Nanotechnology, risk and sustainability: moving public engagement upsteam

The proposal

A new generation of potentially controversial technologies is emerging, posing novel challenges for processes of democratic debate and regulation (Joy 2000, Better Regulation Task Force 2003). Nanotechnology looks set to become the next focus for heated debate about the relationship between new technologies, risk and sustainability (ETC Group 2003, Burke 2003). This project focuses on three specific applications of nanotechnology – in healthcare, computing and cosmetics – so as to open up wider ethical and socio-political issues for public discussion. The project asks how, in the light of recent experiences with biotechnology, socially and environmentally-sensitive governance processes might be developed, which can improve the contribution of nanotechnology to sustainable development, by moving the site of public involvement further 'upstream' within R&D processes.

The issues

There is growing recognition of the need for more proactive public involvement in debates about the social and ethical dimensions of science and technology (DTI 2000, House of Lords 2000, OST 1999, RCEP 1998). Yet such aspirations beg a host of questions (Rip, Misa and Schot 1995). At what stages in R&D processes is it realistic to raise issues of sustainability and the public interest, given the generally private and indeterminate nature of such processes? How and on whose terms should such issues be debated? And how adequate are dominant institutional discourses of risk and ethics in addressing such issues?

Nanotechnology promises to be one of the defining technologies of the 21st century. Based on the ability to measure, manipulate and organise material on the nanoscale – 1 to 100 billionths of a metre – it is set to have dramatic and potentially disruptive impacts across the fields of physics, chemistry, biology, materials science and engineering (NSF 2001). Envisaged breakthroughs for nanotechnology include order-of-magnitude increases in computer efficiency, advanced pharmaceuticals, biocompatible materials, nerve and tissue repair, surface coatings, catalysts, sensors, telecommunications and pollution control. This potential has encouraged a dramatic rise in R&D expenditure. In 2002, the US Government spent $604 million through its National Nanotechnology Initiative, whilst the European Commission has allocated $1.3 billion under its Sixth Framework Programme (DTI 2002).

From a sustainability perspective, nanotechnology appears to have both positive and negative potentials. On the one hand, it promises smaller, lighter and faster devices, using fewer raw materials and consuming less energy (NSF 2001). On the other hand, as the media furore surrounding the Prince of Wales' intervention in May 2003 has shown, there is genuine alarm about the disruptive potential of interventions at the nanoscale (Oliver 2003, Porritt 2003). The Prince is just the latest in a series of commentators to express fears about self-replicating nano-machines capable of smothering the world in 'grey goo' (Joy 2000, ETC Group 2003, Porritt 2003, or for a current fictional account, Crichton 2002). Scientific concerns have also been voiced, about the potentially carcinogenic effects of nanotubes and nanoparticles (Nature 2003). These concerns about nanotechnology resonate with long-standing social science analysis of technology running 'out of control' (Winner 1977).

One of the more notable contributions to this debate so far is a report by the ETC Group, a Canadian NGO, which hit the headlines in February 2003 with its assessment of the potential dangers of nanotechnology. Demanding a moratorium on commercialisation, the report warns of a Pandora's Box of potential hazards, ranging from "nanoparticle contamination to grey goo and cyborgs, to the amplification of weapons of mass destruction" (ETC Group 2003). In the same month, the UK Government's Better Regulation Taskforce called for the development of a new regulatory framework for nanotechnology, and for an early and informed dialogue between scientists and the general public about its impacts (Better Regulation Taskforce 2003).

Although nanotechnology is still an emerging field, the battle lines being drawn up around it are analogous to those involved in earlier controversies over nuclear power, GM crops and mobile phone masts. Lining up on one side are those who see nanotechnology as an area of exciting potential for the economy, society and the environment. Challenging them are those who remain sceptical about the possible vested interests lying behind the science, the questionable nature of the commitments bound up in R&D processes, and the known and unknown risks that could be unleashed by its application.

The challenge

Recent experience with biotechnology, and more specifically genetically-modified crops, points to some of the difficulties involved in meaningful public discussion of emerging technologies. In the 1970s and 1980s, there was little such public dialogue. 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 and Carr 1996). Perhaps not surprisingly, by this stage, attitudes had become polarised (AEBC 2001; Kelly 2002). Claim and counter-claim about the sustainable development significance of different aspects of biotechnology exacerbated the situation. All of this suggests that upstream forms of public engagement, *before* lines had been drawn up, might well have been beneficial. The GM crops experience in the UK also suggests that a 'physical-risk' approach, whilst undoubtedly important, may address only part of what is at stake within culturally plural, morally concerned and educated societies (AEBC 2001; Grove-White *et al.* 2000).

Although there have been various attempts in recent years to engage business and policymakers in anticipatory debates about emerging technologies – for example the 'Digital Futures' project on e-commerce (Wilsdon 2001) – methods for this type of upstream engagement are not well developed. A central aim of this project will be to stimulate methodological innovation in this area, and generate techniques and approaches that could be used and adapted for future technological developments.

The present circumstances of nanotechnology point to the challenges involved in such a proactive approach. Nanotechnology is now at an equivalent stage in R&D terms to biotechnology in the late 1970s. The forms and eventual applications of the technology are radically underdetermined, and many potentially significant developments are commercial-in-confidence, led by corporate actors eyeing competitive advantage.

A further issue of significance is the complexity and convergence of many aspects of nanotechnology. Synergies between parallel emergent technologies that operate at the nanoscale, such as biotechnology, robotics and artificial intelligence, are likely to give rise to many important innovations. It is at the intersection of these previously distinct technologies where many of the sustainability opportunities and challenges appear to be located (Joy 2000). Processes of regulation, social/environmental assessment and public appraisal will need to embrace this complexity from the outset.

Focus of the research

To maximise its clarity and usefulness, this project will focus on **three specific applications** of the technology. These have been selected in discussions with the research team's collaborators at the Institute of Nanotechnology, as offering the best prospects for exploring the wider sustainability dilemmas discussed above:

1. **Healthcare** – nanotechnology is set to impact on almost every area of health care. Nanoparticles are being developed for targeted drug delivery to specific cell types, for tumour ablation in cancer treatment, and for medical imaging purposes to provide clearer diagnostic tools. Parallel advances in electronics are allowing implant specialists to design 'smart' implants that could transform the treatment of blindness. Such advances raise ethical questions about risk and the body, and the extent to which people are comfortable with literally internalising new technologies and new materials (Jacobs 1999).

2. **Computing** – nano-scale biosensors and components are being actively developed with the potential to dramatically increase the speed, 'information density' and lightness of everyday products. Improved nano-engineered crystals are also opening the door to nonvolatile random access memory (NVRAM), a technique whose first fruits can be seen in Sony's PlayStation 2 (Greb 2003). Such advances not only accelerate the rise of 'pervasive computing', but raise ethical issues around privacy, surveillance and the consequences of powerful 'mesh' computers bordering on, if not actually achieving, a form of artificial intelligence.

3. **Cosmetics** – the cosmetics industry is already the biggest holder of patents of nanoparticles. For example, L'Oreal have developed a polymeric nanocapsule capable of guiding active ingredients into the lower layers of the skin, thus increasing the efficacy of suntan lotions and anti-ageing creams. More recent applications – such as the incorporation of glucose sensors into contact lenses, and nanoparticulate hydroxyapatite into toothpaste to restore damaged

tooth enamel – will further blur the boundaries between cosmetics and medicine. At the same time, concerns have been raised about asbestos-like health threats and other forms of environmental contamination from nanoparticles (Brown 2002).

Whilst these specific sub-fields will provide empirical foci for the study, the challenge is to develop more generalised insights into how proactive social discussion of the sustainability implications of the technological field as a whole should be advanced.

Theoretical context

The academic literature on technology assessment has tended to frame technology as 'black-boxed', well-defined and determined, and as possessing an independent logic that results in 'impacts' (social, environmental, health and so on). Two related streams of work which question this predominant technological determinism are constructive technology assessment (CTA) (Rip, Misa and Schot 1995) and those which focus on the ways in which upstream R&D, and design, are 'constructing users' (Grint and Woolgar 1997). Both approaches focus on the ways in which 'technical' processes implicitly exercise assumptions about the social uses to which the technology will be put, under what conditions, by which kinds of actor, and with what aims (Law and Bijker 1992).

These theoretical approaches offer a productive set of questions about the changing basis of social assessment-regulatory processes, as the limitations of predictive power to anticipate consequences become more acute, and more socially visible. This research will make practical use of such insights through critical reflection on the social and power relations that tend to prevail in the framing of nanotechnology by both producers and users (e.g. by regulators, by industry, by NGO actors, by the media and so on).

Aims and objectives

The overall aim of the project is to improve the contribution of nanotechnology to sustainable development by developing socially and environmentally-sensitive governance processes which move the site of public engagement upstream – closer to the heart of R&D processes.

(NB 'Sustainable development' is used in this context to encompass the full range of environmental, ethical and social questions associated with a technology.)

The particular objectives are as follows:

- To draw lessons from recent experiences with biotechnology that can be applied to emerging debates about the sustainability of nanotechnology, with a focus on three specific applications of nanotechnology – in healthcare, computing and cosmetics;

- To examine expert and public perceptions of the social, cultural and environmental implications of these nanotechnology applications, and to explore how they react to associated risks and uncertainties and to opportunities for redesign;

- To develop novel methodologies for interaction between experts and the public which can better integrate public responses into innovation processes, and enhance awareness of these dynamics in public policy and industrial R&D;

- To improve processes of dialogue between nanoscientists, experts, policymakers and the general public, and to contribute to the development of a socially and environmentally-sensitive regulatory framework for nanotechnology;

Methodology

The project aims to clarify the above questions through a five-stage programme, in terms that can inform emerging public, academic, political and regulatory debates about nanotechnology. This will involve intensive activity throughout the 2 year project. The logistics of this will be complex but the research team is experienced in coordinating such processes, and a great deal of thought has gone in to devising a process which will be both effective and manageable. Organisational roles will be distributed in accordance with the expertise of the various partners as shown below.

It is important to the success of the project that industrial and government partners are involved from the start. Initial discussions with companies such as IBM, HP-Compaq and Unilever suggest that corporate involvement will be forthcoming. We have also received encouraging signals from Defra, DTI and the Cabinet Office. The attached supporting letters are an indication of the level of interest in this proposal.

Phase 1. Learning from past experience (Project months 1– 4)

This will consist of desk-based research, a literature review and interviews with a selection of 15-20 EU and UK administrators, NGO actors, journalists, industrialists and scientists about the emergence of the public interface with nanotechnology. The focus of the literature review and interviews will be the ways in which emergent debates compare with earlier debates on biotechnology (particularly GM crops and foods) from the early 1970s onwards. This will culminate in a one-day social learning seminar, at the start of month four of the project, in which leading social science experts on the public and regulatory interface with biotechnology (e.g. Durant, Frewer, Gaskell, Jasanoff, Joss, Mayer, Pidgeon, Wynne) will critically discuss a paper, to be written by the researchers, on the relevance of the history of biotechnology regulation for nanotechnology.

Phase 1 will be led by IEPPP and Demos.

Phase 2. Lifeworld research (Project months 3 – 21)

To identify and elicit insight from experts in the R&D stages of nanotechnology will require interaction with such individuals in their own practical 'lifeworlds'. To achieve this, we propose to engage with up to six nano-scientists and their working associates (two drawn from each of the three specific fields of nanotechnology). Within each pairing, one scientist will be drawn from academia and one from industry. At the start of month three, we will embark upon an initial round of in-depth interviews with each of these experts to explore the kinds of assumptions, visions, and purposes that inform and influence R&D processes, as well as their knowledge, attitudes and assumptions towards the sustainability of nanotechnology. Informed by recent research on deliberative mapping and the technique pioneered by Andy Stirling on the 'multi-criteria mapping' of technology (Stirling 2000; Stirling and Mayer 1999), we will develop a novel appraisal method aimed at 'mapping the lifeworld' of nanoscientists. At this stage, we will also spend a short period (1-2 days) alongside each of these experts, conducting shorter interviews and small workshop sessions with their colleagues in their laboratory environment. This will enable us to gain a richer perspective on the culture and assumptions of nanoscientists. We will then meet with them again (in project month 15), to assess changes in attitudes and practices, and to explore their reactions to the emerging results of our fieldwork with the public. Finally, we will involve them in the expert-public workshop in Phase 4.

The Institute of Nanotechnology will lead the process of selection and recruitment for Phase 2. The fieldwork will be carried out by researchers at IEPPP and Demos.

Phase 3. Exploring public responses (Project months 8-17)

Building on 'anticipatory' qualitative approaches to emergent technologies developed at Lancaster since 1995, Phase 3 will consist of an interactive series of four focus groups aimed at understanding potential public responses to nanotechnology. The focus groups will each consist of 7-9 participants and will be recruited by a professional market research recruiter in accordance to precise criteria of age, life-stage, gender, socio-economic class and ethnicity. The four focus groups will meet twice. The first round of groups (in months 9 and 10) will focus on how people respond to the social visions, scenarios and assumptions as articulated in Phase 2 by upstream 'expert' actors. Using relevant stimulus materials, the research will pay particular attention to the social and political contexts in which risks and benefits come to be evaluated by individuals. What underlying factors are likely to structure such responses? What parallel 'risk events' are people likely to draw upon in developing their responses? How do people respond to informal or implicit social dimensions in real-life situations? And, how doe people come to define risks given that there is often found to be little, if any, public language of risk *per se* (Grove-White *et al.* 1997). In the second round of focus groups (in months 11 and 12) attention will shift to wider social and ethical issues arising from the promise of nanotechnology. Ethical debate will centre on the implications of nanotechnology for questions of human agency, autonomy, human nature and choice. Stimulus material offering different scenarios and trajectories of nanotechnology, both positive and negative, will be presented, to help understand the triggers likely to galvanise public opinion. In each of the focus groups, participants will be encouraged to create a productive group dynamic in which they can constructively assess the unfamiliar aspects of nanotechnology.

IEPPP will lead the process of design, selection and recruitment for Phase 3. The fieldwork will be carried out by researchers at IEPPP and Demos.

Phase 4. Expert interaction with the public (Project months 18 - 21)

In Phase 4, we will hold a 1 day interactive 'expert-public workshop' to examine the implications of the research for developing more upstream R&D processes across the three spheres of application. The workshop will also explore more generalised insights into how proactive social discussion of the technological field as a whole should be advanced. This innovative method will bring together experts from Phases 1 and 2, a sample of 8 people drawn from the focus groups in Phase 3, alongside key regulators and policy makers. This will be a genuinely novel approach to upstream citizen engagement, which will be aimed at clarifying the opportunities and challenges involved in proactive interactions with the public, and improving the sustainability of future processes of R&D.

Demos will lead the planning and coordination of Phase 4. The close involvement of the Institute of Nanotechnology in the structuring and dissemination of findings from each seminar will ensure that it has real purchase on scientists and industrialists within the nanotechnology community.

Phase 5. Dissemination and writing-up (Project months 19-24)

In Phase 5, a final report will be produced, which summarises the research findings, and provides an agenda-setting account of how the sustainability of nanotechnology can be maximised. This report will be aimed at a mixed academic and policymaker readership. It will be launched at a high level symposium (in month 22), to be convened in partnership with the Institute of Nanotechnology, which will be attended by policymakers, nano-scientists, social scientists, regulators, industrialists, NGOs and the media. The report and the outputs of the seminar will be widely disseminated through IEPPP's and Demos' extensive networks.

Other dissemination activities will take place through collaboration with organisations such as Green Alliance and the Royal Society for the Arts, and through targeted meetings with policy-makers in DEFRA, DTI, Cabinet Office and the Environment Agency. The Institute of Nanotechnology has extensive contacts in the nanotechnology domain, and will act as a gatekeeper to the scientific community. In addition, we will interact closely with the Smithsonian Institute (Washington DC), the Centre for Biological and Environmental Nanotechnology (CBEN) at Rice University (Houston), and Sheila Jasanoff, Professor of Science and Public Policy at the Kennedy School of Governance (Harvard).

A series of academic articles based on the research will also be written for relevant environmental sociology, science studies and technology journals. A particular aim will be to extend the literature on public perceptions of new technologies, to examine the social factors through which nanotechnology is likely or not to become a symbol of wider unease in late modernity, and to help foster an active UK social science research base on nanotechnologies.

The Research Team

This project represents a creative collaboration between three organisations that span the worlds of social science, public policy and nanotechnology. Lancaster's Institute for Environment, Philosophy and Public Policy (IEPPP) has a strong track record in the analysis of risk, sustainability and emerging technologies. Demos is one of the UK's leading think tanks, with a reputation for influential contributions to debates about new technologies and society. The Institute of Nanotechnology (IoN) is a registered charity, which was established in 1997 to provide a focus for the burgeoning interest in nanotechnology and keep the public aware of developments in this exciting field.

The uniqueness of this consortium – which for the first time brings together social scientists, nanoscientists and public policy experts – will ensure an interdisciplinary approach to research and dissemination. The involvement of such a diverse group of project partners should also illuminate the different roles that nanoscientists, social scientists and think tanks can play in the shifting ecology of public and media perception of nanotechnology. In writing up the project we will seek to offer reflexive commentary on what our own experience of leading the project can teach us about wider processes of public understanding and engagement with issues of risk and emergent technologies. The specific management responsibilities are further elaborated in section 11 of the application form.

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May 2003

Dear James,

NANOTECHNOLOGY RESEARCH PROJECT

Thank you for sending me a copy of your proposal for your joint research project on nanotechnology, which I read with interest.

As you will know, the Better Regulation Task Force recommended in its report "Scientific Research: Innovation with Controls" that the Government should initiate a public debate on the issues surrounding nanotechnology. We saw, as does your paper, great potential for nanotechnology, but also risks if the public is not involved in the decision making process. In its response – copy enclosed for ease of reference – the Government said that there is no obvious focus for an informed public debate at the moment, but that it would keep the position under review. This would make your work particularly timely.

The Task Force would very much support the work you are doing – although I'm afraid we cannot offer any financial support. I would be very happy to meet you to discuss the Task Force's thoughts on nanotechnology if it would be helpful, but would certainly like to be kept informed of the progress with your project.

Good luck with your work.

yours sincerely

Stephen Falder
Chair, science and regulation sub-group

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22 May 2003

Dear Dr MacNaghten

Nano technology, risk and sustainability: developing upstream models of public engagement

I am writing to express support for the work you are proposing for the above project. We believe that it is very important to consider the wider societal conditions for public acceptability of new technology applications, early in the R&D process.

As I indicated when we spoke, nano technology does not have immediate interest areas for ourselves, but it could, of course, have interest in the future. Understanding potential consumer dimensions will be of interest if applications emerge, and on this basis we would be happy to comment on the planned work.

From the previous projects we have worked on with you, we know you have a good track record in work on social framing of important consumer-related phenomena, and we are keen to continue a productive partnership.

Yours sincerely

S J STANLEY
Head of Consumer Science Insight Group

cc James Willesden, Demos (0207 401 5331)