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Nanotechnology, Risk and Communication

Alison Anderson, Alan Petersen, Clare Wilkinson and Stuart Allan

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Nanotechnology, Risk and Communication

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Anderson, A., Allan, S., (2005), Petersen, A., and C. Wilkinson 'The Framing of Nanotechnologies in the British Newspaper Press', *Science Communication*, 27 (2), 200–220.

Petersen, A., Anderson, A., Allan, S., and C. Wilkinson (2008) 'Opening the Black Box: Scientists' Views on the Role of the Mass Media in the Nanotechnology Debate', *Public Understanding of Science*.

Petersen, A. and A. Anderson (2008) 'A Question of Balance or Blind Faith? Scientists' and Policymakers' Representations of the Benefits and Risks of Nanotechnologies', *NanoEthics*, 1 (3), 243–256.

Wilkinson, C., Allan, S., Anderson, A., and A. Petersen (2007) 'From Uncertainty to Risk?: Scientific and News Media Portrayals of Nanoparticle Safety', *Health, Risk and Society*, 9 (2), 145–157.

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1
Introduction

> Nanotechnology is set to disrupt the face of much of industry. Nanotechnology is about new ways of making things. It promises more for less: smaller, cheaper, lighter and faster devices with greater functionality, using less raw material and consuming less energy. Any industry that fails to investigate the potential of nanotechnology, and to put in place its own strategy for dealing with it, is putting its business at risk.
>
> (DTI/OST, 2002, 6)

Precisely what counts as 'nanotechnology' eludes easy explanation. This may seem somewhat surprising to say, given the rapidly growing number of references to it in different media contexts. Looking across a range of these contexts – such as advertisements for exciting new nano-products, certain (often dystopian) visions in science-fiction cinema, novels and comic books, or even more nuanced representations in the science pages of a newspaper – is likely to reveal a number of competing definitions. At stake, it seems, is more than the usual sorts of disagreements over terminology and classifications among scientists. That is to say, it would appear that what counts as nanotechnology is also a problem of communication – and therefore, quite possibly, one of risk where public perceptions are concerned.

To observe that nanotechnology revolves around the design and manipulation of matter at the atomic and molecular level is to acknowledge, at the same time, that its application invites a host of questions about the likely implications for the way we live our lives. Hailed by its proponents as the next Industrial Revolution, nanotechnology has already attracted significant controversy over an apparent lack of adequate regulatory control (Michelson and Rejeski, 2006). It is neither a new nor a single technology; instead, it involves a fusion of elements of chemistry, physics, materials science and biology (Wood et al., 2007). Hence the term 'nanotechnologies' is sometimes adopted in order to capture this complexity. Confusing matters further, however, is the way nanotechnology cuts across a variety of different scientific fields, thereby necessitating a certain degree of interdisciplinarity. Moreover, older technologies are increasingly being repackaged as 'nano' in the fierce competition to attract funding. These and related issues, taken together, pose a major challenge for ethics and governance, particularly concerning how information about technological innovation is communicated during the early phases of development.

This book examines the increasingly crucial role played by the news media in framing the debate about potential benefits and risks of nanotechnologies. We argue that the ways in which the significance of possible risks associated with nanotechnology are recurrently framed in the early stages of their rising public visibility is likely to be a key factor in how citizens comprehend and subsequently respond to the technologies. This is especially important, we will suggest, with respect to whether they perceive the benefits as outweighing the risks, a social process of negotiation – economic, political and cultural – certain to impact upon levels of public trust to a significant extent.

Defining nanotechnology

The concept of 'nanoscience' was first described by physicist Richard Feynman in his lecture to the American Physical Society in 1959. This set out his vision of molecular manufacturing – factories using tiny machines at the molecular scale, designed and built atom by atom (see Drexler, 2004). The term 'nanotechnology' was introduced in 1974 by a Japanese scientist, Norio Taniguchi, to refer to precision engineering with tolerances of a micron or less (see Park, 2007). However, there are a whole variety of different definitions currently in circulation and a great deal of definitional ambiguity surrounds the label 'nanotechnology'. These range from the celebratory (which see it as a major breakthrough) to the dismissive (claims that it is nothing new, just applied chemistry with a fancy name to attract funding). As the Centre for Responsible Nanotechnology notes:

> Unfortunately, conflicting definitions of nanotechnology and blurry distinctions between significantly different fields have complicated the effort to understand the differences and develop sensible, effective policy.
>
> (CRN, 2008)

According to Eric Drexler, there are two overarching definitions of nanotechnology: Feynman's original definition, based upon his vision of a molecular manufacturing system, and a more recent broader definition, referring to a host of products built at the nanoscale:

> In recent years a group of scientists, technologists, business leaders, and bureaucrats have exploited the excitement around nanotechnology by using the term to label existing and near-term products which have significant features less than 100 nanometers in size. By this new, loose definition, "nanotechnology" isn't about making nanoscale productive systems, but about making nanoscale products. It can describe anything with small features, ranging from fine particles to thin coatings to large molecules – even big things with tiny holes. Many parts of chemistry, materials science, microelectronics, and biotechnology are now marketed as 'nanotechnology'. This redefinition has created confusion, raised false expectations, and hampered progress toward the original, more powerful goal.
>
> (Drexler, 2008)

The US National Science Foundation (NSF) defines nanotechnology as:

> Research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately 1–100 nanometer range, to provide a fundamental understanding of phenomena and materials at the nanoscale and to create and use structures, devices and systems that have novel properties and functions because of their small and/or intermediate size. The

> novel and differentiating properties and functions are developed at a critical length scale of matter typically under 100 nm.
>
> (NSF, 2008)

Similarly, the Richard Smalley Institute for Nanoscale Science and Technology describes it as:

> an emerging and promising field of research, loosely defined as the study of functional structures with dimensions in the 1–1000 nanometer range. Certainly, many organic chemists have designed and fabricated such structures for decades via chemical synthesis. During the last decade, however, developments in the areas of surface microscopy, silicon fabrication, biochemistry, physical chemistry, and computational engineering have converged to provide remarkable capabilities for understanding, fabricating and manipulating structures at the atomic level.
>
> (Smalley, 2008)

To give an indication of scale, one nanometre is one-billionth of a metre, which is tens of thousands of times smaller than the diameter of a human hair. Nanotechnology, as a distinctive field in its own right, is still in its infancy, largely characterised by the application of methods from nanoscience to develop products (Wood et al., 2003). There has been a considerable amount of re-branding of existing research in order to label it as 'nano' in ways that are likely to be more attractive to funders. Also, it is difficult to abstract it from other developments, such as information technology and biotechnology, where there is increasing convergence and synergy (see Wood et al., 2007). Thus where we use the generic term 'nanotechnology' in this book it is important to recognise that it is interdisciplinary. Our usage thus refers to a whole range of nanotechnologies, including a diverse number of current or potential applications.

While some see nanotechnology as heralding the next Industrial Revolution (Theodore and Kunz, 2005), others argue that it may engender 'horrendous social and environmental risks' (ETC Group, 2003). Proponents of nanotechnology often argue that it has potential far-reaching economic, health, environmental and other benefits. According to some radical utopian visions it will eliminate problems of inequality, starvation and scarcity, thereby bringing about a less-polluted environment [Dunkley (2004) cited in Wood et al., 2008, 15]. However, it has already evoked considerable controversy as a potentially dangerous development, with comparisons being made to previous disasters such as thalidomide and asbestos.

By way of an example, in March 2006 German newspapers reported that Magic-Nano aerosol products had led around 100 citizens to suffer illness with symptoms such as breathing difficulties, coughing, vomiting and headaches. A small number were treated in hospital for pulmonary oedema. However, it later transpired that this nano-scare was a false alarm; the problem was to do with the pH levels in the aerosol, and nanoparticles were not actually present in the product. Nonetheless, this incident led to renewed calls to investigate the risks associated with nanotechnology and to develop regulatory measures. Further concerns have been raised about Samsung's 'Nano Silver' washing machine, which was temporarily withdrawn from sale in Sweden in 2005, following public protests and concern from government regulators. Nano Silver is judged by some to pose unacceptable risks to beneficial bacteria in environmental systems and to human health. Indeed, Friends of the Earth Australia (FOEA) have called on the company to withdraw the range from sale in Australia until peer-reviewed studies can demonstrate its safety for the environment and human health. The environmental group also claim that there is accumulating evidence that carbon nanotubes could be the next asbestos, citing two recent studies published in *Nature Nanotechnology* and the *Journal of Toxicological Sciences* which found that multi-walled carbon nanotubes cause asbestos-like disease in mice (FOEA, 2008b).

Expenditure on research and development of nanotechnologies has dramatically accelerated in recent years and it promises to be one of the most rapidly growing areas of scientific innovation of the twenty-first century. Indeed, over the last ten years, it has become the fastest rising sector in the knowledge-based economic infrastructures in OECD countries (see Throne-Holst and Stø, 2008). As applied to medicine, nanoscience is seen to bring a broad range of benefits, including the development of artificial organs and implants, improved drug delivery, the cleaning of arteries, the repairing of cells and the diagnosis of disease (see Oud and Malsch, 2003; Wood et al., 2003, 21). Nanotechnology also has, or is predicted to have, applications in a range of other areas, such as sunscreens, self-cleaning windows, nanocrystalline alloys, micromachined silicon sensors (used in cars, cameras, etc.), films and coatings, fuel cells and bioremediation (systems capable of fixing heavy metals, PCBs, cyanide and other environmentally damaging materials) (Royal Society and Royal Academy of Engineering [RS/RAE], 2004). It is thought that the market for such products could rise to trillions of Euros in the coming years (see Cordis, 2004).

Our investigation

This book sets out to examine how the benefits and risks associated with nanotechnology have been framed by the news media and within the wider policy-making arena. Our particular interest is in tracing the framing of nanotechnologies in the context of prior controversies over emerging technologies, such as genetically modified (GM) food and crops, embryonic stem cells and human cloning. This includes a consideration of how the parameters of the debate have been represented within policy documents. 'Communication', then, is used in a broad sense to encompass more than simply considering the role of the news media. In addition to examining media portrayals we explore scientists' and policymakers' representations of nanotechnology, since previous studies have demonstrated that they may play a decisive role in shaping policy outcomes through influencing media coverage (e.g. Nisbet and Lewenstein, 2002). We also examine how 'the public' is conceptualised by experts working in this field and explore the question of what 'public engagement' means in practice. The 'public' is often left unproblematised in official discussions, which often employ simplistic formulations of 'public opinion'. Where we refer to the 'public', it is important to note that there are multiple publics with diverse views on science and technology.

In addition to offering a synthesis of the pertinent research literature in the media, science, technology and risk area of enquiry, the book draws on data from one of the first Economic and Social Research Council (ESRC)-funded projects on nanotechnology in the United Kingdom (UK), conducted between 2003 and 2005 and involving all four authors (Anderson, Petersen and Allan with Wilkinson as the then research associate). This brings together the key findings from our quantitative content analysis of UK national press coverage and in-depth, qualitative interviews with scientists, journalists and editors to ascertain their views on the production and coverage of news on nanotechnology. These findings are supplemented by those from further investigations conducted by the authors separately or in smaller groups. In the case of the latter, a British Academy-funded study conducted by Petersen and Anderson has added an important dimension to our discussion here. It examined how scientists and science policymakers, working in the field of nanotechnologies, seek to strike a balance in representing their benefits and risks.

It is widely recognised in the social sciences that the levels of attention devoted to a problem are not an accurate reflection of its 'objective' seriousness. Studies of previous biotechnology controversies highlight the socially constructed nature of news coverage and the influence of policy arenas and cultural factors (see Hornig Priest, 2001; Nisbet and Huge, 2006, 2007; Nisbet and Lewenstein, 2002). As Hilgartner and Bosk (1988) observe, issues compete with one another for attention and there is often considerable competition among news sources vying for position, each of whom is likely to be actively seeking to establish their definition of the issues in question as the preferred one to be adopted. Past studies suggest that initial press coverage of biotechnology was relatively sparse and overwhelmingly positive in tone (see Bauer and Gaskell, 2002; Nisbet and Huge, 2006). As we will detail later on in this book, early nanotechnology coverage follows a similar pattern. In the case of past controversies over embryonic stem cell research in the United States (US), it was only when the issue became high on the political agenda that media coverage peaked (see Nisbet et al., 2003). Thus far national press coverage of nanotechnology in the UK has been minimal and largely restricted to elite newspapers; short bursts of more widespread attention can be related to specific policy events and interventions by high-profile actors – in this particular case Prince Charles (see Chapter 4). The issues have yet to move beyond the administrative context and come to be seen as of pressing significance in overtly political arenas.

In the case of GM food and crops in the UK, following in the wake of the food scare surrounding Bovine Spongy Encephalopathy (BSE), particularly potent metaphors emerged as the issues became a political 'hot potato' (see Rowell, 2003). A string of sensational headlines appeared in the national press including: 'Alarm over

"Frankenstein foods" ' (*Daily Telegraph*, 12 February 1999) and 'THE PRIME MONSTER: Fury as Blair says "I eat Frankenstein food" and it's safe' (*Daily Mirror*, 16 February 1999). Concerns have been expressed by many scientists and science policy groups about the potential for public responses to nanotechnology to replicate these earlier experiences (Turner, 2003). FOEA have raised particular anxieties over food-safety issues given that they claim in excess of 100 food, food packaging and agricultural products containing nano-ingredients are currently on sale internationally without mandatory food-labelling measures in place (FOE, 2008a). We argue that journalists' prior experiences of covering such science controversies are likely to colour their treatment of nanotechnology. 'Frankenfood' metaphors are already beginning to be used within the coverage with headlines such as 'Alert over the March of the "Grey Goo" in Nanotechnology Frankenfoods' (*Daily Mail*, 2 January 2008). The Canadian Action Group on Erosion, Technology and Concentration (ETC), which played a key role in turning European public opinion against GM 'Frankenfoods', have switched their major focus from agribiotechnology to nanotechnology. ETC have called for a moratorium on the commercialisation of new nano-scale materials until laboratory protocols and regulatory regimes are in place that take account of their special characteristics and demonstrate them to be safe.

Accordingly, given the degree of interest among scientists and policymakers in the potential of nanotechnologies in various fields (including environmental sustainability, engineering and medicine), a growing number of countries are debating how best to 'engage the public' so as to avoid strong negative public responses, as seen with the 'GM-style' backlash against the technology. As detailed in our chapters, recent science reports and academic discussions on nanotechnologies emphasise the importance of public engagement during the early phase of technological development (i.e. 'upstream'); however, the question of what constitutes such 'engagement' and what the role of the media may be in this process have received only scant attention. In particular, the recent focus on 'upstream' public engagement reveals a linear model of innovation that belies how technologies develop in practice (Joly and Kaufmann, 2008). Despite widespread acknowledgement of the potential significance of the media in influencing attitudes and establishing the agenda for debate, the role of the media in forming public knowledge, we suggest, has been poorly theorised. Scientists often blame ‘the media’ for ‘misrepresenting’ nanotechnology and for not adequately conveying ‘the science facts’. This, we argue, reveals a simplistic portrayal of science mediation and denies the power relations of science.

Publics’ responses to nanotechnology thus far would seem to broadly mirror responses to new genetic technologies in the last decade or so; namely, anticipation of its future benefits (utopianism) mixed with fears of its dangers (dystopianism), especially with unregulated developments. As with developments in the new genetics, which are seen to have the potential to create a new genetic divide, particularly between the developed and the developing world, innovations in nanotechnology are predicted by some commentators to lead to a ‘nano-divide’ between those who benefit and those who are disadvantaged by technologies (Court et al., 2004). Further, as with genetic technologies, fears about the detrimental impacts of ‘tampering with nature’ are manifest in depictions of self-replicating ‘nano-robots’ and ‘nano-swarms’, as in the case of Michael Crichton’s novel *Prey* (2002). Like media portrayals of the risks of GM foods and other genetic technologies (e.g. cloning and embryonic stem cell harvesting), media portrayals of the risks of nanotechnology (e.g. self-replicating ‘nano-robots’) are seen by some scientists as having the potential to lead to a public backlash against potentially useful applications. Although a public opinion poll by the Royal Society and Royal Academy of Engineering (RS/RAE), published in March 2004, found that ‘the overwhelming majority of people had not heard of nanotechnology’ ([RS/RAE], 2004), growing news media coverage and other popular media portrayals may generate a context of fear about its implications, and thus constrain developments in the future. In the same way that scientists sought to control responses to cloning in the aftermath of Dolly by using the media to emphasize the benefits of the technology and to draw a distinction between therapeutic and reproductive applications (Petersen, 2002), some scientists have used the media to highlight the potential benefits and safety of nanotechnology, or to downplay the more dystopian scenarios (see Phoenix and Drexler, 2004). Clearly, much may be learnt about the mediation of science, the social production of risk and the public representation of science by analysing public discourses about nanotechnology, its applications, benefits and dangers.

Outline of chapters

This book comprises six chapters, each of which addresses different aspects of the challenge of communicating nanotechnology.

Chapter 2 lays the ground for what follows by examining broad issues about how science journalism is produced in general, including what constitutes 'newsworthiness' as well as credibility where news sources are concerned. It then moves on to address how journalists negotiate competing claims about the possible risks associated with nanotechnologies.

Chapter 3 considers the media politics of nanotech within debates concerning the role of contemporary media in communicating risk. Here we provide a critical survey of the literature within the field and tease out the key conceptual and methodological issues. We examine the processes through which particular themes and voices become dominant or marginalised. In particular, we address the question of why there has been an absence of reference to particular actors and issues, such as economic, ethical, theological and legal issues, and whether a particular framing is contingent on certain events or periods in the policy-making cycle.

Chapter 4 surveys the literature on news media representations of nanotechnology and presents the findings of our ESRC project on nanotechnology and the news. This leads to an examination of why early news media coverage in general has tended to emphasise the revolutionary beneficial applications rather than the potential risks of nanotech, as was the case with earlier biotechnology debates. A range of examples are provided from UK and US studies of nanotech news coverage.

Chapter 5 examines existing work on the public discourses surrounding nanotechnology, supplementing it with new findings drawn from the authors' own research. It begins by examining studies of public perceptions of science journalism (and attendant risk issues), in general, before turning to those devoted to nanotechnology. The chapter presents further data drawn from the authors' recent ESRC study involving interviews with scientists and journalists about their perceptions of public knowledge and awareness and the role of the media.

Chapter 6 explores how scientists and policymakers seek to establish a positive portrayal of nanotechnologies in the face of concerns about developments and an apparent decline in trust in expertise and the effectiveness of regulatory systems. Based upon the findings from a British Academy funded study, it explores both the expectations and the fears that nanotechnologies engender in relation to health and environmental sustainability and how these are communicated.

In the Conclusion, we offer some broader reflections on our analysis of communicating nanotechnology issues, identify gaps in understanding and propose some areas for future work. We point to the need for a more theoretically sophisticated understanding of the science–society relationship that pays cognisance to the socio-political significance of the media and the inescapably mediated character of science.

2
Reporting Science

> For the past decade, nanotechnologists have wowed the public with our ability to manipulate matter at the atomic level and with grand visions of how we might use this ability. [However, any] technology that promises so much change is bound to generate controversy, because with such awesome power comes the capacity to push beyond boundaries that society has deemed acceptable. Put another way, societal and ethical concerns can rapidly turn wow into yuck. Kristen Kulinowski.
>
> (2004 : 17)

Science, it is often said, gets a bad press. Explanations for this apparent problem, in the opinion of some journalists, tend to revolve around the charge that most types of science fail the test of newsworthiness. Routine science, they believe, is really rather boring. It lacks the stuff of drama necessary to spark lively newspaper headlines. At the same time, some scientists maintain that on those occasions when a certain scientific development is given due prominence, it all too frequently happens for the wrong reasons. Not surprisingly, they are quick to condemn instances of sensationalist reporting – where news values have given way to entertainment values – for misrepresenting the nature of scientific enquiry, and rightly so.

Science typically appears in the press as 'an arcane and incomprehensible subject', Nelkin (1995) observed in her classic study of science journalism in the US. Surrounding it is a certain 'mystique' that implies it is to be properly regarded as a 'superior culture' with