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Consuming, Engaging and Confronting Science: The Emerging Dimensions of Scientific Citizenship

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1. Introduction: Science and Society Reimagined

It is hard to avoid the conclusion today that neither science nor society are what they use to be, and that perhaps they never were as we have liked to think. The weight of contemporary argument presents us with a profound disjuncture in science and society relations which does not leave our established vision of either domain untouched. Worlds that we believed were best kept apart and clearly demarcated from one another are now seen as subject to multiple forms of voluntary and involuntary marriage and recombination. Science and society are understood to be accelerating towards each other on a proliferating number of collision courses rendering conventional ways of analysing and discussing them in isolation from one another irrelevant and obsolete.

Approaches to the recombination of science and society are now many. As Michael Gibbons, Helga Nowotny, Peter Scott and associates (1994, 2000) present the situation, we are witnessing the emergence of a new mode of knowledge production characterized by the closely contextualized production of scientific knowledge in society. As Bruno Latour (1998, 1999) proclaims, cold and detached cultures of science outside of society are warming into involving cultures of research within, and as Jerome Ravetz (1999) and Steve Fuller (2000) insist (in their different ways) cosy Kuhnian scientific revolutions are being redefined with the advent of increasingly open and extended patterns of post-normal scientific community. In the prestigious pages of Nature and Science these approaches have already achieved a level of acceptance that they can confidently identify the need for a new ‘social contract’ or ‘New Deal’ between science and society (Gibbons 1999, Latour 1998). Scientists, insists Latour, have what amounts to little choice; they can continue to defend a nineteenth century ideal of science or turn to the increasingly urgent task of elaborating ‘with all of us, the hoi polloi, an ideal of research better adjusted to the collective experiment on which we are all embarked’.

Calls and entreaties for major reforms in science and society relations and a move away from more élite and authoritarian forms of government towards more open and inclusive patterns of governance are clearly starting to impact on policy discussions. Perhaps most noticeably in the British context, an acknowledged crisis of public confidence in science has opened the way for the growth of a new science and technology policy culture. As the recent House of Lords (2000) ‘Science and Society’ report outlined; science’s ‘license to practice’ in society can no longer be taken for granted and can only be extended through the introduction of integrated processes of public dialogue. The summary recommendation is that:

Direct dialogue with the public should move from being an optional add-on to science-based policy-making and to the activities of research organizations and learned institutions, and should become a normal and integral part of the process (House of Lords 2000, summary recommendation l).

In response to the new ‘mood for dialogue’ the relative exceptionalism of certain science and technology policy cultures like those to be found in Denmark and the Netherlands has received growing attention. The search is on for international precedents in the democratisation of science and society relations and for institutional innovations that might be adopted more widely to broaden public participation in policy deliberations and decision-making processes (Joss 1999). Outside of established national science and technology policy cultures the European Union appears to be a governmental context particularly well-disposed to the forging of a new ‘social contract’ between science and society. The strategic goal of the EU to become ‘the most competitive and dynamic knowledge-based economy in the world by 2010’ based on the creation of a ‘real European Research Area’ (European Commission 2001a) has generated a particular interest in breaking down barriers to communication between expert communities across Europe and, more generally, in advancing ‘sustained dialogue between experts, public and policy makers’ (European Commission 2001b). At this juncture, the construction of new and more active forms of ‘scientific citizenship’ in support of knowledge-based community appears to be gaining recognition as of central importance to the future of the European project.

A criticism levelled against those identifying the current need for major reforms in science and society relations is that they are guilty of mixing descriptive and normative perspectives; suggesting the existence of a new organization of knowledge production while simultaneously working for its implementation. So for example, Michael Gibbons, Helga Nowotny, Peter Scott and associates have been accused of making a political plea for what they otherwise claim to be bearing objective witness to (Godin 1998: 467). Such criticism appears hard to quell, and we can see the use of a polarized rhetoric where the established characteristics of scientific knowledge production are denounced in the name of ‘social and political desiderata’ which are their exact opposite structuring not only Gibbons et al’s account of a transition from Mode 1 to Mode 2 knowledge production, but also Latour’s identification of a shift from ‘science’ to ‘research’, and Ravetz’s presentation of a progression from ‘normal’ to ‘post-normal’ science. Recognizing the performative dimension of these academic discourses forces us to conclude that behind every authoritative account of major changes of science and society relations stands a more or less explicit vision of how the future ‘knowledge-based society’ should be organized. The work of accounting for change is never innocent of a desire to make a difference to change.

With this in mind, we can say that supporting a call for a new ‘social contract’ or ‘New Deal’ between science and society today implies supporting a particular new type of collectivity which defines and delimits itself more completely by its capacity to produce and disseminate new knowledge. Through such a process of (re)definition the respective territories and populations of science and society are reimagined in a way that produces a closer identity between the two: between the scientific community and society at large and between the scientist and the individual citizen. The

distance between science and society is collapsing into their mutual embrace and varying depths of entanglement. This new intimacy between science and society is described/prescribed by Michael Gibbons in terms of evolving practices of 'contextualized knowledge production' and by Bruno Latour in terms of all inclusive engagement in 'collective experiment' - but what does it mean to connect so closely our senses of individual and collective identity and destiny to our participation in novel forms of knowledge production? If citizens in future are to understand themselves to a growing degree as 'scientific citizens'what shape should the freedoms, rights, duties and responsibilities of these new citizens take?

2. Innovation and Virtue

In contemporary perspectives describing and advocating science and society in closer liaison the key process held responsible for forcing the two into each other's arms is that of innovation. Against a background of opportunities and risks which cannot be ignored, science and society are being encouraged to join forces in order to initiate; advance; safeguard; regulate; expand or terminate processes of innovation. According to Nowotny, Gibbons and Scott (2000: 36), the current situation is one where societies 'like our own' have accepted innovation 'as a new religion rooted in a continuous drive to bring forth the New'. Having jointly 'opted' for the relentless pursuit of novelty and staked our survival on it, science and society must now learn to live and cope together with the inherent uncertainties that follow (ibid: 37). This vision of science and society jointly choosing and even welcoming the uncertainties of innovation is complemented by one of them being jointly shocked and intimidated by the appearance of unnatural risks and dangers they had never envisaged. However, regardless of whether the vision is one of a high-tech Opportunity Society or a late modern Risk Society (Beck 1992), the central place assumed by innovation in structuring the future of science and society relations remains the same. Contesting the 'goods' and 'ills' of innovation; helping to capture the former while building protection against the latter can be seen as providing a concise description of the landscape the new scientific citizen is to roam.

In light of the key role assigned to the process of innovation in inviting and inducing a new 'social contract' between science and society it is important to come to grips with its nature. According to Schumpeter to innovate is to carry out new combinations; to combine materials and forces in a novel fashion in order to produce new things or the same things by a different method (1968: 65). This work of combination Schumpeter saw as a task sui generis performed by a particular type of individual - the entrepreneur. Over the years this approach to innovation has been seen as in need of modification on a number of counts, but perhaps most importantly due to the increasingly high science content of new combinations. New combinations, it is argued, have become more radical as they have become dominated by the novel nature of the materials and forces combined rather than by the originality of the act of combination itself. Innovations have become more closely

wedded to inventions (more ‘science-based’) loosening their identification with the actions of entrepreneurial personalities while strengthening their ties with more impersonal scientific methods and procedures (Freeman 1991, Andersen and Lundvall 1988). Schumpeter himself proposed the growing redundancy of entrepreneurs as their actions progressively broke down all social resistance to continuous change. Innovation was destined to become automatic in the context of science-based production as any ‘objectively possible’ technological improvement would soon be ‘carried into effect as a matter of course’ (Schumpeter 1939: 109).

However, with continuing strong resistance to certain new technologies and often widespread disagreement between experts and lay people alike over the benefits of others, as well as marked variations in innovative performance between different societies, it appears appropriate to ask if something does not remain blocking the long-term rationalization and scientification of innovation processes. Schumpeter was clearly in two minds on the issue, and even late in his career he was still apt to draw a very hard distinction between the work of invention and that of innovation. As he wrote in 1928; successful innovation is ‘a feat not of intellect, but of will. It is a special case of the social phenomenon of leadership’ (1928: 379). Carrying an invention into society is not the same type of task as bringing it into existence in the laboratory. Innovation as Schumpeterian entrepreneurship is a task of economic and social leadership. Entrepreneurs, however, lead not through persuasion, but through their actions. They lead by example; by diverting old or new means of production into new channels against the ‘circular flow’ of economic life (Schumpeter 1968: 89). Entrepreneurial ability is not connected to the possession of new knowledge so much as to the possession of a particular range of practical talents and virtues. Entrepreneurs succeed in Schumpeter’s eyes due to their uncommon command of such strategic qualities as ‘personal authority’, ‘initiative’ and ‘foresight’ (1968: 75). These qualities allow them the freedom of movement they require, beyond the boundaries of economic routine, to set about authoring the new routines that others will eventually come to follow. The ability to exercise virtue becomes a substitute for hard and fast knowledge that cannot be gained in advance of action, and thereby an alternative basis for survival and success under conditions of chronic uncertainty. Arguably, just because innovation, long after Schumpeter’s death, can be viewed as still stubbornly wedded to virtuous action its long-term rationalization now seems unlikely. Holding this to be so, we can expect that science-based innovations, rather than entering society ‘as a matter of course’, will due to their heightened novelty and complexity be associated with an expanding and not a shrinking range of virtuous actions.

Although he is meant to be living in a past world, Schumpeter’s entrepreneur acts under conditions closely resembling those Jerome Ravetz puts forward as defining the contemporary context of ‘post-normal science’. In this context says Ravetz; ‘the facts are uncertain, values in dispute, stakes high, and decisions urgent’ (1999: 649). When science is carried beyond the ‘artificially pure and stable conditions of laboratory experiment’ and into society, established facts, claims

Ravetz, tend to lose some of their reliability and instead of ‘truth’ the new guiding principle for action becomes ‘quality’:

> For post-normal science, quality becomes crucial, and quality refers to process as much as to product...lacking neat solutions and requiring support from all stakeholders, the quality of decision-making process is absolutely critical for the achievement of an effective product in the decision (Ravetz 1999:649).

Here ‘quality’ can be taken as a synonym for what in the case of Schumpeter we label ‘virtue’. Even when they are science-based, innovations as new combinations cannot be brought together and held together by the power of scientific truth alone, but must rely on the broader achievement of ‘quality’ (‘virtue’) in decision-making processes. For Ravetz, the achievement of quality relates to the pursuit of procedures of ‘extended peer review’ where all those affected by, and implicated in, new combinations should be given the opportunity to participate in decisions pertaining to them. Virtue in decision is seen as a collective good. For Schumpeter, on the other hand, virtue in decision-making means leaving all decisions to the few who are uniquely qualified to take them. Apart from with the banker who is to finance him, Schumpeter’s entrepreneur does not negotiate with anyone, he simply shows the way; demonstrates the future. He is a rule unto himself as he rewrites the rulebook of techno-economic life for others to follow. The superiority of his actions, and of the new combinations that result, speak for themselves and need no other defence. Virtue in decision is seen as an individual capacity. What Ravetz and Schumpeter offer us then are the tentative outlines of two alternative polities of science and technology and two very different models of scientific and technological citizenship. Both claim to offer us basic recipes for achieiving legitmacy and efficiency in innovative conduct. While Ravetz sees the moral virtues connected to sustainable innovation being both constructed and exercised in public through engagement in open dialogue, Schumpeter (1992: 160) sees them exercised in public, but bred only in private within the confines of the classic bourgeois family Home. For Schumpeter, access to scientific citizenship must remain highly restricted, tied as it must be to class and gender; entrepreneurship and masculine bourgeois culture end up as one and the same thing. At the other end of the spectrum, scientific citizenship for Ravetz should, in principle at least, be open to ‘all those with a desire to participate in the resolution of the issue’ (1999: 651). The task that remains is to fill out the dimensions of scientific citizenship further and relate these more closely to particular contemporary contexts of innovation.

3. Science Enlarging Politics

Understanding the passage of science into society as impurely scientific and dependent upon variable patterns of virtuous action defines innovation as an inescapably political process. Schumpeter was able to both recognize and resist this by presenting the enterpreneur as someone who helped expand the general rule of Reason in society through the legitimate force of superior will-power. In the absence of Men of such mythical quality, however, new combinations must be accepted as driven by the stronger or weaker knowledges and convictions of a lesser or greater number of individual and collective actors all demanding recognition. This opening up of innovation to broader participation means that controversy is just as likely as consensus to characterize innovation processes. As science helps expand the scale and scope of innovation processes in society, so it helps expand the scale and scope for potential disagreement in society. As Latour (1998) puts it; by adding new ingredients to collective experiments, science does not promise to put an end to politics, it only serves to enlarge politics further. This becomes even plainer to see when we consider that those holding the strongest convictions concerning the social relevance of any particular scientific novelty do not have to be (recognized) scientists themselves. As Schumpeter's entrepreneur was not expected to create all the forces and materials mobilized in innovation, so we can now expect that some of the most important individual and collective actors dedicating themselves to the task of 'contextualizing' scientific knowledge in society will not themselves originate from within the established bounds of science.

In this regard the growth of medical genetics serves as a good example illustrating how incomplete knowledges and diverse convictions combine in large-scale processes of science-based innovation. According to Rheinberger, the move of molecular biology in recent decades out of academic containment and into a position where it can effectively redefine aspects of medicine, medical care and the concept of illness coincides with the making of a new cultural movement. The growth of this movement, he maintains, is based in the first instance on the expansion of a 'shared misunderstanding' relating to the import of medical genetics. While expectations grow concerning the future possibilities of gene therapy, what medical genetics is currently delivering is 'healthy genes, not cure, for the whole population'. This 'misunderstanding' is generated and upheld through shared convictions cultivated in place of knowledge which serve to draw together and unite diverse actors who would otherwise have no obvious connections with one another (Rheinberger 1995: 250). In the wait for new cures for chronic diseases, medical genetics is offering firstly a new way of visualizing and cataloguing illness and pathologies. As the tools and procedures for genetic screening and the identification of genetic markers become more sophisticated and precise so the ability to classify individuals and populations according to the presence or absence of genetic flaws grows. Given this new calculability of sickness and health the most significant innovation currently emerging from the field of medical genetics is itself a new kind of uncertainty and a special quality of risk information (Turney and Balmer 2000: 412). This production of 'genetic risks'

for widespread consumption is not only to be seen as responsible for propelling medical genetics forward and expanding its relevance, but also for creating new subjects - 'persons genetically at risk' - whose destiny becomes thoroughly implicated in the future development of the field. As Novas and Rose (2000: 488) put it:

> ...genetic languages render visible to others and to oneself aspects of human individuality that go beyond 'experience', not only making sense of it in new ways, but actually reorganizing it in a new way and according to new values about who we are, what we must do, and what we can hope for.

As well as being vulnerable to new types of surveillance and new forms of discrimination, growing populations both identified and identifying themselves as genetically at risk are induced and provoked into assuming a far more active interest in their conditions of corporeal existence. Defined by genetic disease they are asked to show a new sense of responsibility in the conduct of their everyday lives and to accept new obligations to help in the betterment of their situation. Caught in the gap between certain diagnosis and unknown cure, the genetically at risk find themselves drawn into novel networks of interaction with multiple sources of knowledge and experience encouraging them to strive towards some measure of control over their future health. By always being inclined to demand more of the science that defines the quality of their lives, the genetically at risk will be encouraged to view medical scientists positioned as much as their servants as their masters in the long-term search for therapeutic cures. As Novas and Rose (2000: 506) relate in the case of Huntingdon's Disease (HD):

> The responsible-genetic subject becomes active in the enterprise of science. This...entails posting promising new research findings in the webforum. Materially, it often implies donating part of one's income towards funding a cure for HD, engaging in various fundraising activities to support the search for a cure, and a willingness to take part in clinical trials for potential therapies to cure HD...Increasingly, those at risk constitute their own forms of expertise, through support groups for those at risk or affected by HD.

In other words, diagnostic innovations in medical genetics are simultaneously serving to generate both a new knowledge of disease and an increasing number of active and engaged 'co-participants' in the field committed to finding a cure for 'their' disease. Although passivity and resignation to what genetic fate has dealt remains an option, moral incentives will typically be strong urging the genetically at risk to choose the path of hope and to do what they can to improve their situation and that of their fellow sufferers (see Callon and Rabeharisoa 2000). The incentives will be towards choosing active membership in the new cultural movement of medical genetics and becoming another virtuous (politically-active) party to the new combinations it is carrying into existence.

Techniques of genetic testing and screening are producing consuming new science-based identities transforming outsiders into insiders of a new expansive form of scientific community. However, as Novas and Rose (2000: 491) insist, geneticization of identity must be viewed in relation to other cross-cutting identity practices. Therefore, even if new genetic identities remain highly consuming and interpellating, they will still be consumed very differently in different contexts in combination with other competing identity claims relating to class, religion, sexuality, nationality and so on. Here, for example, the case of the 'population-based genomics company' deCode and its marketing of a genealogical database based on the Icelandic population is interesting to note. Whereas in other national contexts such a venture would without doubt give rise to widespread protest, roughly 90% of the Icelandic population has expressed its support for deCode's project. According to Lene Koch (2002), such collective support for what could be seen as the sale of Iceland's genealogical history, stems from the unique sense of national pride harboured by the Icelandic people in relation to their perceived common descent. This sense of pride, Koch argues, is only enhanced, not diminished, when the fact of common descent is confirmed through new links to scientific practice, and is advertised more widely in relation to a worldwide struggle against chronic illnesses such as cancer and diabetes.

4. From Enlightenment Government to Democratic Governance

Concern and interest in new forms of scientific citizenship has arisen as commitment to a 'canonical account' (Shapin 1990) or 'Enlightenment model' (Irwin 1999, Healey 1999) of science and society relations has declined and become increasingly fragmented. The Enlightenment model is losing support as it appears less as an accurate map of science and society and more as an established ideology working to secure and protect the greater autonomy of scientists and scientific institutions against society. According to the Enlightenment model, the only scientific citizens are the scientists themselves. For science to engage in the production of properly scientific knowledge it must live in a 'free state' and in a domain apart from the rest of society. Historically, science's grip on Truth is seen as having grown progressively stronger as society's grip on science has grown progressively weaker and ever more closely circumscribed (Latour 1999: 258, Shapin 1990: 991). Science has developed by disentangling itself, and purifying itself out of society and because of this any residual reliance on lay or common sense forms of understanding in scientific contexts can only lower the quality, and dilute the authority of the new knowledge being produced. Science is seen as the goose that lays the golden egg, but only under suitably autonomous circumstances and in the absence of undue external interference (Callon 1999: 83, Shapin 1990: 1000, Hilgartner 1990: 520). Abiding by the Enlightenment model, science becomes unproblematically associated with progress giving it privileged rights of access to the future. Thereby a failure to accede to scientific judgement can only be interpreted in negative terms and as representing an ignorant and irrational defence of old ways of thinking in the face of new (Irwin 1999: 19). Also in line with the

Enlightenment model, it is only natural that communication between science and society is all one-way: that science speaks to society without society ever being given the opportunity to talk back at science. As Hilgartner (1990) outlines, lines of communication between science and society after the Enlightenment model have been established on the assumption that the production and communication of scientific knowledge remain two highly distinct and qualitatively different activities. First, scientists develop new matters of fact, then others in command of a suitable scientific training disseminate these facts beyond the confines of the professional environment in which they have arisen. Dissemination always remains a troublesome and frustrating activity in that it can never add anything of value to scientific facts already produced and can only threaten to corrupt and distort these facts in the process of their 'popularization'. Minimizing the degradation of scientific knowledge in transit between science and society requires that science communication be controlled by those in command of a proper scientific training. Only such qualified communicators will be able to guarantee that science for public consumption is characterised by 'appropriate simplifications' and avoids 'damaging distortions' (Hilgartner 1990: 520).

By valuing so highly the autonomy of science and linking this directly to the preservation of the quality and the authority of scientific knowledge, the Enlightenment model amounts to a model for the insulation of science from society. It is a model that guarantees distance between science and society and actively works to avoid or even deny intimacy between the two. In the European context, in the second half of the twentieth century, it was national government (the Welfare/Warfare State) that intervened to consolidate the hold of the Enlightenment model on institutional reality. While science on occasion was expected to communicate directly with the public, the public was only expected to communicate indirectly with science through the appropriate government channels. As Shapin (1990: 1004) puts it, the government of science in support of the Enlightenment model means that 'it is the State that speaks for (or claims the right legitimately to speak for) the public and to voice public interest in the conduct of science'. The growing irrelevance of the Enlightenment model and its tendency to be identified as an 'ideological construction' of science and society relations stems largely from the withdrawal of the State from its role of protecting science from direct contact with society and the new expectations coming from all directions that science re-enter society in order to help support and sustain new cultures of collective innovation. Increasingly, science can no longer lay claim to the future outside of its active participation in successful patterns of innovative endeavour. Through such participation the ability of scientists to remain the sole adjudicators over the quality and strength of the knowledge they are engaged in producing declines apace. Under such circumstances and as the lines of communication between science and society are subject to radical reconstruction the Enlightenment government of science can be seen to be giving way to a range of uncertain alternatives for the future 'democratic governance' of science.

5. Public Understanding of Science and Advanced Consumer Democracy

The publication of the 1985 Royal Society report on the Public Understanding of Science (PUS) signalled the cautious re-evaluation of science's established relation to society under growing concerns surrounding science's contribution to national economic performance and prosperity. Although originally associated with the British context PUS became something of an international movement during the 1990s assuming a particular relevance in the post-Cold War era as States were forced to reimagine themselves as 'States without clear-cut enemies' in a globalizing world (Giddens 1998: 71, Elam 1997). In the Cold War era, science living relatively apart and invisible to society could be understood as necessary for the overall protection of society, not so in the new era. With the passing of bipolarity, the Enemy has been largely replaced by Competitors and an expanding landscape of sizeable opportunities and emergent risks that science must now be visibly seen to be addressing and acting upon. With the growth of the PUS movement the vision of science as partly locked away from society for society's own good has given way to one where science and society increasingly inhabit each other. As the tone of the new vision was set back in 1985:

> Science and technology plays a major role in most aspects of our daily lives both at home and at work. Our industry and thus our national prosperity depend upon them. Almost all public policy issues have scientific and technological implications. Everybody, therefore, needs some understanding of science, its accomplishments and its limitations (Royal Society 1985: 6).

From the outset PUS was, and has remained a predominantly science-centred and science-led movement for responding to changing circumstances in science and society relations. It has been a movement defensive of science's established authority and autonomy beyond society seeking to represent and protect the integrity of science as it is drawn into ever closer involvement in new patterns of collective innovation. One option for science has been to enter into innovation in the guise of the classic Schumpeterian entrepreneur and apply inherited Enlightenment model authority to the carrying out of new science-based combinations. However, rather than attempt to advance and enforce technocratic-style leadership over new knowledge economies, the PUS movement has emphasized the educational and 'civilizing role' science and scientists can play in the context of the new technological competition. The task of PUS, to begin with at least, was framed as one of combatting public hostility and resistance to new technology and of creating a keener awareness among industry leaders and major investors of the new technological opportunities scientific research was opening up. As Healey (1999: 71) notes, in its initial guise, the PUS agenda was constituted by a fairly straightforward superimposition of new economic concerns over the Enlightenment model of science and society relations. Instead of defending the freedom of science outside of society, PUS was to defend the freedom of new forms of science-based innovation with-

in society. Innovations which should have found a place in society as a matter of course were seen as being blocked by ignorant and irrational patterns of resistance in society. The PUS solution to this situation was to focus attention on the need for improvements in 'science literacy' in society so that resistance based on public misunderstandings of science might be progressively avoided and eradicated (Irwin and Wynne 1996). PUS accepted that in a democracy public opinion matters in decision-making processes and that the emerging situation was one where publics were increasingly being asked to vote on scientific and technological issues beyond their untrained grasp. As originally imagined, therefore, PUS was to engage in a kind of missionary work striving to bring the light of Popperian-style objective knowledge and a basic level of scientific literacy into the everyday lives of ordinary citizens allowing them to set their sights on the achievement of a higher, but still restricted, scientific citizenship (Hagendijk 2002). Inculcating the public in the 'factual background' to reigning controversies surrounding new technology would in the long-run contribute to greater efficiency in decision-making processes. Science-based innovation had created the need for a better-informed, scientifically-literate, citizenry to protect the legitimacy of existing democracy.

Over time, however, PUS has gradually modified its tune and accepted that bad decisions concerning science-based innovation may also on occasion stem from the unnecessary arrogance and over-assuredness of some scientists as well as from the ignorant and over-emotional attitudes of some publics. The quality of uncertainty accompanying science-based innovation is increasingly viewed as of a different quality and of another magnitude than that conventionally encountered under more controllable laboratory conditions (Callon 1999: 85, Wynne 1999: 8). What is reliable and works in the laboratory is typically far less robust in other places, at other times and categorical assurances about the safety or superiority of science-based new combinations in society are now something that scientists are learning to deliver with growing caution (e.g. May 1997). In recent years, PUS has been characterised by debates leading to something like an 'enlightenment of the Enlightenment model of science and society relations'. New supplementary knowledges are gaining recognition as important to the survival and success of science-based innovations and the burden of ignorance blighting the carrying out of new combinations is now seen as rather more evenly spread across the lay-expert divide. The PUS movement is now more prepared to take a lack of public confidence in new science and technology seriously and public worries about the unforeseen risks accompanying new technologies as only reasonable (Durant 1999, House of Lords 2000). No longer need the public be seen as unnecessarily resistant, but only naturally cautious and uncertain about consuming major novelties encompassing only recently acquired scientific knowledge. From fighting public ignorance and resistance to new technology, PUS is gradually rededicating itself to the task of winning, coaxing and securing public consent for the carrying out of radical new science-based combinations. Rather than simply correcting public opinion from a position of high authority, the new task for PUS is to help the public help itself in forming adequate opinions on controversial issues pertaining to science and technology.

The PUS movement has thus grown more reflexive about its own science-based authority as it has come to learn more about publics it initially presumed ignorant. PUS can now acknowledge that it has itself been ignorant and in command of only a primitive understanding of the processes behind the formation of public opinions towards science and technology. Scientific missionary workers are themselves starting to see the light and the error of their past ways. In a symptomatic analysis of the 'democratic turn' in PUS, Durant (1999: 316) suggests an interesting identity between the contemporary crisis of liberal democracy and the contemporary crisis of science in society. Science and democracy have developed alongside each other, but strangely, while those countries that still have little science/democracy continue to want more, those that have most are experiencing public discontent and disillusionment about developments in both fields. According to Durant, while opinion polls show that most people in Western countries have not lost faith in democracy or science in general, and if anything are even more committed to both than before, where they do have their doubts is over the quality and trustworthiness of current politicians and scientists. Like in politics, like in science, says Durant, traditional authority figures don't command the same respect anymore and the public are less and less willing to defer to what old-fashioned voices of authority tell them. Following arguments from Giddens, Durant (1999: 317) maintains that what has led to a loss of public faith in politicians and scientists alike is developments in the media and in communications technology in general collapsing the distance between leading politicians and scientists and ordinary citizens. However, in the case of science what is also important is the role being played by science-based innovation in bringing scientists into much closer proximity with many others in the carrying out of new combinations. Scientists simply cannot cut a credible image in the context of science-based innovation unless they change their own understanding of the sources of their authority in society. Distance may have helped lend enchantment, but proximity in innovation is fast-breeding contempt.

Scientists embroiled in innovative enterprise are dependent on the public in ways they were not before and for this reason PUS cannot carry on viewing the public in terms coloured by the Enlightenment model as naturally ignorant and hostile - this becomes a counter-productive scientific understanding of the public. From an initial focus on public resistance to new technology, PUS is now starting to work with a vision of the public as capable of active and mature reasoning on technological issues even if this only tends to lead to greater indecision. Unable to intervene and bring closure by simply telling the public what to think, PUS is now becoming increasingly preoccupied with designing and implementing 'public experiments' and 'public laboratories' for extended discussion and debate of contemporary science and technology. From viewing the public as not really ready or fit for scientific citizenship, PUS is now starting to work more actively (and experimentally) towards constructing environments for the cultivation of a new type of scientific citizen (Irwin 2001). These scientific citizens are imagined as participating in a different type of consumer democracy. Unlike conventional consumers of established products with clearly-defined

characteristics, consumer-citizens confronting the novelties of science-based innovation are unavoidably individuals with incomplete information who are being asked to pass judgement on things that literally no one can claim to fully know or understand. The challenge of scientific citizenship is therefore one of political decision-making under conditions of exceptional uncertainty. Under such conditions, and despite the typical urgency with which decisions are required, the raw and spontaneous will of the people can only be assumed to lead to bad decisions. Rather than already having a firm idea about what they want and what they think, scientific citizens are to be seen as citizens actively in search of their preferences; individuals earnestly striving by means of interior deliberation and dialogue with others to reach a definite opinion on novel scientific matters. It is in this context that PUS is currently carving a new identity for itself beyond, if not completely out of the shadow of, the Enlightenment model of science and society relations. PUS appears today as a movement in the process of becoming one that supports the public (scientific citizens in the making) discover their own points of view on issues relating to contemporary science and technology (Irwin 2001). In line with this new role PUS representatives can argue that rights of scientific citizenship do not follow with the basic right to vote on science and technology issues, but more fundamentally, from the opportunity to discover and cultivate one's own opinions and preferences in relation to such issues. The public is justified in fighting for the right to discover through organized debate and discussion what they really think about contemporary science and technology and PUS is dedicating itself to supporting them in this struggle - a struggle for the further democratisation of scientific democracy.

PUS as a movement largely initiated to defend the interests of science in society is assuming a more 'democratic' identity today by linking a particular vision of scientific citizenship to the creation of new types of educational opportunity in different educational contexts characterised by organized debate and discussion. From a movement previously aiming to bring down the light of science to a backward people, it is mutating into one helping already reasonable people further enlighten themselves. PUS is in the process then of developing and refining a new 'expertise of extended scientific community' (cf Irwin 2001: 15). Its task is to help citizens spend time entertaining the new ideas and novel artifacts that science-based innovation is bringing to society; to help citizens broaden their technological outlook and dare to share in the 'exciting opportunities' (House of Lords 2000: Chapter 1) science is throwing up. However, the test of the new democratic credentials PUS is acquitting itself with will follow from how new programmes allowing citizens to discover their own opinions about science are framed (Irwin 2001, Hagendijk 2002). Clearly, scientists alone cannot help publics discover what they think about science as no one would believe them capable of remaining neutral in this task. A reasonable diversity of agents and competing experts of extended scientific community is called for, but where will PUS draw the line in creating room for alternative perspectives on science-based innovations to be presented for public discussion? As Irwin points out, a related key issue is that of the constitution of the final audience for new democratic PUS initiatives. Although PUS may argue that citizens remain the primary

audience in new consultative and discussion forums, and that these citizens are being empowered by being enabled to discover and more clearly articulate their own opinions, the suspicion remains that those responsible for designing new experimental public forums are ultimately doing so for their own purposes: that public experiments in the new democratic governance of science are ultimately more akin to highly sophisticated exercises in social or market research (Irwin 2001: 13). The 'democratic turn' in PUS can also be understood as a professional coming of age of PUS where new approaches are being developed for more effectively mapping, explaining and acting back on the processes through which public opinions on science and technology are formed. Through designing public experiments where citizens can discover their own scientific opinions by researching and comparing between different perspectives on specific programmes of innovation, PUS can be seen as engaging in research of its own on new lines of demarcation between science and society which might work in future replacing an Enlightenment model which is now recognized as more of a political liability than an asset.

6. Public Engagement with Science and Deliberative Democracy

In its new guise of supporting the right of ordinary citizens (scientific citizens in the making) to be given the opportunity to discover what they truly think about contemporary science and technology, PUS has started to claim its allegiance to deliberative models of democracy originating, in the first instance, out of the work of Jürgen Habermas (1996) and John Rawls (1993). As Durant (1999: 317) outlines the 'democratic turn' in PUS:

> The ideals of equality between scientists and non-scientists and of informed public debate as the preconditions for forging socially sustainable public policies need to be translated into new processes of deliberative democracy.

It is through this process of creating a closer identity between PUS and processes of deliberative democracy that PUS is gradually coming to call itself by another name - public engagement with science (PES). Through PES, science is attempting to win and hold the attention of the public. New deliberative forums are being designed as opportunities for science and the public to spend quality time together. Quality time is needed for the exercise of science communication in the public good. As Durant (1999: 318) highlights, 'the extended time-scale of scientific inquiry does not always sit easily alongside the compressed time-scale of the news media. Equally, the complexities and uncertainties of much scientific research do not always lend themselves well to the sloganising and stereotyping of so much journalism'. PES is tasked with constructing new spaces through deliberative procedures where science and technology issues can be given the public airing they deserve. As Amy Gutmann and Dennis Thompson argue the benefits of deliberation:

> Deliberative democracy is the opposite of soundbite democracy, which probably provides a more accurate description of our current political life. Soundbite democracy suffers from a deliberative deficit. The din and deadlock of public life where insults are traded, slogans proclaimed, and self-serving deals are made and unmade, certainly reveal the deep disagreements that pervade public life. But soundbite democracy does nothing to resolve those disagreements on mutually acceptable grounds and still less to help citizens live with their ongoing disagreements in a mutually respectful way.

There appears to be a growing appreciation among the PUS community of deliberative democracy as a science friendly model of democracy and one which scientists can embrace because, not only does it help make science more democratic, but also democracy more scientific. Deliberative democracy is good news because it promises to bring both legitimacy and productivity gains to the practice of science communication. PES is also recognizable as an adaption rather than a rejection of PUS, as within deliberative models of democracy, deliberation is itself seen as a process for becoming informed and for receiving continuous education and training (Manin 1987: 354, Benhabib 1994: 32). PES can appear as enlightened PUS, corresponding to the adoption of a new pedagogic model supporting interactive learning between science and the public; both sides continually collecting, exchanging and analysing information about each other. Both sides highly engaged with each other, monitoring each other and adapting their behaviour towards each other on the basis of what they have most recently learnt. Deliberative democracy also appeals to the scientific community for its commitment to building political decision-making on 'rational consensus' rather than 'mere agreement'. The civilized vision of democratic politics deliberative democracy supports is one of the unhurried exchange of arguments between reasonable persons guided by the principle of impartiality (Mouffe 2000: 86, Bloomfield et al 2001: 503). Or as Benhabib (1994: 30-1) expresses it:

> According to the deliberative model, legitimacy and rationality can be attained with regard to collective decision-making processes in a polity if and only if the institutions of this polity and their interlocking relationship are so arranged that what is considered in the common interest of all results from processes of collective deliberation conducted rationally and fairly among free and equal individuals.

Processes of deliberative democracy can be seen as contexts where citizens simultaneously gain new rights of scientific citizenship while receiving the political education allowing them to exercise these rights. Designed in the hope of producing a new rational consensus, PES initiatives inspired by deliberative democracy resemble political laboratories for carrying out controlled experiments in scientific democracy. The sort of ideal laboratory conditions to be aimed for are summarized by Benhabib as follows:

1. participation in deliberation is governed by the norms of equality and symmetry; all have the same chances to initiate speech acts, to question, to interrogate, and to open debate;
2. all have the right to question the assigned topics of conversation;
3. all have the right to initiate reflexive arguments about the very rules of the discourse procedure and the way in which they are applied or carried out. There are no prima facie rules limiting the agenda of the conversation, nor the identity of the participants, as long as each excluded person or group can justifiably show that they are relevantly affected by the proposed norm under question (Benhabib 1994: 31).

While the different advocates of deliberative democracy are able to admit that numerous obstacles will always stand in the way of the construction of such ideal democratic laboratory conditions, these obstacles, it is argued, should be approached firstly as of an empirical and practical nature (Mouffe 2000: 88); we should not think ourselves justified in abandoning our democratic ambitions just because the path to achieving them is so demanding. Also as many advocates of deliberative democracy emphasize; the very act of participating in deliberative experiments produces 'better' citizens and individuals who find it ever harder to withstand the power of a good argument (Pellizzoni 2001: 66, Cooke 2000: 948, Macedo 1999: 10, Warren 1992). As Benhabib again expresses it:

> The very procedure of articulating a view in public imposes a certain reflexivity on individual preferences and opinions. When presenting their point of view and position to others, individuals must support them by articulating good reasons in a public context to their co-deliberators. This process of articulating good reasons in public forces the individual to think of what would count as a good reason for all the others involved. One is thus forced to think from the standpoint of all involved for whose agreement one is 'wooing'. Nobody can convince others in public of her point without being able to state why, what appears good, plausible, just and expedient to her can also be considered so from the standpoint of all involved (Benhabib 1994: 32-3).

As a basis for the 'democratic turn' in PUS and its self-mutuation into PES, deliberative democracy provides a model of democracy where scientists have good chances of appearing before others as already model scientific citizens. By valuing rationality, reserve, selflessness and powers of argumentation, deliberative democracy is a democratic politics played out on scientists' home turf. As Manin (1987: 354) points out, it is presupposed that participants in deliberative forums have received 'a certain degree of instruction and culture' and due to their professional training, scientists are always likely to be significantly advantaged in this respect compared to other participants. Deliberative forums are forums where already reasonable and already articulate citizens can excel (Sanders 1997), and for this reason they can appear to scientists as more acceptable means than

others for extending scientific community further into society. They are forums where scientists can make use of their existing 'civility' and acquired intelligence to help secure a new legitimacy for innovation-related research. There is a sense, therefore, in which the PES commitment to deliberative democracy appears to conform to a conscious strategy for developing a new range of political technologies for the preservation of public confidence in science and the further sanctioning of science-based innovation. This strategic approach to the democratisation of science can be read into the proposal of Nowotny, Scott and Gibbons (2000) for science to self-consciously 'move into the Agora'. If science is to secure what they call a 'new social contract with society' it must take it upon itself to become fully familiar with the larger 'contexts of implication' surrounding every major programme of science-based innovation. Having worked to identify these contexts scientists must see themselves as obliged to acquire an 'intimate and interactive, as well as anticipatory awareness'(Nowotny et al 2000: 209) of the emerging reactions of the wider public to their research. In the absence of such an awareness there is no escaping the prospect of research being subject to regular, unexpected and perhaps even fatal disruption. As Gibbons (1999: c84) expresses it, science engaged in radical innovative pursuits must accept that its authority 'will need to be legitimated again and again' and that the only way to guarantee this is for science to enter the agora and 'participate fully in the production of socially robust knowledge'. Deliberative democracy may be a better model of democracy than others for configuring the agora to the advantage of science and those designing deliberative forums might be conceived of as attempting to exert some measure of social control over processes of collective entrepreneurship related to science-based innovation. If innovation after Schumpeter (1928: 379) still remains a 'feat not of intellect, but of will', then deliberative forums are clearly contexts where a collective will to innovate can be cultivated and directed.

The level of public engagement with science sought through processes of deliberative democracy can be expected to be highly variable depending upon how they are designed and led. On one level, deliberation might be restricted to achieving public consent to specific programmes of science-based innovation. This is PES still very close to PUS where the purpose of deliberation is firstly to officially authorize particular innovative actions. Here scientists might be persuaded to change their minds about some aspect of their own practice, but the major question to be settled through deliberation remains whether or not they should be given the go-ahead. What is under discussion is the legitimacy of a programme of research and once this question has been settled deliberation ends, and public participation in decision-making is for practical purposes brought to a close. This is deliberative democracy in the service of a representative scientific democracy where the legitimacy of the latter is no longer associated with the 'predetermined will of individuals, but rather the process of its formation' (Manin 1987: 352). Institutions of deliberative democracy are clearly potentially useful tools for intervening in the process of the formation of a collective will in relation to science-based innovation and for delimiting public participation in decision-making to isolated choices - votes. Here PES remains more concerned with the 'self-correction' of

public opinions and preferences than with mobilizing public knowledge and experience. Science and society cross paths, deliberate, reach a decision, and then go their separate ways again.

On another level, deliberative procedures for the authorization of innovative actions might be conceived of as just the beginning of public participation in science and technology decision-making and not the end limit. Here the focus would shift from the the advantages of deliberative democracy for producing 'governance virtue' and the legitimation of innovative actions alone, to its potential for generating significant 'cognitive virtue' (Pellizzoni 2001: 66) and 'the conditions whereby actors can widen their own limited and fallible perspectives by drawing on each other's knowledge, experience and capabilities' (Smith and Wales 2000: 54). Here science and society would cross paths, start deliberating, and then continue to become ever more closely entangled with each other. This is what Michel Callon calls the 'co-production of knowledge model' of science and society relations where:

> The dynamics of knowledge is the result of a constantly renewed tension between the production of standardised and universal knowledge on the one hand, and the production of knowledge that takes into account the complexity of the singular local situations, on the other hand (Callon 1999: 89).

In this context, public participation is not simply delimited to authorizing the carrying out of new combinations, but becomes essential to the work of bringing together and holding together new combinations themselves - without public participation things simply fall apart. Under these conditions the horizons of scientific citizenship broaden significantly as the established boundaries between experts and lay people; rationality and irrationality; producers and users of new technology become distinctly blurred. The democratisation of science and technology comes to reflect the growing realisation that the knowledge on which the carrying out of a new combination is based is a genuinely 'social property' and not merely an extension of superior individual capacities and powers (Bohman 1999: 594). This situation of mutual dependence and interactive learning (Lundvall 1992) allows the leadership of innovative ventures to be brought into question as it becomes harder for any particular subgroup or individual to claim they possess sufficient cognitive authority (Reason enough) to decide over the innovative process as a whole. Deliberation becomes less of a political theatre for wooing public support for innovation and a more decisive means for helping to navigate and negotiate a course for collective entrepreneurship. Science and technology become more fully-recognizable as complex large-scale social enterprises:

> Science is effective not only because it can use the impersonal forces of nature and machines; it also enlists the aid of many different groups and occupations, all of whom are necessary participants in a large collective project...As in any large collective enterprise, there are many points at which the on-going co-operation of many different people

> and groups of people is required for research to go forward. At each of these points, the credible threat of noncooperation forces a less hierarchical and authoritarian, more decentralized and democratic procedure...Inclusion in the process of decision-making of all those involved in collective enterprises establishes and enhances the critical scrutiny and epistemic authority of experts, while their political authority is diffused and decentralized among the new agents added to the collective enterprise (Bohman 1999: 599-600).

Under the co-production of knowledge as described by Callon and Bohman it can be expected that different types of 'concerned' groups will arise from within collective research enterprises dedicated to trying to redefine or modify the current priorities guiding research. As mentioned earlier, new groups of individuals identified by medical science as sharing the same genetic risk profile may be encouraged to do more to take their shared fate into their own hands. From being simply 'sufferers' and 'victims' of genetic misfortune to which medical science can point when establishing the need for additional research funding, organized patient groups can start to redirect the collective research enterprise by initiating research of their own on 'their' disease and threatening non-cooperation in relation to the research the established experts wish to pursue (Callon 1999: 90). As procedures of deliberative democracy may be mobilized in the service of representative democracy in securing broad public consent to new programmes of science-based innovation, so they may be modified and used in support of more radical democratic struggles coinciding with new patterns of public confrontation with science and technology.

7. Public Confrontation with Science and Radical Democracy

By linking its own fate to just that of deliberative democracy, the new public engagement with science movement can be seen as not only implicated in the democratisation of science, but in a more widespread process for the renewal of democratic politics as well. Deliberative democracy stands for a broad-ranging programme for 'remoralizing' democratic politics today and the (re)grounding of political life more firmly in 'Ethics' and 'Reason' rather than competition and the aggregation of preferences (Mouffe 2000: 45). In this context, scientific culture can be seen as in some sense exemplary for the future of democratic culture. The traditional élite (anti-democratic) culture of science is not completely foreign to deliberative democracy as it appears to offer some ideal resources for the moral improvement of contemporary democratic life. The problem deliberative democrats have with existing democracy roughly corresponds with the one scientists following the Enlightenment model have always had with society: it is ruled too much by lowly passion; unruly and excessive behaviour; false assertions; manipulative leadership; shady deals and widespread ignorance. Deliberative democracy is therefore about lifting democracy above the levels to which it has sunk. This is clear, for example, in the writing of Giddens when discussing the background to the contemporary democratisation of democracy:

> The state should expand the role of the public sphere, which means constitutional reform directed towards greater transparency and openness, as well as the introduction of new safeguards against corruption. It isn't by chance that governments all around the world have faced accusations of corruption in recent years...Supposedly quite open, liberal democratic institutions in most countries have in practice depended upon backstage deals, privilege and patronage. One of the biggest changes affecting the political sphere is that government and citizens now live in a single information environment. Existing ways of doing things come under scrutiny and the scope of what is seen as corrupt or unacceptable widens (Giddens 1998: 73).

Deliberative democracy is about a recovery of authentic democratic values and the expansion of a more elevated public sphere. In this process, PES takes on a twofold identity; working not only to secure a new democratic face for science in society, but also to bring new standards of reasoning and argumentation from science to public life. In other words, as science 'enters the Agora' in alliance with deliberative democracy it risks enforcing unnecessarily strict rules of public engagement seriously limiting the legitimate forms of expression scientific citizenship can take. Just as passion and outrage were necessarily absent from science according to the traditional Enlightenment model of science and society relations, so they can end up being rendered alien to the exercise of scientific citizenship by the alliance of PES with deliberative democracy. In the latter context, passion and outrage become not only threats to Truth, but also to the achievement of a Fair and Just scientific democracy (cf Sanders 1997).

There is a sense, then, in which a strong reliance on processes of deliberative democracy for reforming science and society relations may be used as a strategy for containing; tranquillizing and foreclosing on the new politics of science-based innovation. Following Chantal Mouffe (1999, 2000) in her critique of deliberative democracy, PES can be accused of attempting to promote a vision of new combinations without real adversaries, greatly reducing the available space for expressions of dissent in innovation processes. Being in opposition to the 'rational consensus' reached in a deliberative forum on new technology becomes again an expression of ignorance and irrationality and testimony to a general 'anti-science' attitude. The scope for conceiving of science-based new combinations otherwise and carried out in line with different priorities is restricted and the political imagination guiding innovation constrained. As Mouffe (2000: 41) insists, the idea of political questions susceptible to being decided rationally and in accordance with an impartial standpoint that is equally in the interest of all speaks against the cultural logic of democratic politics. It abstracts 'the political' out of politics, leaving us in a realm of universal human equality that suggests there could be a 'democracy of mankind', when in practice there can only ever be a democracy for a 'people'. It carries the implication that relations of power can be bracketed out of politics and the conflicts they give rise to reduced to a simple competition of interests possible to

harmonize through rational argumentation. Against this vision of politics played out on a neutral terrain, Mouffe (2000: 49) defends one in which:

> Consensus in a liberal democratic society is - and always will be - the expression of a hegemony and the crystallization of power relations. The frontier that it establishes between what is and what is not legitimate is a political one, and for that reason it should remain contestable. To deny the existence of such a moment of closure, or to present the frontier as dictated by rationality or morality, is to naturalize what should be perceived as a contingent and temporary hegemonic articulation of 'the people' through a particular regime of inclusion-exclusion. The result of such an operation is to reify the identity of the people by reducing it to one of its many possible forms of identification.

Translating this vision to apply to the social enterprises carrying out science-based innovations, PES in alliance with deliberative democracy becomes a means for narrowing down the interpretative flexibility of new technology, and under a veil of Morality and Rationality deciding whose will shall count over that of others in the innovation process. Deliberation becomes a way of negotiating who shall be recognized and who shall be ignored in the carrying out of new combinations. As Bohman (1999: 602) points out, in order for the epistemic division of labour supporting innovation to be democratic it is just the definition of knowledge that must be held open for input from all those 'involved and affected'. However, here the problem on many occasions remains that unless attention is explicitly drawn to much of the knowledge labour expended, and the active cooperation offered, bringing and holding new combinations together this will tend to become taken for granted and rendered invisible (Star 1991, Shapin 1989). Demanding recognition; 'acting up' and confronting those currently ruling over the carrying out of new combinations typically remains essential if access to, and influence over, the deliberative forums that matter most is to be won by many groups implicated in innovation. The classic example in this instance is that of AIDS activism where an emergent public affected by AIDS was largely excluded from decision-making processes deciding over their fate (Epstein 1996). Activists successfully challenged the collective research enterprise producing knowledge about AIDS by publicly bringing into question the established moral and epistemic authority of the medical experts presiding over the research process. The continued cooperation between researchers and their patient public came to hinge upon the possibility of opening up epistemic norms and moral criteria to negotiation eventually offering activists access to various decision-making and funding bodies setting priorities for research.

By connecting scientific citizenship to the alternative model of a radical and pluralist democracy room is created for legitimate forms of public confrontation with science and technology outside of deliberative contexts giving rise to a new vision of the virtuous scientific citizen. As Mouffe outlines, the main issue for a radical democratic politics is not how to erase power from politics (an impossibility), but how to advance forms of power in agreement with democratic values. As a

consequence the objective is not to eliminate passions nor limit them to the private sphere for the sake of rational argument, but to mobilize them and welcome their intervention when put to good democratic effect. According to Mouffe (1999: 756), the specificity of modern democracy lies just in its acceptance and legitimation of conflict and the refusal to suppress this through the imposition of an authoritarian order. While radical democracy does not reject the need for degrees of consensus in political life, this consensus will always remain of a conflictual and contestable nature. Radical democracy values dissent in equal measure to consensus and supports the institutions through which both can be manifested. Therefore, as Mouffe expresses it, a radical and pluralist politics advances a 'mixed game' combining collaborative and conflictual actions and rejecting political practice that concentrates on one to the exclusion of the other (see also Young 2001: 671).

The radical scientific citizen is fully prepared to participate in demonstrations and direct action aiming to secure a currently denied democratic identity in innovation. Street marches, boycotts and sit-ins and other means of publicly confronting those ruling over science and technology are accepted as legitimate practices of democratic criticism. The scientific citizen in the guise of the activist bears witness to current wrongs and injustices in scientific affairs which require that the ordinary rules and practices perpetuating these wrongs must be broken with. Their unjust effects need to be publicly communicated and demonstrated for all to see (cf. Young 2001: 673). Such action can be seen as impelled by reasonable anger and frustration directed at the perceived intransigence of those currently deciding over innovative matters. Thus, scientific citizens are warranted in indulging in public displays of outrage in their attempts to openly shame and scandalize those currently in authority. It is permitted to be disruptive and disrespectful in public and to create disturbances around collective deliberations which are presently experienced as highly exclusionary in character. While the scientific citizen as activist may be taking a partisan position in defence of a particular individual or group in society, they are also to be understood as assuming a moral stance in defence of general ethico-political principles (like scientific democracy) which are accepted as existing through many different and conflicting interpretations subjecting them to continuous contestation (Mouffe 2000: 103, Young 2001: 673).

In their efforts to publicly expose existing wrongs and injustices, scientific citizens in the guise of activists will be encouraged to assume the role of producers of new science communications working to construct alternative public understandings of science and technology (APUS). Again these alternative oppositional public understandings do not have to be interpreted as purely 'anti-science' in sentiment, and may indeed still remain themselves high in scientific content; instead they should be seen symmetrically, like mainstream PUS, as generally legitimate attempts to impact on the public appreciation of some aspect of science and technology in particular. Like conventional PUS, APUS activities can be viewed as attempts 'to tell the truth before a larger public' (Barry 1999) typically encompassing the introduction of new practices of testifying and witnessing. In both cases, the ambition is to show, or point at, something that demands larger attention; some-

thing which needs to accepted as self-evident and real. While in the case of mainstream PUS the pointing is usually towards the technical or experimental virtuosity of established scientists (Collins 1988), in the case of APUS it will typically be towards the 'markers of the unacceptability of another's (scientific) actions' (Barry 1999: 76 - my addition). While PUS has been designed to reassert the independent and unaided authority of established experts, APUS will usually be seeking to open up specific areas of science and technology to broader forms of public participation and representation. Both PUS and APUS are in the business of producing interpenetrating technical and political 'demonstrations' of a non-innocent kind (cf Barry 1999: 77). Both are about the crafting of new tools of politico-scientific persuasion intended to affect the conduct of others.

8. Conclusions

Why the emerging interest in scientific citizenship today and multiple new forms of public participation in science and technology? The answer relates firstly to the new faith being placed in processes of science-based innovation for securing sustainable sovereign territories. In a globalizing world, where States continue to struggle for their existence in the absence of clear-cut enemies, innovation and technological competition are gaining recognition as perhaps the most important forces shaping the creative destruction of sovereign powers (Elam 1997, Giddens 1998). When the future of 'our' society is seen to depend upon science and technology, it is only to be a expected that interests will arise wishing to redefine citizenship in more 'scientific' terms. However, as these interests take hold so both the physical and conceptual territory of government become refigured (Rose 1996).

Scientific citizens participate in the task of deciding what constitute important opportunities and acceptable risks in the carrying out of science-based new combinations. They are members of collectivities that define and delimit themselves more completely by their capacity for producing and disseminating new types of useful knowledge. By creating a closer identity between science and society; the scientist and the citizen; collectivities intent on enabling innovation are liable to experience both a growing socialization of science and an advancing 'laboratorization' of society. This two-way process in support of enhanced innovative capacity will not, however, proceed as a matter of course and will require continuous support. For citizens to identify themselves as 'scientific citizens' they will need to be persuaded to prize new rights and freedoms and to accept new duties and obligations. Scientific citizenship generates the need for a remapping of the moral terrain of science and society relations and the articulation of a new landscape of citizen virtue and vice.

In his classic theory of innovation and entrepreneurship Schumpeter connects the carrying out of new combinations with feats of individual will and the exceptionally virtuous actions of entrepreneurs. The only person Schumpeter's entrepreneur is prepared to negotiate with is the banker who

is to finance him, everyone else involved in innovation is depicted as remaining nothing more than slaves and simple extensions to his will. Schumpeter's entrepreneur takes sole responsibility for deciding how to ride the waves of uncertainty generated through innovation. He leads, others follow; he speaks, others listen. The role of such traditional authority figures in innovation today appears highly restricted as the idea that they could successfully master all the uncertainties arising in the carrying out of new combinations appears highly implausible. With the death of Schumpeter's entrepreneur, it can be argued that, before all else today, success in innovation depends on the creation and maintenance of a collective will to innovate. It depends on the exercise of virtue in governance in the face of inescapable uncertainty. As Hinchliffe (2001:185) maintains, this governance virtue needs to be cultivated not so much for responding to periodic 'uncertainties of knowing', as for achieving a continual 'knowing of indeterminacy' in innovation. When innovation is accepted as founded on a knowing of indeterminacy, those responsible for crafting a collective will to innovate grow more alert to the subtle shifts in public expectations of new technology and how these might be turned to local advantage by new labours of persuasion. Working to refine and enlarge a collective will to innovate coincides also with the task of articulating an attractive vision of science-based community, and a range of positive community values setting 'us' apart from 'them' - our competitors. Different 'concerned groups' in innovation like patient organizations in medical contexts can be seen as generating their own 'will to innovate' based on an alternative 'us/them' dichotomy which both strengthens and complexifies the overall process of collective will formation.

Therefore, partially replacing Schumpeter's entrepreneur in the contemporary context of science-based innovation, we have a growing range of new 'experts of scientific community' (Irwin 2001). These experts are fulfilling an entrepreneurial function by acting as leaders of some vision of extended scientific community, drawing together sciences and publics, and combining them through the medium of some model of active scientific citizenship. Included on the list of vying new experts of scientific community must also be those social scientists currently calling for a 'new social contract' or 'New Deal' between science and society. Such calls are equivalent to practices of scientific statesmanship attempting to articulate as they do what constitutes, and what does not constitute, virtue in scientific governance today.

Among new experts of scientific community, a particular interest seems to exist for deliberative models of democracy thought capable of advancing both innovative efficiency and legitimacy in science and society relations. Models of deliberative democracy appear to resemble appropriate technologies for cultivating virtue-intensive wills to innovate. By emphasizing the place of education and training in deliberation for the production of 'more informed' debate, deliberative democracy can be seen as providing the intellectual foundations for a 'democratic turn' in the public understanding of science movement today and its mutation into a public engagement with science movement. However, a strong reliance on deliberative forums to the exclusion of other forms of

political expression in the construction of virtuous scientific citizens may prove counter-productive in the long-run. By building on the possibility of founding decisions in innovation on 'rational consensus' above and beyond 'mere agreement', deliberative democracy is in danger of cutting short and foreclosing on the politics of science-based innovation. According to the alternative model of radical and pluralist democracy, tools of deliberation when used to the exclusion of other forms of political expression become tools of hegemony, not of rationality (Mouffe 2000: 49).

A final issue to contemplate is that while greater public participation in science and technology can only appear positive in the light of the historical dominance of the Enlightenment model of science and society relations, in the long-term the most important issue may be how to help citizens limit their exposure to the claims of scientific citizenship. Just because science and technology are so pervasive in everyday life there is potentially no end to the science and technology related-issues for responsible citizens to engage with. A precondition for active citizen engagement in some area of science and technology must in the end be disengagement, passivity and indifference in another. Ultimately, the rights and freedoms of scientific citizenship will hinge on the ability of citizens to choose for themselves their points of entry into new scientific community. The benefits of participation in any particular field must remain possible to weigh up against the costs. Participation is also always a matter of deciding how much of self to sacrifice in the public cause. This makes powers of choice over levels and sites of participation into prize possessions.

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