

The novelty trap: why does institutional learning about new technologies seem so difficult?

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Abstract: *The emerging controversy over nanotechnology is redolent of the pattern of past disputes over new technological fields, which the author describes as the 'novelty trap'. In each case, ambitious claims for revolutionary innovation are met by sceptical concerns about unintended consequences and new risks, to which advocates respond with reassurances of continuity with past experience. The paper goes on to identify possible obstacles to institutional learning that may result in the repetition of this pattern, including three versions of the deficit model of public understanding. Finally, the author poses the possibility that the pattern itself may represent an emergent form of societal technology assessment, which embodies informal social learning.*

Keywords: *technological controversy; deficit model; social learning*

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Nanotechnology is news. The past couple of years have seen numerous reports in tabloids and broadsheets trumpeting the benefits and risks of revolutionary new materials, self-replicating robots and the like. The tones have varied from sober to hysterical. Some have called for a blanket moratorium (ETC Group, 2003). Recent reports on nanotechnology emanating from diverse bodies such as the Economic and Social Research Council (Wood *et al.*, 2003), Greenpeace (Arnall, 2003) and the Royal Society with the Royal Academy of Engineering (2004) have attempted to present a balanced characterization of the field. But whatever the register of voice, the controversy is unavoidable.

For those of us who have followed scientific and technological controversies over the past two or three

decades, the debate evokes a strong sense of 'déjà vu all over again'. Passionate public battles have been fought as a succession of novel technological fields has emerged with high aspirations to improve human welfare. Nuclear power promised us, in the words of Alvin Weinberg, 'clean electricity too cheap to meter'. Information and communication technologies (ICT), we were told by Al Gore among others, would put the world on the 'information superhighway'. Genetically modified (GM) crops would, according to biotech companies and George Bush Jr, 'end third-world hunger'. Now, nanotechnology is being trumpeted as 'the next big thing' that will revolutionize almost every aspect of the world we live in.

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Past experience suggests that scientists, business people and politicians interested in promoting the development and application of new technologies should be wary of what I have termed 'the novelty trap' (Rayner, 2003b). In response to grandiose claims on behalf of an emerging but as yet untried technology, sceptics are wont to question the idea of a free, or at least almost-free, all-you-can-eat lunch. If the product or process is so new and revolutionary, they argue, can there also be new and revolutionary drawbacks?

The experience with nuclear power has sensitized the public to the potential for new technological systems to generate hidden costs, especially where large public subsidies are involved in promoting research and development. It is also the emblematic case for the emergence of environmental, human health and social risks associated with 'revolutionary' complex technological systems. Instead of clean electricity too cheap to meter, we are faced with enormous nuclear decommissioning costs and a nuclear waste stockpile that is vulnerable, at best, to 'normal accidents' (Perrow, 1984) and, at worst, to a terrorist attack with the potential to render the entire Northwest of Britain uninhabitable. Instead of the information superhighway, we now hear more about the 'digital divide' (Tapscott, 1998). Public response to the expansion of biotechnology encompasses concerns about biodiversity and the growing dependence of third-world farmers on global agribusiness as well as human health and cultural issues (Levidow, 2001; Rayner, 2003a). As a result public confidence in agricultural biotechnology has steadily declined throughout the 1990s (Gaskell and Bauer, 2001). And already some are pointing out that the portrayal of nanotechnology as 'new' and 'revolutionary' puts risk on the agenda (Smith, 2004).

The response of the promoters of novel technology to concerns about novel risk has been consistent. It is to substitute their claims of revolutionary novelty with comforting assertions of continuity. They hasten to reassure a critical media and an anxious public that 'this is nothing new; we have been doing this for years'. Thus throughout the 1980s it was not unusual to hear executives and regulators in the US nuclear power industry arguing that a nuclear reactor was really just a 'giant kettle – a new way of boiling water'. GM crops, the biotechnology companies assured us, were just 'extensions of traditional plant breeding'. Nanotechnology, we are now already being assured, is really just a new name for chemistry or materials science and, to prove it, we are reminded of the colloidal gold nanoparticles produced by Michael

Faraday in the 1850s (Thomas and Kulkarni, 2003). Such back-peddalling serves only to deepen rather than assuage public discomfort and, as agribusinesses have learned to their costs in Europe, the public is the ultimate customer (Hinterhuber, 2002).

Contrary to oft-repeated claims about public scepticism and a crisis of confidence (Select Committee on Science and Technology, 2000), social science research indicates convincing support for science and technology in general (Office of Science and Technology and Wellcome Trust, 2000). The rapid diffusion of personal computers and mobile telephones exemplifies the potential enthusiasm that consumers can have for novel technologies. Notwithstanding concerns voiced in the scientific establishment about loss of public trust in science and technology (Select Committee on Science and Technology, 2000), the public presumption of credibility remains strong. However, it is vulnerable to loss if too much is claimed for the benefits and if there is back-peddalling in the face of criticism.

Baiting the novelty trap

What baits the novelty trap? Novelty is often employed in marketing, but it is not the only ploy used to increase market share. As the phenomenon of the 'model year' in motorcars demonstrates, incremental rather than revolutionary change can also be a powerful motivator of markets. In other words, why is there such a strong temptation to characterize an emergent field of science and technology as revolutionary rather than as an incremental advance on existing technology?

This is a particularly interesting question in the case of nanotechnology, which appears to be a highly heterogeneous set of technological and scientific innovations that have arisen in diverse applications such as electronics, bioscience, cosmetics and pharmaceuticals, and industrial coatings. Many of these developments appear to have been undertaken as incremental improvements on existing products and processes, such as silicon chip manufacturing. There is, therefore, a real question about how such a heterogeneous set of technological advances became stabilized in scientific and policy discourse as a novel technological field. Why do we speak of nanotechnology as a whole rather than discuss the constituent advances separately?

Clearly, a major factor is the ability to attract public and private investment. Nanotechnology became a household word at least partly in response to the decisions of both the US and UK governments to allocate significant public funds to research and development with the goal of improving national

competitiveness. Worldwide public and private investment in basic nanoscale research was approximately \$6 billion worldwide in 2002 (Cientifica, 2003). That same year the UK government spent about £30 million on nanotechnology (Department of Trade and Industry and Office of Science and Technology, 2002). US federal government commitments have soared from approximately \$600 million to almost \$1 billion in the three budget cycles from 2002 to 2005. More than 30 national governments have now launched nanoscience research and development initiatives.

The creation of new funding opportunities for research is obviously important, but access to money does not account for all of the attraction of declaring a field of scientific inquiry to be 'novel'. Personal psychological and social rewards are also important motivators: declaring that one is working in a revolutionary field of science and technology with huge implications for transforming the world we live in certainly has the potential to create excitement among researchers. This may be especially important when a traditional field, such as chemistry, becomes widely viewed in the scientific community as a post-mature field entering into intellectual decline. The potential to revive under-funded academic departments and the renewed ability to attract the best graduate students into the field are surely strong motivators here.

Taking the bait, tempting as it is, also entails a number of potential downsides, one of which stems from the act of consolidating diverse activities or technologies under a single umbrella term, such as 'nanotechnology'. In doing so, there is the possibility that the emergence of a problem with one element in the set can stigmatize the entire set. Unfortunately, the indications from social science research on risk and stigma are that one bad apple may be all it takes to get the whole barrel thrown out (Flynn *et al.*, 2001).

Institutional learning

Given the strong sense that we have 'been here before', why do we seem continually to repeat the same pattern of social behaviour? Marx once said that history repeats itself, 'the first time as tragedy, the second time as farce' (Marx, 1852). We might add, 'the third and subsequent times as the introduction of new technologies'! In other words, why does there appear, at least on the surface, to be so little social or institutional learning that can effectively inform the process of introducing new fields of technological endeavour?

The topic of learning has long been a preoccupation of psychology, but in recent decades it has become a

major focus of policy, management, innovation and organizational studies. The psychological model is essentially one of individual learning (for example, Kolb 1984; Lewin, 1936; Piaget, 1972). The individual learning approach has often been imported into organizational studies as a succession of learning cycles (for example, Argyris, 1978; Mumford, 1990), in which the learner tests new concepts and revises them as a result of experience and reflection. Such approaches essentially treat the organization as an individual writ large (Dodgson, 1993).

Others (such as Lave and Wenger, 1991) have developed a view of learning as a social construction, arguing that individual learning is inevitably embedded in a cultural context. Anthropological perspectives, such as that of Douglas (1986) demonstrate the extent to which individuals rely on institutions to think and learn for them. This last approach also emphasizes the role of the institution in excluding information that has the potential to undermine it, or even render it unworkable (Evans-Pritchard, 1940). This is a phenomenon sometimes referred to as the 'social construction of ignorance' (Rayner, 1986).

The introduction or 'stabilization' of novel technological fields appears to be subject to systematic obstacles to social or institutional learning. Institutional learning is shared public knowledge in everyday use rather than individual learning. While individuals may learn, their knowledge may be locked out of the public and policy discourses that arise around novel technological fields such as nanotechnology.

What factors may be militating against institutional learning? In the remainder of this paper I shall first suggest that the ready availability of deficit models of the public relationship to science and technology represents a powerful instrument by which the need for learning and change in organizational behaviour is resisted. I shall go on to speculate about what structural factors may lead a range of institutions to resist organizational learning about how to manage the introduction and assessment of novel technological fields. I shall conclude by asking whether public conflict over novel technological fields might itself constitute a form of social learning about how to conduct societal technology assessment.

Deficit models

There appear to be at least three different versions of the social understanding of science, called 'deficit models', in current circulation. In its most straightforward form, the deficit model proposes that the media, consumers and public express opposition to new technologies because they do not have the

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appropriate scientific knowledge to understand the benefits and risks involved (Gross, 1994). The solution to opposition, therefore, is public scientific education to assuage concerns so that people will cease to question the value and the management of the technology. 'If only the public understood the facts, then they would love us and leave us alone,' the theory goes.

By the end of the last decade, this version of the deficit model had largely fallen from favour, at least at the rhetorical level. Almost everyone involved in negotiating the interface between science and the public now acknowledges that communication is a two-way process. As UK Science Minister Lord Sainsbury has said:

We have moved decisively away from the era in which it was enough for science communicators simply to educate the public about science and its benefits. What is needed now is an effective two-way dialogue and debate between those who do scientific research and the public. (DTI, 2002.)

There is explicit agreement that scientists and science policy makers also need to listen to the public and seek to understand and respond to their concerns. However, for the most part, the reality of practice in science communication has yet to catch up with this rhetorical change. Promoters of new technologies continue to confront public concern by providing reassuring information about the technology. The deficit model is dead: long live the deficit model!

We have also seen the emergence of a new deficit model – deficit model II. This suggests that the problem is not simply a lack of scientific information about particular technologies, but a failure of public understanding of the processes of science (Wynne, 1991). It is not possible, for instance, for science to prove a negative proposition, for example that there is *no* risk attached to a particular activity or technology. If this version of the deficit model were correct, it would predict that the public demands or expects zero-risk. However, in two decades of research on public behaviour with respect to technological and environmental risk, I have never encountered a zero-risk expectation among the public.

This is not the end of the deficit model, though. Its most recent manifestation – deficit model III – assumes that the problem is not so much a deficit of factual information or understanding of process as a deficit of public trust (Haerlin and Parr 1999; Select Committee on Science and Technology, 2000). The informational focus of science communication is now supplemented by a trust-building imperative: 'If only the public trusted us, then they would love us and leave us alone.'

Each of these versions of the deficit model reiterates the fact that effective communication about science is

an important and valuable activity for scientists, government, industry and non-governmental organizations (NGOs). Certainly, in the 21st century every citizen would benefit from a critical appreciation of the potentialities and limitations of science and technology.

However, framing the relationship between science and governance primarily as a problem of science communication domesticates it as a process problem that can be solved by the application of better communication techniques. It enables the institutions of science and governance to elide more fundamental structural challenges to established patterns of institutional authority in both science and politics. If the issue is one of communication, there is no need to question the appropriateness of existing procedures, established patterns of access to decision making, institutional prerogatives and power distributions.

The deficit-communication paradigm does not raise controversial questions about the relative roles of scientific advice and moral and aesthetic judgement in the policy process. By not doing so, it allows the scientific community to sidestep emerging challenges to its own institutional autonomy and authority as well as the close relationship to political power that it has enjoyed during much of the 20th century.

Although one should be very careful about making metaphorical allusions to science as the religion of modernity, our scientific contemporaries often appear to occupy a privileged position in relation to institutions of governance and commerce analogous to that enjoyed by the priesthood in earlier eras. Governments and managements both rely on scientists and technologists as the interpreters of the world, operating through an increasing array of scientific assessment processes in fields as diverse as environmental protection, public health and economic policy. Also, the Modern Prince expects scientists, like the priesthood that preceded them, to be agents for human control over dangerous forces such as disease or natural disaster. Science is not simply one activity or aspect of society; it has become the primary culture of legitimation for modern society.

With this observation we turn our attention to the limitations of institutional learning for specific groups. We will look in turn at scientific institutions, governments, business, NGOs, the media and, finally, the social sciences. I do not pretend to have answers, but at least it may be instructive to raise relevant questions about the difficulty of institutional learning for various constituencies and to inform a possible research agenda.

Learning obstacles for scientific institutions

Historically, the scientific establishment has been slow to acknowledge emerging public concerns about technologies. When it has responded, its elite institutions have generally rallied around the scientific citadel to deflect criticism from the media, NGOs and the public. Critical scientists have been cast out as renegades (Eriksson, 2004). It is apparent, however, that the lessons of past controversies have often failed to guide the response to the new one.

In part, the problem may be due to the fact that emerging technological fields (as well as scientific controversies such as BSE and the MMR vaccine) usually lead to the stabilization of new communities of scientific expertise around them. Because the relevant expertise is already invested in the technology, these tend to be advocacy communities drawn from relevant disciplines that may not have been attentive to earlier disputes around quite different technologies. In other words, the failure is one of institutional learning and transfer of memory among different specialists.

There may also be a larger structural factor at work. Science has enjoyed a highly privileged role in advising governments since the Second World War, in which technological innovation played such an important part in securing the Allied victories over Germany and Japan. This privileged role has isolated scientific experts from criticism by non-experts. Opening up the scientific establishment to media and public scrutiny may be seen as undermining the deference that science has enjoyed through most of the second half of the twentieth century. (The scientific establishment often fails to distinguish the decline of deference to scientists from trust in science, which remains robust.)

However, in the case of nanotechnology it might be argued that the scientific establishment has learned and has anticipated public concern much earlier in the emergence of the field than has been the case in the past – for example with GM crops. We note above that the Royal Society and the Royal Academy of Engineering (2004) have issued a joint appraisal of nanotechnology at the request of the UK government. This can fairly be said to demonstrate both a more proactive and a more balanced approach than the scientific organizations have taken in the past. While the initiative is to be welcomed, only time will tell whether this proactive early embrace of public concern represents sustainable institutional learning or is merely a short-term deflection of public concern.

Learning obstacles for governments

Again, it can be fairly argued that precisely because the government commissioned the Royal Society and

Royal Academy of Engineering study, it too has learned to be proactive with regard to public concern about emerging technologies. I would counsel cautious optimism. Governments invest in new technological fields because they generally believe they will lead to competitive advantage in the marketplace for the nation's businesses, leading in turn to economic growth and improved social welfare. This encourages a strong presumption in favour of novel technologies.

Electoral cycles may influence the institutional memory of politicians as they move in and out of government and around the various ministerial (and shadow cabinet) portfolios. Civil servants, or at least the high-flyers, may be rotated through various government departments for perfectly good institutional reasons (to prevent the emergence of bureaucratic fiefdoms, for example). However, this may mean that individual learning is not translated into institutional memory for particular departments and ministries.

Another factor may be the growing reliance on both sides of the Atlantic on 'science-based' and 'evidence-based' policies. As we have already noted, science has become the dominant culture of legitimation for policy. This role for science is especially valued by decision makers in a pluralistic society where diverse parties claim legitimacy for often incommensurable values. Science can be invoked as the value-neutral arbiter of social and cultural disputes. It is conceivable, therefore, that decision-making institutions may be reluctant to relinquish such a powerful refuge for the legitimation of policy by opening it up to public scrutiny.

Learning obstacles for business

In my personal experience, individuals in the business sector are often quick to learn from their own exposure to scientific controversy. Certain firms (such as Unilever and Marks and Spencer) have recognized that they can earn significant reputational benefits from being seen to be responsive to public concerns (for example about GM foods). However, concerns about intellectual property and market competitiveness often seem to be obstacles to firms acting on individual knowledge available to them and even more so to sharing such knowledge with other firms.

Learning obstacles for NGOs

The emergence of a multiplicity of NGOs over the past 30 years represents a spectacular success for the sector. The USA, for example, now boasts 1–2 million NGOs, 70% of which are less than 30 years old (WRI, 2003). The appeal of NGOs depends in part on their narrow issue focus, in marked contrast to the broad-spectrum agendas that characterize the now much-discredited

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institution of the political party. The danger of taking a more nuanced approach to the issues that are raised by new technologies, especially when considering trade-offs in the name of social welfare or economic growth, may be viewed as compromising the NGOs' 'critical advantage' in the political marketplace. If they begin to look more like parties, will they lose appeal?

NGOs also enjoy a remarkable level of freedom to set their own agendas without much in the way of public scrutiny, let alone accountability (Edwards and Hulme, 1995). A successful campaign of opposition to the latest potential technological insult to human health or the environment is likely to raise the public profile and income of campaigning NGOs. There seems to be little incentive, therefore, for them to focus on breaking out of the well-established cycle of cornucopian claims and catastrophic counter-claims that characterize these kinds of disputes.

Finally, NGOs appear to experience a high turnover of personnel, often relying on the youthful idealism of their employees. This may militate against organizational learning.

Learning obstacles for the media

The scientific establishment often complains about the weakness of science reporting in the press and on television. A favourite lament is that there is a lack of scientifically qualified reporters covering science topics. Even if scientists do develop relationships with specialist science reporters, when political controversy erupts the story is usually taken out of the hands of the specialist correspondent to be covered by political or current affairs teams. This is especially frustrating to scientists, who often fail to realize that such issues are not essentially scientific issues that can be resolved by the demonstration of established facts, but rather political issues that will be determined by appeals to values. However, the absence of sustained media attention to science policy and science politics that characterizes economic and political reporting is unlikely to support the kind of social learning around the emergence of new technologies that we might desire.

Another learning problem connected to the transmogrification of scientific issues into social or political issues involving science lies in the kinds of expertise that the media seek out whenever controversy erupts. Reporters generally consult scientists for insight into such controversies, even when the issues are as much about public values, trust in institutions and democratic governance as they are about strictly scientific matters. Furthermore, the pool of scientists so consulted is depressingly small and often those

portrayed as 'experts' opine on fields far from their real areas of specialist knowledge. Scientists, of course, have no special expertise in matters of policy or public values. The social scientists who do study such issues are seldom called upon for comment by the media.

Learning obstacles for the social sciences

This brings me close to home because, of course, the social science community must take responsibility for getting its voice heard. Often this is a question of vocabulary. We do not always speak in a voice that is accessible to audiences beyond the academy, so we are unable to contribute to wider social learning.

We are also subject to limitations on our own institutional learning. With each new round of controversy over an emerging technology we tend to reproduce earlier rounds of research and reach similar conclusions. To a considerable extent we share the same craving for novelty (or at least the idea of novelty) as our colleagues in the natural sciences. Clearly there is room for a much more cumulative approach to social science learning in this field. One obstacle to a more cumulative approach is our too ready acceptance of a handmaiden or marketing relationship to big science. Our research is often funded on the shirrtails of big-science programmes, such as genomics, and this draws us into contributing to the problem of reliving the past.

Another limitation on our own contribution to alleviating social conflict over emerging technologies is the poverty of our menu of solutions. The stock social science response to technical controversy appears to consist of a reiteration of the precautionary principle and a call for greater public participation in decision making. Until we can learn more about the nature of technological controversy that enables us to offer a richer range of responses, our ability to contribute to wider social learning will inevitably remain restricted.

Technology disputes as technology assessment

This brief excursion through possible obstacles to institutional learning has neglected the possibility that the public controversy engaging the scientific establishment, government, business, NGOs, the media and social scientists may itself be a form of societal technology assessment. In other words, we may have collectively learned that the pattern of claim and counter-claim about novelty, risk and continuity is a way of engaging plural rationalities in testing and evaluating new technologies in an unplanned, undirected process. As such, it may be what some social scientists describe as a clumsy solution, in which

'clumsy' is a counter-intuitive term to describe robust, emergent solutions to intractable or, at least, persistent problems (Verweij and Thompson, forthcoming).

This would seem to be the case for nuclear power in the USA, where the social conflict eventually led to almost universal, although strictly implicit, agreement that the nation would continue nuclear R&D but impose a moratorium on the addition of new nuclear generating technology. This implicit consensus has endured for over two decades.

If we do decide that the persistent pattern of societal disputes over emerging technological fields is indeed the result of social learning and represents an implicit system of technology assessment, the question becomes 'Can we improve on it?' If conflict is central to social learning we should not seek to eliminate it, but we may wish to explore ways to reduce its costs, which at present seem to be rather high both in economic terms and in wear and tear on the social fabric.

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