director
Food Ethics Council

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Summary

This paper argues that public engagement in science should be seen as an asset to innovation, not as a damage limitation strategy. It focuses on the UK government's ten-year *Science and innovation investment framework*.

The paper is concerned with two key strands of science policy. The first strand is about promoting science and technology. At the centre of recent policy reports on science, including the *Framework*, is the challenge of innovation. Put simply, this is to improve Britain's record at turning research in marketable products. Although the challenge sounds straightforward, the government treats innovation as a complex, non-linear process, involving consumers and business people as well as scientists.

The second strand is about risk and public trust in science. It has only become an issue for science policy over the past ten to twenty years. Within the past five to ten years, there has been a sea change in the way it is understood. Whereas the stress was previously on deficiencies in public understanding, it is now placed on public engagement.

There are 'binary' and 'integrated' versions of the public engagement strand. The binary version focuses on improving communication between the scientific community and the public. It assumes that they are *separate*. The integrated version argues that public concerns about science in contemporary society hit on substantial problems, and should be taken seriously. It treats science and society as *conjoined*.

The binary approach prevails in science policy. However, this paper argues that an integrated approach would be more consistent with current policy thinking on innovation, which recognises that science and technology transfer are non-linear processes that already routinely involve people who are not scientists.

This paper proposes establishing a new Research and Technology Organisation (RTO) to promote public engagement in innovation. RTOs, or technology intermediaries, specialise in innovation. In contrast to the RTOs that already exist in the UK this one would be public, in four senses:

- It would be non-profit organisation with a remit to actively promote and facilitate innovation in the public interest, and to engage citizens in project design.

- It would be directed by a board of stakeholders from government, business and civil society, accountable to the Secretary of State for Trade and Industry and closely advised by a citizen panel.
- Its operation would be transparent to public scrutiny.
- It would obtain a proportion of its funds from central government, sufficient to sustain its commitment to transparency and public engagement.

The new RTO would facilitate innovation and provide expertise in public engagement to businesses, universities and government departments. It would complement commercial RTOs rather than competing with them.

This paper ends by considering the risks associated with establishing a new organisation to help integrate public engagement and innovation.

Dr Tom MacMillan

Food Ethics Council, 39-41 Surrey Street, Brighton BN1 3PB United Kingdom

T: +44 1273 766 654   F: +44 1273 766 653

tom@foodethicscouncil.org   www.foodethicscouncil.org

1. Introduction

This paper is about integrating two key strands of government policy on science.[i] The first strand is concerned with promoting science and technology. The second relates to risk, trust and public engagement in science and technology.

The first strand is what science policy has always been about. Whether the government's aspirations have been military or economic, and whether the science dividend has been thought simple or subtle, the primary aim has been to promote science in a quantity and of a quality that suits the national interest.

The second strand has only recently entered science policy. Of course, science has long been crucial to the state's efforts to manage certain kinds of risk. But the policies governing these activities were not about science, as such. Rather, they were about specific fields of risk, for example drug use, food safety or environmental pollution.

The second strand began filtering into science policy in the late 1980s. Its entry has accelerated during the past decade, spurred by a succession of science-related controversies. These have been unprecedented in the public concern they have provoked, the media attention they have commanded, and the political and economic stakes that have hinged on their resolution.

Some of these controversial episodes, notably the 'mad-cow' crisis, called into question the way that science was *used* in policy. In response, the government has implemented measures to improve its own use of science, not just in one field of risk or one department but across the board.

Other episodes centred on risks and concerns *deriving* from science and technology. The ongoing controversies over genetically modified (GM) crops, mobile phones and stem cell research are prime examples. They have thrown into relief serious public unease with the governance of science and technology, which extends beyond worries that regulators are understating particular risks. Repairing this damage to public trust has become a prominent science policy objective.

By and large, these two strands of science policy are pursued independently of one another. They are assigned to different teams of civil servants and take shape in different documents, some focusing on 'innovation' and others on 'public engagement'.

However, one strand promotes something that the other indicates is subject to considerable public concern. Inevitably they meet. Their intersection is conceived as a delicate trade-off: the nation will only reap the rewards of science and innovation, if public concerns are addressed. Non-scientists are consumers of science and technology and potential future scientists. Society also grants scientists a licence to operate. Unless more effort is made to engage the public in science, popular risk-aversion threatens to scupper the UK's promise to be a global player in science and technology.

This paper argues for a different way of seeing the relationship between these two strands of science policy. It argues that efforts to engage citizens in science – as citizens, not just as consumers or the next generation of scientists – could make a valuable contribution to innovation and to the economy. Public engagement should be treated as an asset to innovation, not a damage limitation strategy.

The next two parts of this paper examine recent policy statements on innovation (Section 2) and public engagement (Section 3). Section 4 distinguishes between 'binary' and 'integrated' variants of the public engagement strand, according to whether they consider science and society to be separate or conjoined. Whereas the binary version prevails in science policy, Section 5 argues that the integrated version of the public engagement strand is intellectually and practically more consistent with the government's approach to innovation policy. Section 6 makes one concrete proposal for integrating public engagement and innovation policy. The conclusion highlights a number of risks associated with weaving these two strands of policy more closely together.

2. Innovation

Science policy has always been about promoting science and technology in the national interest. The pursuit of knowledge has come second to more temporal understandings of the national interest, usually in military or industrial terms. The priority accorded to different notions of the national interest has changed over the years. Since the Cold War, for instance, fortress Britain has lost ground to UK Plc (Figure 1). The government's ten-year *Science and innovation investment framework*, published alongside the July 2004 *Spending review*, lays out current thinking about science and the economy:

> Harnessing innovation in Britain is key to improving the country's future wealth creation prospects. For the UK economy to succeed in generating growth through productivity and employment in the coming decade, it must invest more strongly than in the past in

its knowledge base, and translate this knowledge more effectively into business and public service innovation. The Government's ambition, shared with its partners in the private and not-for-profit sectors, is for the UK to be a key knowledge hub in the global economy, with a reputation not only for outstanding scientific and technological discovery, but also as a world leader in turning that knowledge into new products and services. (HMT/DfES/DTI, 2004: 5)

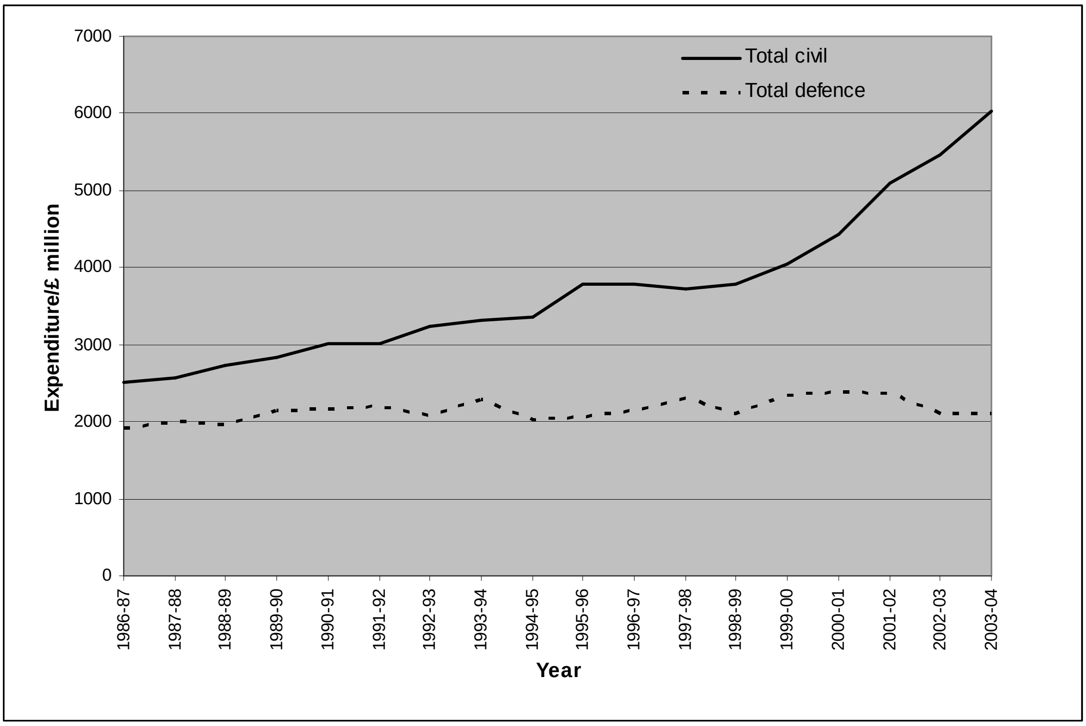

Figure 1: Net UK government expenditure of science, engineering and technology in cash terms, 1986-87 to 2003-04. Source: OST (2003).

The major policy reports on science and the economy published since 2000 converge on the challenge of innovation: how to improve "Britain's poor record in turning its established strengths in basic research into marketable products and commercial success…" (Lambert, 2003: 15; Table 1).

Year	Title
2004	*Science and innovation investment framework 2004-2014* (HMT/DfES/DTI, 2004) *Science and innovation: working towards a ten-year investment framework* (HMT/DTI/DfES, 2004)
2003	*Competing in the global economy: the innovation challenge* (DTI, 2003) *Lambert review of business-university collaboration* (Lambert, 2003)
2002	*SET for success: the supply of people with science, technology, engineering and mathematics skills* (Roberts, 2002) *Investing in innovation: a strategy for science, engineering and technology* (DTI/DfES/HMT, 2002)
2000	*Excellence and opportunity: a science and innovation strategy for the 21s century* (DTI, 2000)

Table 1: Major reports on science and the economy published or commissioned by government since 2000.

To illustrate this challenge, several of these reports compare the UK's international ranking in research indicators with its economic performance. We come second only to the US in our share of world citations and produce the third highest number of journal articles (HMT/DTI/DfES, 2004: 17). This is no mean feat because we spend a lower proportion of Gross Domestic Product (GDP) on research and development (R&D) than twelve other leading research nations and we have the smallest pool of scientists in the G8. Yet the UK's performance in exploiting this research base through innovation has been mediocre. By indicators of innovation, such as business spending on R&D as a proportion of GDP and per capita patenting rates, the UK is average for the EU and sub-average for the OECD (DTI/DfES/HMT, 2002: 23, HMT/DTI/DfES, 2004: 11, 25). One recent report offers a more direct comparison: whereas the "UK has a citation rate that is 53 per cent higher per capita than Germany… Germany makes 230 per cent more patent applications per capita than the UK" (Lambert, 2003: 87).

Whilst the *Framework* and its recent antecedents consider it essential to maintain and improve the UK science base, 'knowledge transfer' to businesses is therefore a major concern for them. The notion that innovation involves the linear flow of ideas from organisations that 'do' science to organisations that 'apply' it has long been lambasted by academics (for an analytical review see Edgerton, forthcoming). The concept of knowledge transfer in contemporary UK science policy embodies much of this critique. Two aspects of the complex picture of science and innovation presented in policy are particularly important to this discussion.

First, current policy thinking explicitly recognises that innovation is a non-linear process. The *Lambert review of business-university collaboration*, which addressed the challenge of knowledge transfer, states that:

> Innovation processes are complex and non-linear. It is not simply a question of researchers coming up with clever ideas which are passed down a production line to commercial engineers and marketing experts who turn them into winning products. Great ideas emerge out of all kinds of feedback loops, development activities and sheer chance (Lambert, 2003:12)

Pharmaceutical R&D provides a good example of this kind of iteration. A new drug might be revised in light of clinical trials that take place after the product has been initially formulated. Around 40% of pharmaceutical industry R&D spending is in the clinical phase (HMT/DTI/DfES, 2004: 37).

Second, multiple actors are involved in science and innovation. It follows directly from the insight that innovation is non-linear that there can be no strict division of labour between people who come up with knowledge and people who turn it into products. But science and innovation involve many other actors besides. The DTI's 2000 White Paper on *Excellence and opportunity: a science policy for the 21st century* highlights the "vital role" that consumers play in innovation:

> Consumers do not stand at the end of the scientific pipeline passively waiting to consume new products. They are agents in the process of innovation. Innovations only succeed when they are taken up by consumers, who in the process of using a new product often discover or even create uses for it that the original inventors never deemed possible. (DTI, 2000: 48)

The White Paper lists the telephone and the internet as technologies in which consumer agency has played a major formative role.

The government recognises many other features of innovation in addition to these two. For instance, the *Framework* makes a number of new commitments intended to increase the availability of skilled scientists and support staff (HMT/DfES/DTI, 2004: 81-102). This responds to an ongoing challenge identified in the *Roberts review* of the supply of people with science, technology, engineering and mathematics skills, which "found evidence of emerging shortages to R&D employers" of skilled scientists and engineers, and concluded "that these emerging shortages will act to constrain R&D and innovation in the UK" (HMT/DTI/DfES, 2004: 29, Roberts, 2002). The *Framework* also examines how the public sector might leverage upwards business spending on and demand for R&D (HMT/DfES/DTI, 2004: 53-80).

The purpose of this section has not been to provide an exhaustive analysis of the way that innovation is understood in recent policy statements. It simply illustrates that the government treats innovation as a complex process that is non-linear and involves multiple actors.

3. Public engagement

The second key strand of science policy is about risk, trust and public engagement in science. The use of science in regulating risks, including technological risks, only recently became an issue for science policy. This new strand has emerged out of a growing awareness amongst policy makers, the scientific establishment and social researchers that the governance of science and its use in policy are widely distrusted. This concern rocketed up the agenda in the late 1990s as controversies arose around the handling of Bovine Spongiform Encephalopathy (BSE) and GM foods.

The Bodmer report on *The public understanding of science*, published by the Royal Society in 1986, first drew the attention of the policy community to public unease about science and technology (Bodmer, 1986). It attributed this disquiet to public ignorance and scientific illiteracy. Following the 1993 White Paper, *Realising our potential*, this 'deficit model' was taken up by government departments and the research councils (DTI, 1993).

The deficit model made much of the difference between 'real risks', as assessed by scientists, and the 'perceived risks' that gave rise to public disquiet, implying that public information and education in science was the remedy for mistrust. The Royal Society, together with the Royal Institution and the British Association for the Advancement of Science, established a committee on the public understanding of science (CoPUS) to promote this agenda.

When CoPUS commissioned a poll in 1996 to chart the success of its first decade of public education, it found the level of illiteracy unchanged (Miller, 2001). Meanwhile, social research had shown that people's willingness to memorise scientific facts, CoPUS's main measure of literacy, bore little relation to their confidence in scientists and government (Wynne, 1992).

A report published in March 2000 by the House of Lords Select Committee on Science and Technology tipped policy thinking decisively away from the deficit model (House of Lords

Select Committee on Science and Technology, 2000). The report described a “crisis of confidence” in the governance of science and technology, rather than in science as such. It found that this crisis became manifest when there was conflicting scientific evidence and where debate was couched only in terms of risk, sidelining ethical, social and economic concerns.

The Select Committee argued that the concerns of non-scientists about science and technology were not just about risk, but included broader questions:

- How much choice will they have over the way a technology affects them?
- Will the risks and benefits be distributed fairly?
- How have the actors involved behaved in the past?
- Is it clear who will be accountable if something goes wrong?

The crisis of confidence related to an erosion of public trust in the institutions handling risk, science and technology, particularly when they downplayed concerns such as these as irrational or glossed over apparent uncertainties (OST/Wellcome Trust, 2000, POST, 2001).

Since the Select Committee report was published, the deficit model has fallen out of favour in policy. Programmes to promote the ‘public understanding of science’ have been reformulated as ‘public engagement’ and ‘science in society’ initiatives. Where they previously emphasised the one-way flow of knowledge from scientists to the public, they now stress the need for dialogue.

Despite a marked shift in the language of policy, this has not been simply a matter of out with the old and in with the new. Rather, there are alternative critiques of the deficit model, associated with ‘binary’ and ‘integrated’ variants of the public engagement strand. The binary version assumes that science and society are separate. It attributes the current crisis to shifts in the way that science is represented and communicated in society. In particular, as in the controversy over GM crops, increasingly powerful media interests and campaign groups are accused of exploiting public unease about technology. For instance, in a speech to the Royal Society in 2002, the Prime Minister accused a “small band of people”, opposed to certain technologies, of attempting to stifle rational debate (Blair, 2002). He argued that in some cases reasonable public concerns about science “descend into a fear, which is amplified by parts of the media” (Blair, 2002). The major learned societies are also concerned about media reporting, setting up a Science Media Centre at the Royal Institution (MORI, 2002). In this view, public engagement is mostly about improving communication, and less about acting on the substance of public concerns.

The integrated version assumes that science and society are conjoined, and have 'co-evolved' (Jasanoff and Wynne, 1998). It attributes the crisis of public confidence to changes in science and governance, rather than to shortfalls in communication. It argues that the relationship between science and policy has shifted markedly in recent decades. We live in an age when the 'manufactured risks' of technology exceed the risks of 'natural hazards' (Beck, 1992). We also depend increasingly on the sensory power of science for our awareness of these new dangers, such as climate change and ozone depletion (Taylor and Buttel, 1992). The more that political institutions derive their legitimacy from expert framings of problems and policy options, the more crucial public trust of science becomes to their authority. The integrated critique of the deficit model argues that the public have hit on a real problem with science in contemporary government and society, and their concerns should be taken very seriously.

The binary version of the public engagement strand is more prominent within science policy. Nevertheless, some public concerns about risk regulation and the use of science in policy have been taken seriously, particularly when they have coincided with expert opinion. Thus, not only has the government initiated several experiments in public dialogue, but it has also introduced measures to tighten up the technical evidence base for decisions.

The grandest attempt to engage the public in a key policy issue has been the *GM Nation?* public debate. This centred on an extensive programme of public events involving 36,000 people, in June and July 2003. The debate has been heavily criticised. The Commons Environment, Food and Rural Affairs Committee has described it as a wasted opportunity and independent academic evaluators claim to have identified methodological flaws (Horlick-Jones et al., 2004). Industry groups allege that the debate was captured by critics of GM crops. Throughout, the public debate steering board expressed concerns that the programme was critically underfunded and rushed. Arguably, some of the more modest public engagement processes undertaken by government have enjoyed greater success (POST, 2001).

Meanwhile, in the aftermath of the *Phillips inquiry* into the handling of BSE, there has been a torrent of initiatives to shore up the scientific advisory system (BSE Inquiry, 2000, POST, 2001). In July 2000, the government's Chief Scientific Advisor (CSA) published *Guidelines 2000*, which set out key principles for using science in policy-making:

- Think ahead, conduct horizon scanning and build the capacity of rapid-response research.

- Broaden advice, including non-scientific disciplines such as philosophy.
- Act with the presumption of openness, publishing relevant advice and papers.

These guidelines were followed in December 2001 by the *Code of practice for scientific advisory committees*. The government's *Investing in innovation* strategy also has guidance on the use of science in policy recommending their departments appoint their own CSAs (DTI/DfES/HMT, 2002). Even more recently, the Office of Science and Technology has established a Science Review Directorate (SRD). The SRD is reviewing how other departments use science in policy.

Thus, over the past ten to twenty years, risk and public trust have become issues for science policy in themselves. In the past five to ten years, there has been a sea change in the way these issues have been presented within policy.

4. A knotty intersection

The new strand of science policy is largely independent of the old. Statements on public engagement emanate from the Office of Science and Technology or from the Research Council's focus on science and *society* – they tend not to engage with *economic* policies on science. But the two strands do meet in the major science policy reports. The July 2004 *Science and innovation investment framework* contains the government's most robust agenda for public engagement to date.

A chapter of the *Framework* is dedicated to 'science and society'. It begins by explaining why the government has sought to move away from the deficit model:

> Over recent years the focus of the Government's Science and Society public engagement activities has moved forward from simply promoting public understanding of science to the wider agenda of facilitating public engagement with science and its application. This has the aims of: government and scientists responding proactively to public priorities and concerns; people having greater confidence in the benefits offered by science; greater engagement with major issues facing society, such as climate change; and careers in science becoming more attractive to both adults and children. (HMT/DfES/DTI, 2004: 103)

The *Framework* also pledges a large increase in the OST's Science and Society budget, from £4.25 million per year in 2005-6 to over £9 million per year by 2006-7. Whilst this paper argues that the further changes are due, it recognises that the government's approach to public engagement has been evolving rapidly.

Indeed, there is even a marked difference in approach between the *Framework*, published in July 2004, and the consultation paper that preceded it in March. The consultation paper focused on public engagement at the 'tail-end' of science and technology. It envisaged a future in which "the public is confident about participating in decision making involving the *use* of science – and confident about the resulting decisions" (HMT/DTI/DfES, 2004: 34 emphasis added). Accordingly, public engagement would happen *after* the science, when it is 'used' or 'applied', not during it.

By contrast, the *Framework* states that the government will:

> … work to enable the debate to take place 'upstream' in the scientific and technological development process, and not 'downstream' where technologies are waiting to be exploited but may be held back by public scepticism brought about through poor engagement and dialogue on issues of concern. (HMT/DfES/DTI, 2004: 105)

In short, if public engagement is considered to be worthwhile, then the earlier one engages, the better it should be for science, for business and for the public.

The case for advancing public engagement 'upstream' was made by a number of respondents to the consultation paper, from a range of different perspectives (Table 2). Several public bodies have already flirted with upstream public engagement (BBSRC, 2003, Foresight, 2002). There is also a growing interest in addressing the practical challenges associated with advancing public engagement, which range from issues of commercial confidentiality to the fact that the earlier there is engagement, the less clearly defined the issues tend to become (Food Ethics Council, 2004; Royal Society of Arts, 2004; Wakeford, 1999).

Organisation	Statement or recommendation
British Association for the Advancement of Science	"Support, on a national basis, dialogue processes (discussions and consultations) that establish beliefs, views and evidence that are openly discussed in the public domain and in the media at earlier stages, generally, than at present." "Establish procedures that indicate how policy-making processes will consider public and stakeholder views at the initial stages of process development."
GeneWatch UK	"Public involvement can significantly improve research investment decisions by identifying important public needs and concerns before significant funding, training and infrastructure commitments are made."
Nuffield Council on Bioethics	"Ethical, legal and social issues raised by developments in medicine and biology are of direct concern to society and should be discussed from an early stage."
Research Councils UK	"We are developing a strategy on science and society… [which includes c]onsulting with the public on the priorities and policies of the Research Councils."
Royal Society	"In order to achieve increased levels of public confidence in decision-making about issues involving science, areas of potential concern need to be identified early (e.g. by Foresight panels, Departmental Chief Scientific Advisors, regular consultations with groups like supermarkets, NGOs who are sensitive to public concerns, horizon scans involving scientists and the public of the type organised by the Royal Society in 2003). In issues of clear public interest, the public will need to be involved. The Government should seek to fund such involvement and take its results seriously."

Table 2. Extracts from selected responses to the March 2004 consultation on *Science and innovation* (HMT/DfES/DTI, 2004; copies of responses can be requested from scienceframework@hm-treasury.gov.uk)

This movement upstream seems to suggest an increasingly integrated approach to public engagement. It is a precondition of public engagement *in* science and technology, as opposed to *after* it, that citizens should be involved early on. However, calls for prompt engagement do not necessarily imply that science and society are integrated. Indeed, on closer inspection, a binary approach still prevails in science policy.

According to the *Framework*:

> Researchers and policy makers must earn public confidence and trust in science through addressing public priorities and concerns. In this way the scientific community, working with government and other partners, can ensure that society's understanding and acceptance of scientific advances moves forward, and does not become *a brake on social and economic development* in the UK. (HMT/DfES/DTI, 2004: 156 added emphasis)

This echoes the consultation paper, which argued:

> [O]ne of the principal risks to reaping the full benefits of the UK's investment lies within society's complex and ever changing relationship with science. This in turn has the potential to *inhibit* the future development of science and innovation in the UK, to the *detriment* of public services and the economy. (HMT/DTI/DfES, 2004: 33-34 added emphases)

In both these statements, public concerns are seen as a potential check on scientific and economic progress, albeit sometimes a positive one. Thus, society is assumed to be external to science and innovation.

The pre-eminence of this binary understanding of science and society within the *Framework* presents a major obstacle to achieving the government's stated objective of improving public engagement in science and technology (HMT/DfES/DTI, 2004: 103). This is because a binary approach to public engagement harbours the central fallacy that underpinned the deficit model, even as it purports to move beyond it. By treating public concerns as *separate* from science and scientific knowledge, it denies their intellectual substance. Binary approaches are therefore condemned to treat public engagement as an add-on to processes of knowledge creation, rather than an integral part of them.

5. Towards an integrated science policy

The 'binary' and 'integrated' versions of the public engagement strand are not merely different means to the same end. It matters a great deal which of these two approaches the government takes. The binary version focuses on communication between the scientific community and the public, whether upstream or downstream. Science may proceed more slowly as a consequence, but its direction remains more or less constant. The integrated version implies that non-scientists can actually add economic and social value to science.

The notion that public engagement is an external check on science – however necessary or desirable that check is considered to be – rests on two assumptions, neither of which tallies with the complex policy understandings of innovation described above in Section 2.

First, it treats 'outside' involvement in science, innovation and science policy as a novelty. Yet the government recognises that science, innovation and knowledge transfer are non-linear processes involving many actors besides scientists. Indeed, science policy aims to facilitate the productive iteration between universities and businesses, 'research' and 'application'. Partnership programmes such as LINK and Faraday have pump-primed such collaboration. Stakeholders from businesses take part in science through established initiatives such as the Foresight programme, as well as through newer schemes such as DEFRA's Research Priorities Group. The government even acknowledges the role that consumers play in the process of innovation (DTI, 2000).

Either this complex view of innovation is temporarily suspended in discussions of public engagement, or there is inferred to be a social and psychological divide between the kinds of non-scientists who are already involved in science and innovation, and the kinds who are not. Neither option is plausible.

Second, the idea that public engagement checks scientific progress rests on the belief that knowledge expands rather like balloon – it is only the speed of progress that is variable, not its direction. This corresponds to the notion that scientific knowledge has no social or moral content. As Tony Blair put it to the Royal Society:

> Science is just knowledge… Science doesn't replace moral judgement. It just extends the context of knowledge within which moral judgements are made. It allows us to do more, but it doesn't tell us whether doing more is right or wrong. (Blair, 2002)

Whether or not this is true in principle has been a topic of endless debate amongst philosophers and social theorists (for an introduction see Delanty, 1997). However, the question is moot when it comes to innovation in practice. As the *Lambert review* stresses, innovation and knowledge transfer are about knowledge that is embodied in people and organisations, and embedded in actual places (Lambert, 2003). The objective of science policy is not simply to speed up research and innovation, but to promote the types that best serve the national interest, however that interest is conceived. Knowledge may be a key resource in the knowledge-economy, but it is a resource of varying value – it is a premise of contemporary science policy that some kinds of knowledge are worth more, economically and socially, than others.

Thus, whilst a binary approach to public engagement prevails in policy, government thinking on innovation is more consistent with an integrated understanding of science and society. Broader and increasingly open public engagement is more consistently seen as an asset to innovation and scientific progress than as an impediment (Irwin, 2004).

The issue here is not whether one of these two strands of science policy should be subordinate to the other. It is only realistic to assume science policy will continue to be primarily about the economy and innovation, with 'science and society' taking second place. Rather, what matters is whether the two strands are addressed in concert. At the moment, public engagement and innovation are tackled separately. There is minimal interplay between the 'science in society' initiatives outlined in the government's *Framework*, and the numerous measures intended to boost innovation (HMT/DfES/DTI, 2004).

Yet there is great potential to integrate public engagement into innovation policy. The argument for strengthening public engagement applies equally to the public and to the private sectors – public engagement is not merely a matter of giving taxpayers more say in the ways their money is spent (Royal Society of Arts, 2004; Wakeford, 1999). In principle, government, businesses and citizens should all gain from playing greater stress on public engagement in policies on innovation. What might science policy look like, in practice, if it sought to integrate these two component strands more even-handedly?

6. Engaging in innovation

The concrete initiatives set out in the *Science and innovation investment framework* fall broadly into two camps: those which are concerned with the supply of science and those which are concerned with the demand for it from businesses. Similarly, calls to move public engagement upstream have tended to focus on increasing supply-side participation in academic and public-sector research to offset the current confinement of public involvement to tail-end technology assessment (Table 2). Taking measures to strengthen the institutions of knowledge transfer that exist in between is one way of realising the potential synergy between public engagement and innovation.

The relative neglect within government policy of institutions for knowledge and technology transfer has come under fire from Research and Technology Organisations (RTOs). RTOs, or technology intermediaries, specialise in innovation. They undertake application-focused research, perform quality tests, set up companies, broker joint ventures and negotiate intellectual property agreements. They help to create the kinds of cross-disciplinary and university-business relationships that appear to catalyse innovation.

QinetiQ, the largest RTO in the UK, argues that:

> The choke-point is the gap between research output and innovation performance to achieve the translation of science, engineering and technology into wealth in the UK. To bridge this gap, funding has to be concentrated on the part of the value chain that needs improvement, not that part in which we are already excellent. (QinetiQ, 2004: 1)

QinetiQ also notes that the "need for intermediaries in the UK is indicated by the way that some of the RDAs are setting up organisations" to fulfil this role (QinetiQ, 2004: 3). The RTO umbrella body, the Association of Independent RTOs is concerned "with the current government concentration on the creation of commercial enterprises by universities when an increase in innovation intensity is already successful in knowledge-transfer organisations and will have a bigger economic impact in the medium term" (AIRTO, 2003: 5).

The government's *Innovation report* acknowledges that RTOs play an important part in innovation (DTI, 2003: 66). It also notes that Scottish Enterprise has allocated £450 million over 10 years to establish new Intermediary Technology Institutions (DTI, 2003: 60). However, neither the *Innovation report* nor the *Science and innovation investment framework* propose concrete measures to strengthen the role of RTOs.

The policy proposal that comes closest to addressing this relative neglect of the middle ground between the supply of science and the demand for it from businesses is the *Framework's* proposal for a Technology Strategy (TS), previously suggested in the *Innovation report*. The TS will "provide a business-driven framework for identifying emerging technologies which will have a significant impact…" (HMT/DfES/DTI, 2004: 70). It will be guided by a "Technology Strategy Board, which will be independent of Government, business-led, and expertly informed through engagement with stakeholders in the science base and business to provide clear and transparent guidance to Government in setting funding priorities" (HMT/DfES/DTI, 2004: 70-71). However, this proposal is for an institution to steer innovation, and not to facilitate it directly in the way that the RTOs recommend. The TS is also very weak on public engagement. It follows from the discussion in preceding sections of this paper that it would be more consistent with policy thinking on innovation for the TS to be citizen-led and not just business-led.

A greater investment of resources in technology intermediaries could go some way to addressing the relative neglect of the mechanisms of innovation. However, in the mode suggested by the RTOs themselves, this investment might be counterproductive because the privately-owned infrastructure for innovation is largely out of bounds to public engagement. AIRTO argues that “the constitutional structure of an intermediate company is irrelevant compared to its function in promoting knowledge-transfer which leads to downstream growth” (AIRTO, 2003: 5). On the contrary, it follows from the discussion in previous sections of this paper that any additional investment should be directed at RTOs with an explicit remit to engage the public in innovation and a constitutional structure that allows them to do so. Quite aside from being in keeping with the government’s commitment to public engagement, this would also be consistent with current policy thinking on innovation.

There is no such RTO in the UK. In several other EU countries, however, RTOs have a closer relationship with the state and receive considerable public funding (QinetiQ, 2004). Examples include the Fraunhofer Gesellschaft in Germany and the Dutch TNO. The Fraunhofer Gesellschaft is non-profit organisation employing 12,700 staff. Over €900 million of its €1 billion annual research budget comes from private and public sector contract research (Fraunhofer Gessellschaft, 2004). TNO is a statutory organisation about half the size of the Fraunhofer Gesellschaft (TNO, 2004).

Although the Fraunhofer Gessellschaft and TNO obtain greater state support than UK RTOs and are more accountable to government, neither lays great stress on broad public participation. To envisage how public engagement might be integrated into a technology intermediary, it is helpful to look to another institution that exists elsewhere in the EU, Constructive Technology Assessment (CTA). Pioneered in the Netherlands, CTA is an explicit attempt to address the fact that downstream technology assessment, including participatory technology assessment, has proved ineffective at predicting and pre-empting the consequences of new technologies and social responses to them (Irwin, 1995; Rip et al., 1995).[ii]

Conventional technology assessment assumes that “the creation or design of a technology is an insular or self-generating activity; the public’s role is in shaping, through policy and regulation, how that technology will be applied” (Schot, 2001: 39). As already explained, this view does not sit easily with policy thinking on innovation. By contrast, CTA holds that members of the public may have valuable knowledge to contribute to the design and development of a technology. Therefore:

> CTA proposes bringing together all interested parties early in the design process… [I]n CTA, technology is assessed from many points of view throughout the entire process of design and redesign, and the interests of all parties can be incorporated in the design from the beginning. (Schot, 2001: 40)

The objective of CTA is to steer investment towards technologies that meet the needs and expectations of the people they will affect, including the bystanders as well as direct stakeholders (Rip et al., 1995).

Examples of CTA such as the Dutch Sustainable Technology Programme show that CTA can lead to effective public engagement in innovation, but also highlight some of the safeguards that are needed to ensure that it does so. One of the successes within that programme was a partnership project between several government ministries and the companies Gist Brocades and Unilever, which explored whether it was possible to create appealing novel protein foods to displace meat and relieve pressure on the environment. Citizens were involved in the project through scenario-type workshops. As consequence of these workshops, the technology developers redirected their efforts to pay more attention to the taste and texture of the projected product. By contrast, many of the other projects within the programme bypassed citizens and consumers, partly due to heavy pressure to devise concrete proposals that would attract funding from businesses (Schot, 2001).

Establishing a public RTO, with a remit broadly informed by CTA, promises to bridge the supply-demand gap in the DTI's *Innovation report* proposals at the same time as strengthening public engagement in science. The RTO would be public in four senses: it would be non-profit organisation with a remit to actively promote and facilitate innovation in the public interest, and to engage citizens in project design; it would be directed by a board of stakeholders from government, business and civil society, accountable to the Secretary of State for Trade and Industry and closely advised by a citizen panel; its operation would be transparent to public scrutiny; and it would obtain a proportion of its funds from central government, sufficient to sustain its commitment to transparency and public engagement.

In other ways, however, the organisation would not be public. Much like the Fraunhofer Gesellschaft and the TNO, the bulk of its research funding would derive from contract work. Although its remit to promote innovation in the public interest would mean that government departments would be major clients, it would actively seek to work in partnership with businesses. Some of the technologies it facilitated would be freely available public goods, but many would be commercial products. Despite the organisation's commitment to transparency, project partners would be entitled to keep specific information confidential if there was a clear case that publication would be damaging to them.

The public RTO would complement, not replicate, the services offered by existing technology intermediaries. Whereas existing RTOs offer specialised expertise in particular fields of technology, the new organisation would offer expertise in public engagement. It would collaborate with private RTOs rather than competing with them.

7. Conclusion

This paper has identified two key strands within science policy. One strand is about promoting science and innovation. The other is about public engagement. The paper has argued that an integrated approach to public engagement is more consistent with government thinking on innovation than the binary approach that currently prevails in policy. It is encouraging that the government is seeking to move public engagement upstream. However, the crucial difference between the two approaches is the degree to which public engagement is linked in with science and innovation, however early on it happens. An integrated approach treats public engagement as an asset to scientific and economic progress. A publicly-accountable RTO could be a powerful instrument for putting a more integrated innovation agenda into practice.

The effectiveness of a new RTO in facilitating genuine public engagement in innovation depends on its capacity to meet three challenges.[iii] The first challenge is to ensure that the organisation serves to open up technological choices, and not to close them down (Stirling, 2004). Its value to clients and to the wider public would greatly diminish if it operated in a 'justificatory' mode, whereby public engagement legitimated decisions made in private. Experience of public engagement in technology assessment demonstrates that this is a serious risk. However, it also suggests ways to mitigate this risk, such as establishing clear evaluation criteria for public engagement in advance and putting in place mechanisms for institutional learning.

Second, there is a danger that institutionalising public engagement takes the wind from the sails of more spontaneous forms of public engagement in innovation, often operating informally on a small scale. The proposed public RTO should not aim to be a substitute for independent processes that engage citizens in innovation. Furthermore, it should supplement the measures already proposed in the *Framework* to catalyse independent public engagement. It should not be financed at their expense. If it is necessary to divert resources towards this initiative from others, then they should come from innovation-oriented proposals that currently make no provision for public engagement.

Third, the organisation must be structured to prevent its capture by sectoral interests within innovation, such as technology design or production. A primary consideration should be to build in mechanisms that prevent experts simply overriding citizens when opinion diverges. Citizens should be involved in designing the organisation to meet this objective. The Dutch experience of CTA demonstrates factors affecting the risk of capture and also offers examples of good practice in maintaining a balance of power between designers, financiers, research scientists, stakeholders and citizens.

A new RTO that met each of these three challenges promises to be an effective tool for promoting innovation in the public interest. However, in proposing a new organisation, it is appropriate also to sound a note of caution. One of the lessons for science policy from other fields, notably international development, is that new institutions are not always the answer to increasing public responsiveness and accountability:

> Perhaps the first step that agencies serious about participation and pluralism might take is not to reach for the latest handbook on participatory techniques, but put their own house in order: to consider how their internal hierarchies, training techniques and office cultures discourage the receptivity, flexibility, patience, open-mindedness, non-defensiveness, humour, curiosity and respect for the opinions of others that active solidarity demands. (Hildyard et al., 2001)

Indeed, in general, deliberative and participatory processes only promote democratic citizenship and professional accountability if they are complemented by other measures to redistribute power within government and the public sphere (Dryzek, 2001; Fung and Wright, 2003; Winner, 1992).

Therefore, in addition to integrating public engagement into science and innovation policy, it is imperative to overhaul the ways that policies on science and innovation are devised. The need to foster a culture of greater openness in the formation of science policy, as well as its implementation, shows through in the *Science and innovation investment framework*. Whereas numerous businesses and scientific organisations were proactively consulted, the *Framework* records no meetings between ministers and civil society organisations, or efforts to canvass the views of citizens who were not immediate stakeholders (HMT/DfES/DTI, 2004: 188-190). The *Framework* notes that the government will be “considering how better use can be made of public debate and dialogue in developing policies for science and technology" (HMT/DfES/DTI, 2004: 105). This should be made an urgent priority.

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[ii] Many other EU countries are better equipped than the UK to perform technology assessment. Dedicated institutions such as the Danish Board of Technology and TA-SWISS lay a heavy emphasis on public participation in technology assessment.

[iii] I am grateful to Andy Stirling for highlighting some of the risks associated with institutionalising public engagement.