Social Perspectives on Nanotechnology Research and Development: A view from Australia

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Abstract

There are growing calls for the evaluation, regulation and improved governance of nanotechnologies to anticipate and address their likely social impacts. The national science research organisation in Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is carrying out scientific research at the nanoscale in a range of areas. At the same time as the technical work, a team of social scientists has concentrated on the social implications and public perceptions of nanotechnologies in a local Australian context.

In this paper we introduce some of the findings of our experiences in public engagement approaches and our attempts to integrate these into research governance within CSIRO. We describe some of the key concerns about nanotechnologies as raised by participants in our research and reflect on some of the tensions and challenges such forums raise for social scientists working as practitioner-researchers within scientific institutions, and discuss issues of contingency and contestability in relation to our research findings.

Introduction

In Australia and elsewhere, there has been increasing recognition of the need for the evaluation, regulation and improved governance of nanotechnologies. As part of this, there have also been calls for public and scientific debates in order to anticipate and address the likely social, environmental and ethical impacts of such technologies. The national science research organisation in Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is carrying out scientific research at the nanoscale in a range of areas. At the same time as the technical work, a small team of social scientists has concentrated on the social implications and public perceptions of nanotechnologies in a local Australian context. Working across two interrelated projects, this team has explored social perspectives on nanotechnology research and development. The twin objectives of this research were – firstly – to establish a discussion between CSIRO and 'interested publics' (Dietrich and Schibeci 2003)[1] on the implications of the CSIRO-designated 'emerging science' of nanotechnology. The second objective was to explore ways of integrating a broader range of perspectives on science and technology into research planning and assessment within CSIRO.

One of the interesting dimensions of the two projects – and something we discuss further in the paper – was the involvement of scientists and technologists researching and developing nanotechnology applications. The project team consisted of the Research Manager and Director, Nanotechnology Centre (within CSIRO's Manufacturing and Infrastructure Technologies division) as well as the Director of CSIRO's Emerging Science Area of Nanotechnology (now a non-operational grouping as nanotechnology activities are carried out under different umbrellas).

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[1] Dietrich and Schibeci (2003) suggest the term 'interested publics' to collectively refer to not only scientific 'experts' but also 'lay unrecognized experts' including government, non-government, industry and community-based groups, along with general community members. Methodologically, the issue then is not simply one of bringing together 'the public' and 'scientists' in order to foster a dialogue between two separate spheres, but rather to investigate strategies and approaches that enable us to bridge knowledge divides and find common ground across conflicting values that necessarily exist within a broadly-conceived 'public'.

In this paper, we start with an overview of our findings from two public engagement workshops. Following this, we turn to reflect on the use of public participatory approaches in the area of nanotechnology development. While our research team is committed to public participatory approaches in this area, we are nevertheless aware of the need to be self-reflective about the knowledge claims that can be made on the basis of two small public engagement workshops. As we discuss below, participatory approaches – and knowledge claims made on the basis of such approaches – need to address important issues in terms of their own contingency and contestability (Stirling 2005). For this reason, a principal challenge facing researchers using participatory approaches in the social assessment of technology is how to draw generalisations and insights without decontextualising participants' comments from the general and particular frameworks in which these comments are made. Participants' claims and evaluations necessarily draw on broader evaluations and interpretative frameworks, such as the nature of scientific research in general. They also reframe these ideas in response to the highly specific and contingent discussion (or set of discussions) established within the specific context of the workshop itself.

A tale of two projects

As noted above, this paper is extensively based on two one-day public engagement workshops held in the Victorian regional city of Bendigo and in the metropolitan city of Melbourne held in March and December 2004.

Bendigo workshop

The Bendigo workshop brought together 22 participants composed of CSIRO staff, nanotechnology specialists, government representatives, and people living in the region in order to learn about and discuss some of the applications and possible implications resulting from nanotechnology research and development. Its purpose was to listen to and analyse public input in order to begin the process of shaping an ethical and ecological framework with which to evaluate research decisions within CSIRO around this set of emerging technology.

Participants were predominantly non-scientists, rural though not necessarily primary producers. There were also a number of CSIRO and university scientists, some working at the nanoscale and others specialists in other areas. Most local participants were invited – some required persuasion as the relevance of nanotechnology was not clear to them. Those who did attend included a number of teachers, local council workers, retirees and others who could take leave from work. Many were also active in regional social and environmental groups, such as land care, energy networks and affordable housing.

In general, the Bendigo workshop participants highlighted issues related to regional economic development, as well as to public health and safety. They wanted CSIRO to demonstrate that it takes the issue of public participatory processes seriously, by being more proactive in conducting and funding effective public communication and participatory research activities. As part of this, they wanted CSIRO to foster an understanding of and commitment to the needs and priorities of rural and regional Australians. As they recognised, this would require CSIRO to address issues arising from the potential conflict between matters of public interest and those of commercial confidentiality.

After listening to two presentations by nanoscientists in the morning on 'what is nanotechnology', participants were divided into small groups and asked to role play the Bendigo Regional Development Committee. Each group was tasked with constructing a list of criteria to be used to judge a proposed nanotechnology proposal (or scenario). The object of the task was not for the small groups to come up with a definitive opinion on whether their specific nanotechnology project should be supported, but rather to compose a list of criteria required to evaluate the proposal. In this way we hoped to understand the values people draw on to assess technology, in a belief that values, beliefs and practices are mutually constitutive. To assist them, the five different scenarios included background information from both enthusiasts of similar applications and those wary of potential nanotechnology products or uses. An extract of

one scenario, the food-related scenario, is presented below, along with the criteria developed by participants. The other four scenarios on health, smart clothing, energy and *Fusarium* (a type of wheat fungus) were considered via a similar process by their groups and are described more fully in the project report.[2]

Food-related Scenario

> Your region covers one of the main agricultural and food production centres in Victoria. The impact of nanotechnology on local producers and food packing companies is unclear, although there is the potential that smart packaging of food will extend shelf life and expand global markets. The Victorian Farmers Federation (VFF) proposes to study the impact of nanotechnology on the region's agricultural sector.

In commenting on their discussion, the group noted that the VFF represents only around 50 percent of local farmers. For this reason, they argued, the proposal needs to consider other perspectives and to be evaluated in a broader context. For example, they noted that the most critical regional issues facing Bendigo relate to the viability of the family farm (e.g. the ageing farm workforce) and water supply and pricing. These critical issues were incorporated into their list of nine criteria discussed below, suggesting the extent to which participants frame evaluation of new technologies in relation to notions of livelihoods, rights, and justice (see also, Leach, Scoones and Wynne, 2005:11).

Subsequently, the nine criteria can be broken down into three themes: the broader consideration of technology in relation to critical issues facing the region; the impact of the specific proposal on the region; and the impact of the specific proposal downstream and in general. Firstly, in terms of broader assessment of nanotechnology, participants were interested to know the likely impact on local water use. In general, the question was asked how 'we' can deploy nanotechnology to help with water usage and costs. Any discussion point referred to the likely contribution of nanotechnology to the inter-generational viability of the family farm and sustainability of the local community. The question was asked whether new nanotechnologies could assist with other complementary products. For example, could nanotechnology be deployed to assist farmers to use stubble to produce ethanol? Or was there potential for nanofertilisers incorporating a time release sensor? The possibility of remote sensors, however, provoked concern that information technology capabilities may allow producers to remotely control production activities. What participants did <u>not</u> want to see was the use of technology to support agribusiness: they wanted the technology used to maintain the traditional model of farms so farmers could continue to live locally.

The next set of criteria referred to particularities of the proposal, specifically on the design and impact of 'smart' food packaging; namely, how does this product contribute to improvements in product use (including life-cycle analysis), what are the impacts of freight and storage on the Bendigo region and further downstream? So, for example, the question was asked whether 'locals' could anticipate benefits from the improved freight and storage of locally produced food. The issue of who carries the cost was also debated, with recommendations that the proposal needs to consider whether any cost savings stay in the area. The final comment: "We want to be a food basket – not a basket case", in many ways summed up participants' views.

However, the concern over the specifics of the proposed project (smart packaging) was not limited to local issues alone. Participants argued that the impact and cost-benefit of new forms of packaging should be incorporated into the proposal's background study. Participants noted in particular a concern with recycling and life-cycle analysis, as well a desire to reduce energy use both locally and in general. They did not want a situation where they (Bendigo) reduced energy use or accrued other benefits, only to pass on additional costs to the end user. Finally, there was general consensus that there needs to be community approval. They were concerned to ensure that 'we' take the community along with us by inquiring, for example, whether the quality of the food is really improved.

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[2] For further information, please refer to Nanotechnology: The Bendigo Workshop, DMR-2561. available at http://www.minerals.csiro.au/sd/index.html.

Melbourne workshop

The 17 participants at the Melbourne workshop included Melbourne-based and self-selected participants who responded to advertisements in the local media. A number of these participants were associated with civil society groups such as environmental and/or ethically oriented non-government organisations (NGOs).[3] In addition, three science reporters (for a national, an interstate and a local radio network) were in attendance. The day began with six 'expert' presentations on nanoscience; a business and investment perspective; ethical and social issues; and environment and ecology. Participants were placed in three 'stakeholder' groups – community, government and industry – and invited to question the 'experts' from their stakeholder perspective. Stakeholder groups were then asked to formulate a separate response to the hypothetical scenario: 'What statement will Australia make to the United Nations Forum on Nanotechnology in 2006?'

Three statements capture much of the discussion, feeling, intent and views of the three groups:

- Democratic accountability is important in science and technology research and development. Australians have shown themselves to be interested the impacts of nanotechnology and other emerging technologies, and CSIRO and similar organisations have nothing to fear from a genuine proactive science-community dialogue.
- A higher level of transparency and openness from researchers than has been the case in the past is needed. The potential for growth of industrial applications of nanotechnology research and development is exciting, but its development should be used to decouple resource consumption from economic growth through initiatives in the recovery, recycling and reuse of material products as well as ensuring the cleanness of natural resources used like water, soil and air.
- The commercial development of a nanotechnology industry requires international equity (or 'level playing field') to allow local industry and smaller players to survive and develop.

It is worth mentioning two sets of issues related to (1) health, safety and regulation, and to (2) intellectual property, ownership and control, as these themes have been raised in similar participatory exercises elsewhere, such as the 2005 Nano Jury exercise in the UK (Nano Jury, 2005), and the 2004 Danish Board of Technology's survey on citizens' attitudes (DBT, 2004). In relation to health, safety and regulation, some participants were familiar with the debates over the safety of carbon nanotubes (for example, Kleiner 2003) and were concerned that this, and perhaps other similar nanoscale materials such as titanium dioxide nanoparticles used in sunscreens, would become 'the new asbestos'. These concerns were raised in the context of notorious cases, such as 'mad cow disease' from beef in the UK and asbestosis from building products in Australia, where public health and safety did not triumph over other commercial motives. Underlying the dominance of this issue appeared to be a sense of regulatory failure and a lack of trust in both private and public institutions to protect the public interest.

A related set of issues centred on intellectual property, ownership and control of new technologies. While specific nanotechnologies were not discussed, the experience of dominant or monopolistic companies emerging in other sectors such as computing software (Microsoft) and biotechnology (Monsanto) were invoked. The concentration of ownership and control of new technologies were seen to raise particular difficulties for national regulatory systems. There were associated issues raised as to whether nanotechnologies will be chosen or imposed on consumers, and whether different social groups will have equitable access or if some will be disadvantaged by the introduction of new technologies.

[3] For details refer to Citizens' Panel on Nanotechnology: Report to Participants, DMR 2673 available at http://www.minerals.csiro.au/sd/index.html

Different perspectives on nanotechnology/nanotechnologies

In general, participants expressed widespread support for public engagement on the part of CSIRO, particularly in relation to CSIRO's role as a 'public good' research organisation. For some this meant that CSIRO should be involved in national and international discussions on the regulation and development of nanotechnology, while others wanted CSIRO to first demonstrate its own level of trustworthiness in more concrete ways, such as being transparent about its research relationships with commercial organisations and demonstrating independent health and safety, environmental and social impact assessments of its own nanotechnology research and development. The mix of CSIRO scientists and non-scientist participants was an important component to this discussion, and indeed the workshops. At the very least, the active participation of CSIRO scientists demonstrated some level of commitment regarding CSIRO's claim to be interested in public engagement.

At another level, however, this mix of participants resulted in two highly complex workshop environments. As is perhaps to be expected, we were not all there for the same reasons and this resulted in quite significant tensions and differences in opinion as noted below. For example, we (the authors of this paper and the main organisers and facilitators of the workshops) can best explain our involvement in terms of a normative commitment to participatory research. This commitment is derived from our understanding of the contingency of scientific and technological endeavours, our ideas about deliberative democracy, and our belief in the importance of different perspectives and disciplines in framing and addressing problems. We would also like to think that our reasons for engaging interested publics in social research around nanotechnology are substantive, i.e. that such participation will bring about better ends. But the issue is not simply one of bringing together 'the public' and 'scientists' in order to foster a dialogue between two separate spheres; rather, to investigate ambiguous and contested knowledge divides that exist within a broadly-conceived 'public' and where possible find common ground across conflicting values.

The diversity of opinions raised in the project was not something that could be 'smoothed over' or 'talked through'. Even within our project group there were different objectives, such as between those who justified the workshops in the above terms and those who justified them in terms of identifying public priorities and perceptions This common justification was most often made by scientists (both CSIRO and non-CSIRO), and can be interpreted as response to the deep structural states of risk and fear that characterise the practice of science in a 'risk society' (Beck 1992). Yet despite a commitment to being a willing listener, there are times when 'experts' find it difficult to accept and take on board 'lay' opinions. This can make it difficult for non-scientist to offer an opposing opinion. In our workshops, those who were most forthcoming in offering different interpretations of nanotechnology development were most often those strongly motivated by normative values of their own. In particular, the most vocal of these were often established non-government and/or academic critics of what they saw as economistic, market-push approaches to technology development, which they viewed as overwhelming wider social and ecological considerations.

There are at least two implications arising from this. Firstly, it is likely that forums of 'interested publics' will attract participants with conflicting interpretative frameworks and with different motivations. And while this is probably true for all public engagement exercises, it is more pronounced in emerging technology-related forums where risks cannot yet be measured, quantified, or even known. In addition, people's motivation for attending will shape their participation. For example, whether they want to open-up or close-down the process of technology choice (Stirling 2005) will influence the terms and nature of their participation. For this reason, the belief that such forums might be a way of achieving public acceptance of nanotechnology is unrealistic. Simply put, incompatible frameworks cannot be 'educated away'.

A second implication is the need to be circumspect in how we assess the predictive value of such forums given that we are dealing with participants' interpretation, Interpretation is an act that necessarily takes place in a specific social context and in situated interactions; it is, as Bevir and Rhodes (2005) argue, *situated* meaning in action. The values and interpretive frames

displayed by our participants in their utterances and actions are therefore the outcome of particular contexts, strategies and exchanges. While it is quite possible that in many cases such values and frameworks draw upon long-standing ideas, beliefs and commitments, we cannot be sure that the same arguments, frameworks and positions would be articulated by the same participants in a different forum or venue. It is possible that in another context, participants might well express different choices, actions and behaviours – perhaps even in part as a result of their interaction in that forum. Nanotechnology brings an added degree of contingency here as it is still an unfamiliar set of technologies for most people.

One example relating to the representation and discussion of nanotechnology from the two workshops may help to clarify the importance of context. The Bendigo workshop consisted predominantly of rural residents, the majority of whom were invited via a key informant process rather than self-selected. There were several participants who were there as individuals but also played roles in local energy and community-based organisations. In this workshop, two scientists researching in the area of nanotechnology (one from CSIRO and one from the University of Technology Sydney) presented an overview of nanotechnology and a range of potential nanotechnology products and applications, in areas as diverse as health care, food packaging and building materials. Two compelling representations of nanotechnology were constructed in these 'expert' presentations. First, there was an implicit judgement that it made sense to talk about nanotechnology in the singular despite the acknowledged range of sciences and technologies involved. This was no doubt related to the presenters' intended aim to present nanotechnology in a direct and uncomplicated way to participants. Nonetheless, in doing so the presenters also endorsed to some extent the use of nanotechnology (singular) as a valid umbrella term, which conceptually unites a field of scientific enquiry working at, or approaching, the nanoscale. The other representation constructed during these presentations was the potentially radical nature of nanotechnology. Examples drawn on by the presenters reinforced an idea of the radically transformative implications of some nanotechnology. As a result, the representation of nanotechnology as composed of a diverse range of sciences and technologies – many still in the very early stages of development – was downplayed in preference for a more aggregated and transformative science-technology.

The second workshop, nine months later, saw a shift in this presentation of nanotechnology. Six presenters gave their perspective on the science, its commercialisation, its regulation, environmental assessment, ethical issues and social issues respectively. Some of the presenters emphasised the fallacy of conceptualising nanotechnology as single science-technology platform. A second and related shift was to downplay the transformative nature of nanoscale research and development. In response to critical questions from some participants, these shifts became more pronounced particularly from those presenters who supported a strong nanotechnology research and development program within Australia. In responding to more critical comments from participants, they stressed the iterative and cumulative nature of nanotechnology development. Nanotechnology from this perspective was referred to as a novel component – lying somewhere between the micro- and the nano-scale – in a range of mundane, everyday products. From the point of view of one workshop participant, the move to disaggregate nanotechnology in the workshop was strategic, or instrumentally motivated. For this participant, the danger of a more disaggregated view of nanotechnology was that it deflected from the need to consider nanotechnology governance from an industry-wide and national perspective.

Over time this shift has also become apparent in the public representation of nanotechnology, which suggests that we observed something more generalised forming in this local exchange. Many scientists working at the nanoscale within CSIRO have reverted to earlier terminology to explain their research area, such as advanced materials and molecular biology/manufacturing. Indeed the CSIRO's 'Emerging Science' area of nanotechnology which in part funded our research has also been dissolved. It seems plausible that there has been a shift in how scientists and their research organisations *interpret* contemporary social and political contexts, and in particular the perceived threat of a backlash against nanotechnology. In this context, many scientists and proponents active in the public domain may be distancing themselves and their research efforts from the notion of a radically transformative nanotechnology and are

disaggregating the range of science and technology platforms grouped together under the 'nanotechnology' umbrella. While a suspicious, mistrustful public might interpret this shift as a deliberate smoke-screening, others may also see this as responsiveness to a situated context.

Some reflections on contingency, contestability and policy

The cautionary tone we adopt with respect to the generalisability of findings from public consultation does not imply that public consultation has no relevance in terms of policy advice. This is one of the common misconceptions of interpretive approaches and reflects a narrow understanding that policy-relevant knowledge comes from prediction based models or correlation between independent variables (Bevir and Rhodes, 2005: 181). We believe that the value of our findings from the two public engagement forums is better seen in terms of 'informed conjecture' (Bevir and Rhodes 2005: 181). One area where we see we can play a possible role is in countering the exclusion of broader societal considerations which tends to accompany dominant discourses of technology and risk (Wynne 2002). While our findings are not predictive, they do provide qualified insight into the relationship between meaning and potential interpretative acts and provisional findings on the different understandings held by a variety of interested publics. At the same time, however, we recognize the complexities of representing the richness of differing views and perspectives, and how in analysing these, the tendency is towards a reductive picture and story. We have taken note of Stirling (2005: 229) who writes that the provision of 'plural and conditional' advice – as the outcome of what he terms an 'opening up' approach – may best serve the institutions and interests of a representative democracy. Certainly, we have been able to draw on research efforts here in Australia when invited by a number of government panels to comment on wider social and regulatory issues relating to nanotechnology.

Concluding remarks on the outcomes of our research

As well as the unpacking some of the social issues discussed above, our research underlines a real public desire for openness, transparency and engagement on the part of research institutions and an expectation on science organisations like CSIRO to be more proactive in understanding the needs and priorities of Australians. There is an opportunity to build on this public desire to understand and, more importantly, *inform* science directions, but much work remains within scientific institutions to clarify motivations and strengthen connections between public engagement exercises and research governance.

In 2005 and 2006 members of the research team and authors of this paper were invited on a number of occasions and in various forums to contribute to discussion at a national level. This includes a recent submission invited by the National Nanotechnology Task Force, which has been set up by the Australian Federal Government on the recommendation from the Nanotechnology Working Group of the Prime Ministerial Science, Engineering and Innovation Council (PMSEIC), and whose role it is to develop options for a whole-of-country, coordinated nanotechnology strategy.

In addition, in 2005 our research team conducted a project together with nanoscientists, technologists and other scientists within CSIRO. The goal was to impart the findings of these two public engagement forums, and, using actual cases of current research, explore possible responses to nanotechnology governance. The four responses elicited can be said to relate to different levels of action, that is, at the level of the individual scientist, of the project team, of science leaders and managers, and at the level of policy makers within the organisation. All four responses could include some form of public input which would add to the quality of the decision making. The four responses are briefly outlined here.

a) <u>Technology design to encourage accountability (or "at-the-bench" design)</u>
It is possible to insert an identifying marker in a nano-product that indicates its source. This may be an incentive for users and manufacturers to be accountable for what is made and likely to be used or misused.

b) Project proposals
These could include evidence of consideration of possible social and ethical implications of the proposed research, in much the same way as a scientist or science team has to include assessment of safety, and comment on level of risk.

c) Social and ethical guidelines
Research managers make decisions on which research to support, foster and prioritise. A framework or set of guidelines which have been drawn up using public input could assist in such decision making.

d) Culture response
Interactive, interdisciplinary workshops encourage thinking about different ways of doing science, and dialogue around the social, ethical, commercial and ecological aspects of nanotechnology research and development

So far as we know, not one of these possible responses has been adopted. As mentioned before, the term 'advanced materials' appears to have been substituted for 'nanotechnology', though we can only speculate as to why.

Our research team's experience accords with the view expressed by Leach et al (2005), that institutions of scientific knowledge have been invited to recognise "that publics have salient knowledges and critical perspectives that should be taken seriously as substantive inputs into the planning, design and implementation of scientific intervention and development initiatives previously assumed to be the sovereign domain of expert scientific bodies." We have conducted our public participatory research with the aim of 'opening up' and not 'closing down.' Evaluating outcomes of the research will in part depend on whether this has been achieved. For our audience of this paper, that is, other science, technology and society researchers, practitioners and policy makers, we hope we have elucidated some of the contingencies and contestabilities experienced in public engagement on some of the implications and social aspects of nanotechnology in Australia.

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