ENGAGING NANOTECHNOLOGIES: A CASE STUDY OF 'UPSTREAM' PUBLIC ENGAGEMENT

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1 *Introduction*

The cumulative inability of the UK State to anticipate adverse public reaction to technological risk issues is perhaps one of the more telling examples of institutional failure in recent decades. Following the spectacular failure of the British State to anticipate the political controversy and adverse public reaction to genetically modified (GM) foods and crops in the late 1990s, a number of influential policy reports were written, all calling for, *inter alia*, more proactive public involvement and deliberation in debates about the social and ethical dimensions of science and technology (DEPARTMENT OF TRADE AND INDUSTRY, 2000; HM TREASURY/DTI/DfES, 2004; HOUSE OF LORDS, 2000; ROYAL COMMISSION OF ENVIRONMENT AND POLLUTION, 1998; WILSDON; WILLIS, 2004). In the 1970s and 1980s, the argument runs, there was little meaningful public dialogue on agricultural biotechnology. But by the late 1990s, when controversies about particular GM applications made debate unavoidable, a dominant – and question-begging – regulatory discourse was already in place, with major commitments having already been made by industry and governments (GROVE-WHITE et al., 1997; LEVIDOW; CARR, 2000). Perhaps not surprisingly, by this stage, attitudes had become polarised (AGRICULTURE AND ENVIRONMENT BIOTECHNOLOGY COMMISSION, 2001; KELLY, 2002). All of this suggests that 'upstream' forms of public engagement, before lines had been drawn up, might well have been beneficial. Such thinking has contributed to the belief that upstream forms of public engagement might play a role in the development of a more anticipatory and socially robust governance framework.

Perhaps not surprisingly, nanotechnologies have been presented as a key site for experimenting with novel forms of 'upstream public engagement'. Here is a technology

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with substantial promise of radical transformation seen as in danger of running up against comparable adverse public reaction to that experienced with genetically modified foods and crops. The publication in July 2004 of the Royal Society/Royal Academy of Engineering report on nanotechnologies signalled a significant moment in the evolution of these debates on anticipation (ROYAL SOCIETY/ROYAL ACADEMY OF ENGINEERING, 2004). Learning from recent experience with biotechnology, policy-makers and scientists have now begun to look to the social sciences for improved insights on the likely future impacts of nanotechnologies, and on the role of public engagement to help fashion more socially robust technologies (MACNAGHTEN et al., 2005). These commitments to more 'upstream' forms of public engagement in processes of scientific-technological innovation are a significant move, and raise many unresolved questions for the social sciences. At what stages in research and development (R&D) processes is it realistic to raise issues of public accountability and social concern? How and on whose terms should such issues be debated? Are dominant institutional discourses of risk, ethics and 'social responsibility' adequate for addressing these issues? Is it realistic to assume that citizen-consumers can exercise constructive influence over the pace and direction of technological (and related social) change? How can these questions be reconciled with the need to maintain the independence of science, and the economic dynamism of its applications?

This paper attempts to make a modest contribution to this debate through an examination of the process through which selected members of the public were able to articulate their responses on the social and ethical dimensions of emerging nanotechnologies (KEARNES; MACNAGHTEN; WILSDON, 2005). There were substantial challenges in negotiating such an 'upstream' conversation, arising from: a) the lack of agreed definition of the term within the nanoscience community; b) the fact that most nanotechnologies remain at an early or pre-market stage of development, existing largely in terms of their promise; c) the reality that most people are unfamiliar with the term, and so presumably do not have pre-existing attitudes as traditionally conceived; and d) the possibility that salient dimensions of public concerns may not align with a broadly conceived 'risk' and 'benefit' rubric (as tends to be assumed by official regulatory and risk assessment vocabularies), and that additional work may have to be conducted to frame the conversation such that it embraces wider public values and sentiment. Indeed, in the related domain of GM foods and animals, a clear research finding was the inadequacy of such official framings in capturing the character of legitimate public concerns (GROVE-WHITE et al., 1997, 2000).

2 *The methodology*

A methodology was developed aimed at understanding the factors likely to shape future public responses to nanotechnologies, and to capture the character of public concerns. A focus group methodology was chosen, designed to encourage discussion of potential issues arising for nanotechnology within a framework set by participants' historical and everyday experience of technology rather than imposed by official regulatory and risk-assessment vocabularies. The sample consisted of five groups, each of which met twice, with a gap of one week between the sessions. Participants were recruited on the basis of their

existing participation in local community or political issues, but with no prior involvement or exposure to nanotechnology. They included a group of professional men (doctors, architects, civil servants etc.) – Group 1; a group of professional women (mostly employed as middle managers in business) – Group 2; a mixed gender group with demonstrable political interests – Group 3; a group of women with children at school age – Group 4; and a mixed gender group all of whom expressed an interest in technology – Group 5. The groups were conducted in Manchester and London in the late summer of 2005.

The group discussions were designed to enable participants to develop their understanding of what nanotechnologies were, of how they were being developed in 'real world' circumstances, and of the issues they were seen to pose by different stakeholders. Given the complexity and unfamiliarity of the topics under discussion, the groups were run on two consecutive sessions, each lasting approximately two hours. The first session began with a discussion of science and technology, of how they are impacting on everyday life, on the ways in which they are contributing to 'social' questions and dilemmas, and on what people sensed to be the key issues for the future. Halfway through the session, the concept of nanotechnology was introduced using definitions and a scalar diagram taken from the Royal Society/Royal Society of Engineering report (2004) and setting out domains of application in medicine, materials and information technology. Participants were next presented with some everyday consumer products that had been fabricated using nanotechnology, including a golf ball, a tub of anti-wrinkle cream, and a stain-resistant shirt. Using a set of concept boards as a stimulus, people discussed three different visions of nanotechnology: a mainstream view, which focused on projected incremental developments and economic benefits; a radical utopian perspective, which emphasised more disruptive potentials for nanotechnology to transform human sensory and physical capacities; and a sceptical outlook, which focused on potential risks to the environment and human health, and to wider negative social and ethical potentials. Each of the boards used text taken from publicly accessible government, civil society, media and corporate sources. At the end of the first session, participants were asked to spend the week before the next session exploring the issues with friends and colleagues, consulting websites, and keeping a journal for any reflections arising. The follow-up session explored how participants' perceptions and responses had evolved during the week, and time was set aside to examine in detail particular social and ethical dilemmas. The session finished with a discussion of how key stakeholders, including Government, should proceed and of the conditions necessary for a governance framework.

Given the unfamiliarity of the term, and the undoubted importance of 'framing' to subsequent responses (NISBET; SCHEUFELE, 2007; SCHEUFELE; TEWKSBURY, 2007), the various presentations of the term and its applications were carefully crafted to reflect the range of ways through which nanotechnology is being produced in the public domain. In particular, the three visions of nanotechnology presented in the stimulus materials reflected three dominant frames – or styles of thought (FLECK, 1979; HACKING, 1992; ROSE, 2007) – involving not simply what nanotechnology is, but what it explains, and what is represents. By exposing participants to the multiple frames characteristic of the emerging public debate, and by encouraging discussion and exchange on the credibility, legitimacy and authority of such frames, the design was intended explicitly to simulate the real-world

dynamics through which nanotechnologies and their associated social relationships become co-produced.

3 *A backdrop of ambivalence*

Both quantitative and qualitative research on public attitudes to science and technology has tended to focus on public responses to particular applications with little thought given to their cumulative impacts and how these diffuse into the felt experience of everyday life. For this reason, prior to examining responses to nanotechnologies, participants were asked to reflect on their historical experience of science and technology, on how it had impacted on day-to-day living, on where this was seen as going, and on what issues this was likely to pose for now and for the future. What emerged was a clear sense of the duality of technological experience.

On the one hand, across the group discussions there was a real sense of enthusiasm towards technological innovation, notably in the information and communication technology domain where innovation had become so integrated into personal and working life that people found it difficult to imagine life before email or the mobile phone. While the material integration of technology had produced numerous benefits it was perceived also to have been socially disruptive. To the younger and more technologically literate participants, technology had created additional pressures and expectations. To the older and more traditional groups, technological innovation was perceived as a contributing factor to the perceived loss of community, the decline in courtesy and social relationships, the invasion of privacy, and the blurring of family/work boundaries. Such expressed concerns were present in discussions of current impacts but became intensified in discussions on the future. The anticipated ever-increasing pace, scope and intensity of technological innovation lead to considerable unease about prospective trajectories, exacerbated, in part from people's perceived lack of 'voice' in the deliberation and development of technological R&D, and from a sense that ownership and control were being consolidated into increasingly large and unaccountable actors, outside the reach of communities and even national governments. The exchange below is a particularly vivid example of the 'kept in the dark' narrative, articulated with respect to people's historical experience of genetic technologies and the lessons that need to be learnt for the consideration of analogous technological innovation:

> Eliza: "Well, things like genetics I'm uncomfortable with… It would be interesting to see how it plays out. But I don't feel that I have control over [that], or have any input into how that happens, you know like cloning or genetic modification or [pause]… It's rushing very quickly ahead, I don't ever feel like that's been an election issue or [that] it's been in someone's manifesto. These sorts of things, I think, are going to be really big questions for humanity, and I think that they're not really on the agenda, but I don't feel that … that I can express my opinion…."
>
> Julie: "What you're saying is we haven't had a say again? … In that these things are just coming through and... they don't feel the need, no."

> Eliza: "But also that the speed with which things are going forward as well, like I was trying to say before, I don't know, there are a lot of quite well sort of publicised questions around um, genetic modification which… haven't been addressed really… that's the way I feel, although I'm a little bit wary about jumping into, rushing forward with another new technology where I feel that the old questions haven't even been addressed… Well, I agree with… the sense that, you know, this idea that we're meddling with things that we don't actually fully understand, and I know that can seem like a very kind of… unadventurous."
> (Group 2)

This set of exchanges is particularly interesting in the way it weaves together collective expressions of unease as a reflection less of the technology *per se* but how it is being shaped, in real world circumstances, with apparently little room for wider public involvement and discussion (for analogous accounts of this phenomenon see COMMISSION OF THE EUROPEAN COMMUNITIES, 2007; GROVE-WHITE et al., 2000; JASANOFF, 2003; MARRIS et al., 2001; WYNNE, 1980). The choice of discussing genetic technologies, unprompted, across the various discussion groups, as somehow paradigmatic of broad-based concern with the trajectories of technological innovation, was widespread and begs explanation. Across the group discussions genetic technologies were discussed as emblematic of trends which included: the perception that technological innovation was speeding up, that such innovation appeared to be increasingly beyond public control, that existing social and ethical questions had not yet been adequately addressed, that domains of life were increasingly subjected to technological intervention with unknown consequences, and that the pace and scope of change was seen as driven by commercial and short-term goals with little regard to public values and sensibilities (GROVE-WHITE et al., 1997; MACNAGHTEN, 2004). Time and again, people looked to the experience of government and corporate handling of genetically modified foods and crops as grounds for a more cautious approach. Such discussion cultivated a backdrop of caution in which public responses to nanotechnologies came to be framed.

4 *Conceptualising concerns to nanotechnology*

Unsurprisingly, when participants were requested to offer an opinion on the term nanotechnology, there was little familiarity or knowledge, a finding that parallels attitudinal survey research both in the UK and United States (BAINBRIDGE, 2002; COBB, 2005; COBB; MACOUBRIE, 2004; DEPARTMENT OF TRADE AND INDUSTRY, 2005; PRIEST, 2006; ROYAL SOCIETY/ROYAL SOCIETY OF ENGINEERING, 2004; SHEETZ et al., 2005; WALDRON; SPENCER; BATT, 2006). When pressed, participants tended to characterise nanotechnology as scientific, clever, small, possibly medical, strange, futuristic, and something associated with science fiction. Even for the more technologically literate participants who had heard of nanotechnology and of its 'uncanny' potential (NORDMANN, 2005), it nevertheless was perceived as foreign, strange and other-worldly:

> Alistair: "It's almost the best of all the terms for being one where I know the idea that nanotechnology is really small technology and occasionally I'll read something in The Guardian or wherever about – 'it's amazing, these guys have written their names in atoms on something' and you're like, wow, that's cool. And you have this very nebulous notion that this is really clever and that there are… all these possibilities that are, you know, waiting to be unlocked in nanotechnology. But I actually have no idea you know what they're really doing and or what these possibilities are. I just have this very vague notion that it's very clever and it could be really important. And that's kind of the epitome of what we were talking about before, about not really knowing the detail."
> (Group 3)

This background and vaguely affirmative sensibility can help to explain the relatively positive perceptions of nanotechnology found in attitudinal survey research (BAINBRIDGE, 2002; GASKELL; ALLUM; STARES, 2003; LEE; SCHEUFELE; LEWENSTEIN, 2005; MACOUBRIE, 2005), where people may be responding broadly to the connotations of the term 'technology' without much understanding of the detail. Thus, Americans may be adopting modestly more positive attitudes than Europeans reflecting their apparently more 'pro-technology' values (GASKELL et al., 2005). In contrast to the research cited above our interest lay in the examination of the process through which attitudes evolved and were expressed, and in their underlying narrative structure. Perhaps the over-riding impression gained in our research was the difficulty of grasping what nanotechnology was, of what it might do across different areas of application, and importantly how it was likely to impinge on everyday life. The passages below, at a stage of discussion following a period of research and reflection, illustrates how two of the discussion groups struggled to develop and fix their own thinking:

> Phil: "It's just so difficult to grasp…"
>
> Dave: "That's why it's so hard to make a decision on whether you think it's positive or negative. It's so huge, it's not like a single thing like cloning is… it's such a huge area."
>
> Louise: "Now, I don't, I've gone completely the other way. Well, it's when he starts to talk…"
>
> Lynne: "I think they need to… separate the different areas of nanotechnology in order to get a grasp of what it is… because it's very easy to look at everything at once and get a bit overwhelmed. So you could look at – this is where it could go medically, this is where it could go militarily, this is where it could go manufacturing wise sort of thing."
>
> (Group 5)
>
> Rochelle: "It's so extreme the way they're using it now. From things like as I said, from packaging to medicines to animals. It is so vast the whole scope."
>
> Karen: "It depends whose hands it falls into."

> Renee: "I was surprised [by] the amount of different things they were talking about and in a way I was, I don't know, felt annoyed that I didn't know more about it, because there's obviously scientists actively talking now, developing these sorts of things, and there's been no sort of discussion. I mean I didn't even know really what it was, about whether or not it's appropriate that they should be doing these things."
>
> (Group 4)

Examining the narrative process through which people came to develop collective and shared accounts of what was 'at stake' in nanotechnology was a key objective of the research and was found to be linked to people's assessments of the institutional dynamics seen as likely to govern the development, regulation and oversight of the technology. Typically, the evolution of expressed attitudes followed a pattern roughly as follows: from a state of initial ignorance, to surprise at how much research and R&D was being invested by both governments and industry, to enthusiasm as to the potential for social good not least in the medical domain, to unease and anxiety that nanotechnology innovation might lead to largely unanticipated and disruptive problems in real-world circumstances, to pessimism over our ability to govern and regulate the technology for the common good. What led people to positions of unease and apprehension was not simply a consequence of realising that nanotechnology would enable scientists and other actors to extend control radically over matter, nature and the human body; but that such control over the pace, scope and direction of change would be governed by powerful bodies, propelled by the logics of industrial capitalism, and where the lay public would be 'left in the dark'. These perceived 'real world' dynamics led to predictions that nanotechnologies would exacerbate global inequality and facilitate evermore intense subjection of individual bodies. What emerged thus was a dense array of concerns; few specific or unique to nanotechnology but distinctive in their sheer breadth and convergence. For reasons that will be discussed later in this paper, nanotechnology appeared to have *intensified* response along familiar and consistent themes around the body, unanticipated risks, nature's revenge, control, inequalities, and pace of change. For many people the anxiety potential of nanotechnology came to the fore in relation to the concerns of nanoparticles potentially violating bodily processes, either through cosmetics or foods. Just as genetically modified foods heightened concern on account of being undetectable by texture, smell or appearance (ADAM, 1998), the invisibility of nanoparticles and their potential ubiquity into everyday consumer goods resonated with background fears linked to an enduring narrative of 'bodily invasion'.

> Rosie: "I imagine. This face cream which has got very small nanoparticles in it, I don't know whether it's made of nanoparticles or whether it's just using nanotechnology. But if I rub that on my skin or someone's rubbing it into their skin and therefore there's things going into my skin I'm not aware of. We've already said this really but no-one knows exactly what that's going to do and it might have long term effects where, just imagine, free radicals which I'm sure you know potentially make cells get confused and breaks the genes in the cells and makes them grow out of control.

> Any little bit of dirt, like something that shouldn't be in there pops into the cell, messes with the actual sequence of what that cell does and you know – that's so scary."
>
> Julie: "Yeah because it can happen without you realising, whereas before, things, if they were going to invade your body or invade something, you would see it happening."
>
> Philip: "It's the invisible threat."
>
> Julie: "Yeah, that's it."
>
> Helen: "Because you cannot see it…"
>
> (Group 5)

A visceral example of this dynamic was voiced in the London group of mothers. In the initial session these women had clearly enjoyed the proposition that nanotechnology might visibly and demonstrably ameliorate signs of ageing through newly potent anti-wrinkle creams. Now, when confronted by acknowledged uncertainties as to the potential toxicological effects of nanoparticles, the conversation shifted in tone:

> Rochelle: "Since last week I've completely changed my approach to these creams. When you said it had those 'nanosomes', I thought, 'oh great, fantastic, I'd use it' – [now] I wouldn't touch it now with a barge pole [even] if you paid me money to put that stuff on my face now. It's so frightening."
>
> Victoria: "I think we're very trusting as buyers in the market, or in general, the public, we're very trusting of the products we're given and, the thing is, now you find out afterwards – we're suddenly having to become very sceptical because things come out afterwards."
>
> Renee: "Well, you sort of assume it's always been tested."
>
> Karen: "Yes."
>
> Renee: "Which clearly obviously things like cosmetics don't have the controls that the drugs do."
>
> Rochelle: "But surely wouldn't they be better to sort of like say, right, we don't know enough, and until we know enough, or we've changed our regulations, or whatever, then we don't let it go on the market."
>
> Victoria: "There's too much money in it I think."
>
> (Group 4)

The potential for harm – for example in the unknown toxicity of nanoparticles – was commonly seen as symptomatic of the wider phenomena of advanced technology proceeding in the face of natural limits and processes. Genetically modified foods, MRSA (Methicillin-resistant Staphylococcus aureus), mad cow disease and others, were presented

as examples of technological innovation that had been developed in the face of unanticipated risks of a complex and uncertain nature. Beck's 'Risk Society' had become an everyday reality (BECK, 1992). Nanotechnology was seen as a further and worrying extension of this dynamic, led, as it appeared to be, through a hubristic sense of its perceived ability to transform both society and nature:

> James: "They will find new bacteria and we will be more resistant. Antibiotics and things are becoming resistant. There will be more diseases that will come. We will never completely get rid of disease."
>
> (Group 5)
>
> Neil: "I think it's accelerating the evolution of disasters… You were going on – on the board there – about accelerating the evolution of human systems, brain power and healing powers and stuff. It'll get 'out of the cage', I'm sure, and evolve through various bio-strains and mechanisms and it will be adapted, possibly. There are cases with GM super weeds now."
>
> (Group 1)

5 *The metaphysical explanation*

So why did nanotechnology present such troubling visions. There are perhaps three interlocking explanations. First, people responded to the metaphysics embedded in the radical and utopian vision of nanotechnology as cause for alarm. The metaphysical project, common in this particular narrative of nanotechnology, presents the technology as an enabler of human capacities, needs, desires and potentialities. Through nanotechnology, the argument runs, people will be able to transcend their material and 'natural' constraints and thus realise full liberation and emancipation. While such a narrative has been given most visible expression in the National Science Foundation report on Converging Technologies (ROCO; BAINBRIDGE, 2002), it nevertheless represents a wider emergent style of thought characteristic of much of nanotechnology in the US policy context (NORDMANN, 2007), and reflective more widely of characteristically American ideals of technology (NOBLE, 1999). Below is how one of the groups attempted to express what they found troubling in this vision:

> Neil: "If you actually took that wholly on board, everything that's printed on there, it's quite a frightening scenario, isn't it. So this wonderful nanotechnology is going to be a cure all for all human ills, it's going to make us all super brilliant and clever and work that much better, our transport's going to be far better even though the fact that nobody will be dying of old age, nobody will be dying of any illnesses so we won't be able to move on this planet. Yet we'll be able to move about quicker because the trains or whatever will be much more efficient. It's – a lot of what is written there is really [is] in effect going against nature isn't it, it's trying to

> beat nature at its own game and going back to what I said before about the medical side of it, it is rather frightening I think. It is very welcoming if it's used to treat cancers and stuff like that but I think that somewhere along the line we're getting into this Brave New World scenario here where everything's [pause], it's this ideal world where everyone lives forever and everybody has everything, everybody can do everything… It's [a] very, very frightening scenario."
>
> Steve: "Well there's echoes of science fiction coming through, Brave New World, to space exploration, super new transit systems and just human evolution as well, being accelerated."
>
> Neil: "But going back to our earlier conversation about the pace of change and there doesn't seem to be any stopping it, this is only 10^{-9}, so 20 years on are we on 10^{-12} and 10^{-15}, this is just the next step …"
>
> Barry: "Exactly. When do you get to that final point, the absolute if you like? They may be nearly there but they may not be."
>
> (Group 1)

These were not gut reactions to some rather optimistic claims of the benefits of a particular technology. Rather, they represented deeper unease with the metaphysical programme driving the technology, its embedded assumptions of what constitutes human progress and improvement, and its potentially troubling implications for wider society. Perhaps even more than biotechnologies, here was a technological programme based on a style of thought that conceives of nature and humans as infinitely malleable, and which presents a thoroughly questionable view of human improvement as given. Jean-Pierre Dupuy has developed a critical analysis of the metaphysical programme that underpins radical nanotechnology and its convergence with biotechnology, information technology and cognitive science (DUPUY, 2007, 2009; DUPUY; GRINBAUM, 2004). For Dupuy, perhaps the most conspicuous element of the nanotechnological dream is its dissatisfaction with the world as inherited through 'bricolage' and 'hit and miss' evolutionary process (DUPUY, 2009). By contrast, the world – and its component constituents of living and non-living matter – is in principle reconstructable and thus available for redesign and improvement, literally from the bottom-up, atom by atom. Indeed, nanotechnology's much cited goal of 'controlling the structure of matter' through interventions at the nanoscale (from 1-100 nm), is at that precise scale at which the distinction between life and non-life has lost all meaning. For Dupuy (2009) this represents a deliberate and clandestine attempt to blur a fundamental distinction that has until now been a significant source of everyday moral judgement and ethical reason.

The imputed ideal of a hyper-technological age involving radical 'improvements' in bodily function and capacity was debated in other groups. While superficially appealing to some, these developments were seen to raise substantial moral and social issues, not least the ability for governments, industry and other darker forces to exercise sufficiently robust

forms of control and oversight over its mediation on everyday life activities. The consensual response was to appeal for such innovations to 'slow down' to ensure that scientific advance was properly in tune with wider public values and societal oversight. The discussion below highlights the sensed dangers of technology proceeding *as if* it, and we, were not part of life and natural process:

> Sally: "I find it quite daunting actually, I find it a bit scary."
>
> Rochelle: "This is the vision of the robotic environment with everything controlled for you and everything 100% perfect and plastic."
>
> Renee: "It's like even the food… Food has got a process the same as we've got a natural process you know, you're born, you get older, you get wrinkles, you die. Same as fruit, you buy a piece of fruit it's healthy, after a piece of time it wrinkles you throw it away or whatever and that is a natural process and I think in some ways it's kind of fiddling with that natural process."
>
> Moderator: "So you think skin should be allowed to wrinkle?"
>
> Rochelle: "Well at the end of the day it's… it's part of life – if we all looked 36 or 37 or whatever."
>
> Karen: "It's just if you get rid of the wrinkles by whatever, are you going to end up causing cancer or something else you haven't even invented yet."
>
> (Group 4)

How should one characterise the ethical character of concerns that are being appealed to? As with Davies (2006) characterisation of ethical talk on xenotransplantation, it is apparent that nanotechnologies have the potential to blur key distinctions through which social life is ordered. This constitutes the second explanation and includes, *inter alia*, the blurring of the idea that enhancement is distinct from therapy, that we can never completely get rid of diseases, that humans live and die, that humans and machines are fundamentally distinct, that matter can be made from the bottom up, and that everything can be made, unmade and remade[1]. It is the perceived neglect of such boundary work within the broader nanotechnology community – or what Dupuy (2009) calls a false humility that consists in denying that anyone has been done out of the ordinary – that people found disturbing, as illustrated in one particular apt remark by a participant in Group 5: *'It's like nanotechnology is the new God'*. This comment, deploying the 'false humility' narrative, reflects not simply the perceived lack of limits in much of nanotechnology talk, but the more troubling perception that nanoscientists were proceeding with little regard or understanding or even awareness of the endeavour in which they were participating. In particular, and making use of an older set of metaphysical assumptions premised on the notion that there exists a wider patterning and order to life which we ignore at our peril, were expressed concerns about the 'unnaturalness' of the undertaking. One way in which this was expressed was in arguments on the likelihood of 'nature's revenge': that the more radical and interventionist the attempt to control and intervene in nature the stronger and more potent the likely retort. The exchange below

articulates the use of such a 'Promeathean' narrative, and of nature taking vengeance as a direct consequence of our interference and meddling:

> Julie: "That's the problem, is what we're interfering with again is nature, the natural cycle of things, which is where I have a problem. It's partly that it is sort of right that sometimes crops are wiped out, there's sort of a reason for everything I think."
>
> Rosie: "I wouldn't trust nature not to seize upon it as it's done with these super-weeds…"
>
> (Group 2)

An interesting variant of the above critique were accounts arising from the mechanistic metaphor that tends to imbue much nanotechnology rhetoric. Bernadette Bensaude-Vincent analyses the ways in which molecular biology and materials science converge on a thoroughly 'artificialist view of nature'. She sets out the multiple ways in which nanotechnologies rely on a conception of biological life and the human body using mechanistic concepts and metaphors: most notably around the cell and its molecular components as nanoscale machines (BENSAUDE-VINCENT, 2004). Using George Canguilhem as inspiration, she argues that that such a project has demonstrable ethical components, and that the mechanization of life is inseparable from a project of instrumentalization of life and control over nature. In our discussion groups, the extreme mechanization which nanotechnology represents was also seen as connected to forms of government and corporate control and their propensity for new and more direct forms of subjection. This unease, making use of such 'artificialist' narrative, was voiced eloquently by the one of the London groups, that, 'we're turning into robots':

> Renee: "I mean it's exactly what somebody over here said before, we're turning into robots. That is exactly what it sounds like…"
>
> Renee: "When it comes directly to human beings and trying to make them…, it's like trying to make a perfect race again, going to that."
>
> Karen: "We just don't know the long term effects do we, that's the problem."
>
> Renee: "But you have to know the side effects and what we're letting ourselves in for."
>
> Toni: "So basically our generation's going to be like the ones that they test this all out on, if it all goes horribly wrong, we'll be the guinea pigs."
>
> (Group 4)

Again Dupuy provides a metaphysical explanation to such commentary arguing that precisely when 'being human' is reduced to the status of an object that can be fashioned and shaped at will – the very conception of mind as machine that enables us to imagine our ability to recreate life and matter in our own image – we lose much of our ethical capacity for critical reflection (DUPUY, 2009). Without ethical boundaries grounded in a

conception of social order the concept of self limitation loses meaning. In such an ethically restricted world there is little reason to presume why nanotechnologies will not be deployed to extend control and reduce autonomy. The exchange points to the forms of subjection that a programme of human enhancement was seen as likely to engender:

> Paul: "I think the worrying thing for me… is that it's almost as though we lose control of what's going on because the technology itself is capable of almost taking, replicating, and almost making, you know, pretty much making its own decisions."
>
> Philip: "I think that is a big problem. It's like the thing you were saying with the creativity as well. If the human controls the technology that's fine, as soon as it becomes the technology making all the decisions then that's when you have a problem, because… humans are completely different from a computer."
>
> Paul: "There's some scary dark futures where you have strains of children who are, and are not enhanced in some way, and that's a really dodgy thing. I mean enhancement, the ageing process and things like that…"
>
> James: "Do you have your kids injected at birth to enhance their, the way their muscles grow and things…"
>
> (Group 5)

The above dynamics contributed to the sensed difficulty of developing robust and effective systems of governance and regulation. One the one hand, there was a perceived requirement for wise and strong forms of government and oversight. Yet, on the other hand, there was a shared concern that governance structures and requirements would be compromised, inevitably, by 'real-world' contingencies arising from the constraints of living in a globalised economy as well as the sensed intractability of nanotechnology's metaphysical programme. Crudely, it was seen as unrealistic to advocate a 'slow down' or to develop a properly cautious approach to nanotechnological innovation. A couple of variations were mobilised in the discussions: that an overly precautionary approach would lead inevitably to outward investment; that Government has a poor track record in sorting out even modest technological controversies such as mobile phone masts; that much of innovation is transnational and pretty much beyond the control of individual governments; and that the pressure for commercial return will inevitably lead to corners being cut.

> Karen: "…it is interesting to say that that [referring to previous conversation on the need for research into the toxicity of nanoparticles] will take years and years, yet the whole thing we've been talking about is that these things happen so quickly, so why can't we slow it down, is it going to matter that much if it is slowed down?"
>
> Others: "mmm, yeah, slowed down, yeah"

> Rosie: "But the only thing is, say this country does that and slows it down, then you're gonna go abroad…yeah, and it's gonna come back into this country anyway."
>
> (Group 2)

6 *Some reflections*

This research presents a picture of emergent public opinion characterised by a dense array of issues – moral, social, political, as well as technical – and of the fundamental challenges this poses for governance. Importantly, it suggests that the public can differentiate these issues, and deliberate their social meanings in more complex terms than simply as 'risks' and 'benefits'. Perhaps most significantly it offers an explanation as to why people expressed such bleak and pessimistic views on the future prospects of the technology; that just when we as a collectivity require strong ethical and regulatory governance structures to guide and shape the development of nanotechnologies in socially progressive and responsive directions, that very possibility appears to be denied by a socio-technical system that believes that nothing special is being undertaken, that considers its dreams of control and improvement to require little external endorsement or explanation, and that is embedded within a set of master narratives in which science and technology are staged unambiguously as the solution to a range of social ills (COMMISSION OF THE EUROPEAN COMMUNITIES, 2007). Faced by such double-blind it is inevitable that people respond to what is at hand, mobilising the range of cultural resources and 'folk theories' through which they can make sense and render familiar a strange, uncanny and potentially transformative set of technologies (RIP, 2006). For this reason it is important to articulate the kinds of narrative argumentative strategies used by participants to justify their positions.

Parallel research has outlined several prominent tropes and narratives underpinning public responses to nanotechnology: ranging from the 'slippery slope' narrative, that technological advances that seem beneficial now will inevitably evoke further technological steps and applications that are morally doubtful; the 'colonisation' narrative, that technology will spread out and ultimately colonise life denying autonomy and agency; the 'Dr Strangelove' narrative, that advanced science designed for 'good use' will become corrupted and manipulated by evil people for evil purposes; the 'Trojan Horse' narrative, that innovations developed for progressive purposes will in the long term have unforeseen and potentially irreversible effects; and the 'it's out' narrative, that involves the accidental release of harmful substances often due to technological and/or human failure (SWIERSTRA; RIP, 2006; REJESKI, 2007). In our research we can add at least five further narrative variations through which people were able to develop viewpoints and argumentative positions. These include: the 'left in the dark' narrative, that nanotechnology reflects a further instance of not being able to participate in decisions that will structure future social relationships; the 'bodily invasion' narrative, that involves the introduction of invisible substances that subsequently violate natural processes; the 'Promethean' narrative, involving nature taking retribution on nanoscience's hubristic sense of its ability to transform both nature and humans to its own will and in violation and disregard for evolutionary process; the 'artificialist' narrative,

that inadvertently instrumentalises life and human relationships through conceiving of biological and mental life purely as machines; and the 'false modesty' narrative, involving the pretense that nothing special is being undertaken.

This research thus endorses and compliments David Rejeski's argument that it is illusory to suppose that nano fear will disappear (REJESKI, 2007). By contrast, our research points to a wide range of common narratives that continue to shape and structure popular responses to science and technology. Of course, there exist counter narratives too, around technology as progress, science as salvation and enabler, and so on. But such narratives will be played out on the larger cultural stage whose interplay will depend on complex institutional dynamics, not least around the sensed ability of governments and corporations to provide leadership, authority, effective regulation and adequate control in the face of a scientific enterprise whose purposes and priorities are increasingly questioned.

In this respect this paper contributes to what has been termed the 'new scientific governance' (IRWIN, 2006) but in a manner less concerned with the tacit power relations in public engagement exercises and more concerned with the ways in which master narratives of science and technology may be imposing social order in unaccountable and potentially troubling ways. Building on the analysis undertaken in the European Commission working document 'Taking European Knowledge Seriously', this paper gives empirical grounding to the claim that the institutional framing of advanced science and technology (in this case nanotechnology) is in danger of becoming seriously dislocated from wider cultural values and aspirations (COMMISSION OF THE EUROPEAN COMMUNITIES, 2007). Developing institutional reflexivity and understanding of the factors underlying public uneasiness with science will be a major challenge in which the social sciences offer a modest contribution.

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Notas

[1] I am in debted to Alfred Nordmann for this observation.

RESUMOS/ABSTRACTS

ENGAGING NANOTECHNOLOGIES: A CASE STUDY OF 'UPSTREAM' PUBLIC ENGAGEMENT

PHIL MACNAGHTEN

Abstract: This paper develops an analysis of the factors likely to shape future public responses to the social and ethical dimensions of emerging nanotechnologies. The research was designed to offer insight into the following: what sorts of issues are likely under current circumstances to shape public attitudes towards nanotechnologies; what narrative resources do people draw upon to develop their thinking; how do public attitudes evolve through social interaction and knowledge generation; and to what extent can expressed concerns be understood as emblematic of wider societal dilemmas.

Keywords: Nanotechnologies. Anticipatory governance. Public attitudes. Narrative. Metaphysics. Upstream public engagement.

Nanotecnologias e governança: um estudo de caso de envolvimento público em uma ciência em construção

Resumo: *Este artigo desenvolve uma análise dos fatores suscetíveis de moldarem as respostas futuras do público frente às dimensões sociais e éticas das nanotecnologias emergentes. A pesquisa foi construída para oferecer* ***insights*** *sobre as seguintes questões: quais os tipos de questões capazes, nas circunstâncias atuais, de moldar as atitudes do público sobre nanotecnologias; quais as fontes de narrativas em torno das quais as pessoas desenvolvem seu pensamento; como as atitudes do público evoluem através da interação social e geração de conhecimento; e até que ponto as preocupações manifestadas podem ser entendidas como emblemáticas de dilemas societais maiores.*

Palavras-chave: *Nanotecnologias. Governança antecipatória. Atitudes do público. Narrativa. Metafísica. Upstream public engagement.*