Risk Research Institute
part of the Centre for Analysis of Risk and Regulation

risk...

two cultures of risk

Sponsored by
PricewaterhouseCoopers

LSE The London School of Economics and Political Science

First published in the United Kingdom, 2001 by the London School of Economics and Political Science

ISBN 0 7530 1463 7

This publication has been sponsored by PricewaterhouseCoopers

Design: ABA Design

Printed and bound by LSL Press Limited, February 2001

Centre for Analysis of Risk and Regulation
The London School of Economics and Political Science
Houghton Street
London
WC2A 2AE

The Risk Research Institute:
Centre for Analysis of Risk and Regulation

Two Cultures of Risk

George Gaskell* and Nick Allum**

Summary

The recent controversy over the abortive attempt to introduce genetically modified (GM) foods into the UK market has served to highlight the gulf between the scientific establishment and the lay public in their evaluation of risks associated with novel technologies.

The social scientific literature on the perception of risk suggests a number of reasons why this public relations disaster occurred and how it might have been avoided. It has been shown that people do not follow the axioms of probability when judging the likelihood of events or when trading off losses and gains. More importantly, people's judgments of the risks associated with technological hazards are related to the extent to which they are seen as having a number of attributes such as, uncontrollability, unfamiliarity, and being dangerous to future generations. Going beyond this, anthropologists suggest that concerns and conflicts over novel technologies arise in part from the fundamentally different 'worldviews' held by the various stakeholders in the debate. As far as the GM food debate was concerned, government, science and industry, in ignoring these fundamental cleavages and emphasising 'objective risks', failed to appreciate the full scope of the problem they faced in persuading the public that GM foods were safe. The regulators, in particular, failed to appreciate its task as facilitator of dialogue between two conceptions or 'cultures' of risk.

In terms of new technologies in general and biotechnology in particular, the paper concludes with some practical recommendations for risk management.

***George Gaskell is Professor of Social Psychology and a Research Associate of CARR.**
****Nick Allum is a Research Officer on an EU funded project 'Life Sciences in European Society.'**

Introduction

In this paper we discuss the background and implications of what might be thought of as a significant example of a failure of risk management. A failure that cost the global Life Sciences companies, such as Novartis and Monsanto, billions of dollars and that has left the whole concept of the Life Science Conglomerate, combining pharmaceuticals and agri–foods, in utter disarray. Beyond the commercial costs it has led to threats of trade wars between the US and Europe under the aegis of the WTO.

With hindsight it is clear that industry and the regulatory authorities were over–optimistic about the ease with which the technology would be introduced into global society and unprepared to deal with the course of events, somewhat surprisingly given that the technology had been in development for over 20 years and the advent of GM foods was widely anticipated by the mid 1980s. Central to this debacle is the concept of risk itself. And as a case study of systemic institutional failure, the lessons of the GM issue may be of broader relevance. If societies cannot manage innovations such as GM foods, what hope for the introduction of nano–technology, robotics and other developments in the 21st century?

The background

Modern biotechnology appeared in the early 1970s with the invention of recombinant DNA or in vernacular terms, gene splicing. From the onset it was a controversial technology. A conference in Asilomar in 1975 in the US led to a voluntary moratorium while scientists assessed the risks of the technology. Following this, research progressed apace leading in the late 1980s to an explosion of small R and D companies, largely funded via venture capital and stock market flotations. Biotechnology became a new Klondike. Exuberant visions of miracle drugs and new crops that would eliminate the food problems of the third world led to market capitalisations which were only surpassed in absurdity by the recent dot.coms. For the big players this was a time of expansion, acquisitions and mergers. The key product developments were in the areas of pharmaceuticals and GM seeds. Early on, biotechnology was identified by Governments as the technology of the 21st century and while they did all they could to make it happen, they also had responsibility for the regulation of the technology.

Products of biotechnology and initial consumer response

As is often the case with a new technology, it took rather longer than expected to bring some of the projected applications to the market. The first notable consumer product in the area of agri–food biotech was the Flav'r Sav'r Tomato®, a joint development by Calgene in the US and Zeneca, ICI's biotechnology division, which reached the market about three years later than expected. Heralded as a breakthrough it was sold as a salad tomato in the US at a premium price, and as a can of puree in the UK (both labelled as a product of modern biotechnology). However, it was subsequently withdrawn on account of technical problems leading to Calgene being swallowed up by Monsanto. Notwithstanding the eventual failure of the product, while on the shelves it sold well. That there was no apparent public debate or consumer opposition, may have led the industry to assume that GM products as a whole would meet with consumer acceptance.

The emerging crisis

However, in 1996 a European–wide survey of public perceptions of biotechnology painted a different picture (Durant, Bauer, Gaskell, 1998; Gaskell et al., 1997). While there was widespread support for medical and pharmaceutical applications of modern biotechnology, agri–food applications received a mixed response, and transgenic animal applications were widely opposed. Although there were differences across the European Union, on the whole the European public was ambivalent about biotechnology. Underlying the positions on particular applications we argued were judgements about the relative "usefulness" of these applications to society and the extent to which they are judged to be "morally acceptable". Surprisingly, and of contemporary significance, the 1996 Eurobarometer results suggested that perception of risk was only weakly correlated with public support.

The watershed years

With the benefit of hindsight these survey findings could have been interpreted as an early warning of potential problems, in that they anticipated the controversial debates and even conflicts over agricultural biotechnologies in Europe. The survey showed, for the first time, that the way the public think about biotechnology is rather different to the approach taken by scientists and regulators. But the survey findings were ignored. The next development was the importing of GM soya beans from the United States into Europe. At this time, biotechnology was viewed rather differently in the United States and Europe. In the US after a long period of debate, the regulatory arrangements were in place, the public apparently untroubled and the commercial exploitation of biotechnology was well underway with product approvals and millions of acres planted with new GM seeds. By contrast the cycle of innovation in Europe was at a much earlier stage. Europe's collective and national regulatory arrangements were much disputed, little research had been conducted on the environmental and health issues, and the technology itself was very unfamiliar to the public. In this early phase of the innovation cycle, the introduction of imported GM products clearly had a profoundly disturbing impact. Interestingly, this disruption has not been a one way process; there is evidence that in reaction to the European controversies, the US public has become increasingly troubled. For example, to the dismay of the industry and regulators, a number of food manufacturers have sourced non–GM ingredients for baby foods and other popular food lines. Returning to 1996 and the GM soya, this was an unfortunate product choice to herald the dawn of the new technology. Crucially, while it had advantages for farmers in terms of crop yields, it offered no consumer benefit. Objections to GM soya came from consumer and environmental groups. For consumers the absence of proposals for product labelling was an unwarranted infringement of choice. For environmentalists the issue was a range of environmental impacts of the commercial exploitation of GM crops (Liakopoulos, 2000). Into a growing debate the cloning of "dolly the sheep" accentuated public concerns that biotechnology was a new version of Pandora's Box.

As the BSE crisis unfolded against a history of governmental assurances that "British beef is safe", unpublished research by Putzai purported to show that rats fed on substances found in GM foods suffered health problems. GM foods became the subject of heated exchanges in the

House of Commons, sections of the media campaigned energetically, and the supermarkets, fearing a consumer backlash withdrew GM products. By the end of 1999 when we repeated our 1996 survey on the biotechnology, it was clear that the public had no confidence in GM foods, or for that matter in industry or government. But interestingly, support for medical and pharmaceutical applications stayed at the high level that we had observed in 1996 (Gaskell et al., 2000).

Who was to blame?

Confronted by this unexpected public rejection, the scientific and regulatory communities opted for the blame engineering strategy. The two favourite villains were the mass media and the public themselves. On the one hand the press were widely seen as hysterical, anti–science and over influenced by lobby groups such as Greenpeace. At the same time the public were regarded as ignorant of modern genetics and as such open to persuasion and misinformation. "If only the public understood the concept of risk (or modern biotechnology) there would be no problems with the acceptance of genetically modified foods" was, and still is, the lament of the typical scientist and regulator. By implication, the science behind biotechnology and the way in which it is regulated are fine, the problem is with others.

In passing in our research we find that up to 1996 the coverage of biotechnology in the quality press was generally positive, (Durant et al., 1998). Thereafter, and particularly at the time of the Putzai controversy, media reporting changed track. Biotechnology moved from the science correspondents to the front page and took on a campaigning and political stance. But despite this blanket media coverage, many are, and feel, poorly informed.

The roots of the problem

The fault line: conceptions of risk

In our view a central issue in the GM food debacle is the contrasting scientific and commonsense ways of thinking about, or representing, danger. This, we argue, is emerging as a fundamental fault line in society and has implications beyond the issue of modern biotechnology. For scientists there are objective risks, that are essentially properties of the environment. Such risks can be identified and measured with the framework of sound scientific evidence, so–called 'risk assessment'. Determining whether a risk is acceptable or not can be based on a cost–benefit analysis or on relative judgements against other known risks. 'Sound science' has been the central principle on which US policy making on the new genetics has been based. And beyond this in the domain of foods, there has been the presumption of functional equivalence. Functional equivalence specifies that if a GM product is the same as the non GM product, then it should be judged within the existing regulatory framework for the non GM variety. That the product was produced by a different process, genetic manipulation, is not a reason to introduce additional criteria in the evaluation of safety or to establish new regulatory frameworks. In other words GM soya is just another version of soya and should be evaluated as such.

Armed with the 'sound science' criterion, GM products were assessed on the basis of the familiarity principle. Here potential dangers can be identified from known and scientifically established risks to human health and safety. These are deemed to be the proper basis for risk evaluation, and in parallel the only basis on which the product can be challenged.

'Sound science' and the familiarity principle set the frame for the criteria of risk assessment. The frame defines the relevant considerations, those that have an established basis in scientific research, and at the same time bars the consideration of other issues. In this sense 'sound science' determines the rules of evidence and becomes a filter of the 'truth' – known risks are included but anything else is rejected from consideration as merely an hypothesis or even non–scientific fantasy.

'Sound science' has another important implication in that it determines who is, and who is not, considered to be an expert. In other words whose voice should be heard in discussions of risk and safety and whose should be excluded. For the 'objective risk' community the answer is almost a self evident truth. Those who understand risk are the experts, others who argue from different perspectives, for example along the lines of the precautionary principle, merely muddy the waters. Typically, only scientific experts are allowed to frame the problem and, not surprisingly, they frame it in terms of scientific criteria. The faith in sound science and in scientific expertise extends to areas of decision taking where the issues are beyond the frontiers of current knowledge and concern "uncertainties" or what might be termed hypothetical hazards. At this point, as Sir Robert May, Chief Scientific Advisor to the UK Government recommends, "There are so many unknown factors and so much scientific ignorance, that top calibre advisers are needed to guide us through the fog" (The Royal Society, 1999). So even when the scientists know that they don't know, they still know better than anyone else.

In defence of sound science and all that it entails, scientists and regulators might argue along the following lines: 'On what other basis can a society proceed? Without a criterion of acceptable evidence and a basis for judging expertise, any claim from whatever source, including malicious sources, would have equal weight. And, if this were to hold, society would be at the mercy of luddites and other 'fringe opinions'. Equally they might point to the success of science and technology, and to the record of fixing any unforeseen consequences. Increasingly, however, these views are challenged by a growing recognition that the constitution of societal risks is much more complex than strict scientific or actuarial assessment. Defining the scope of risks to be considered and whether they are worthwhile, takes the issue into the public domain.

How the public view risks

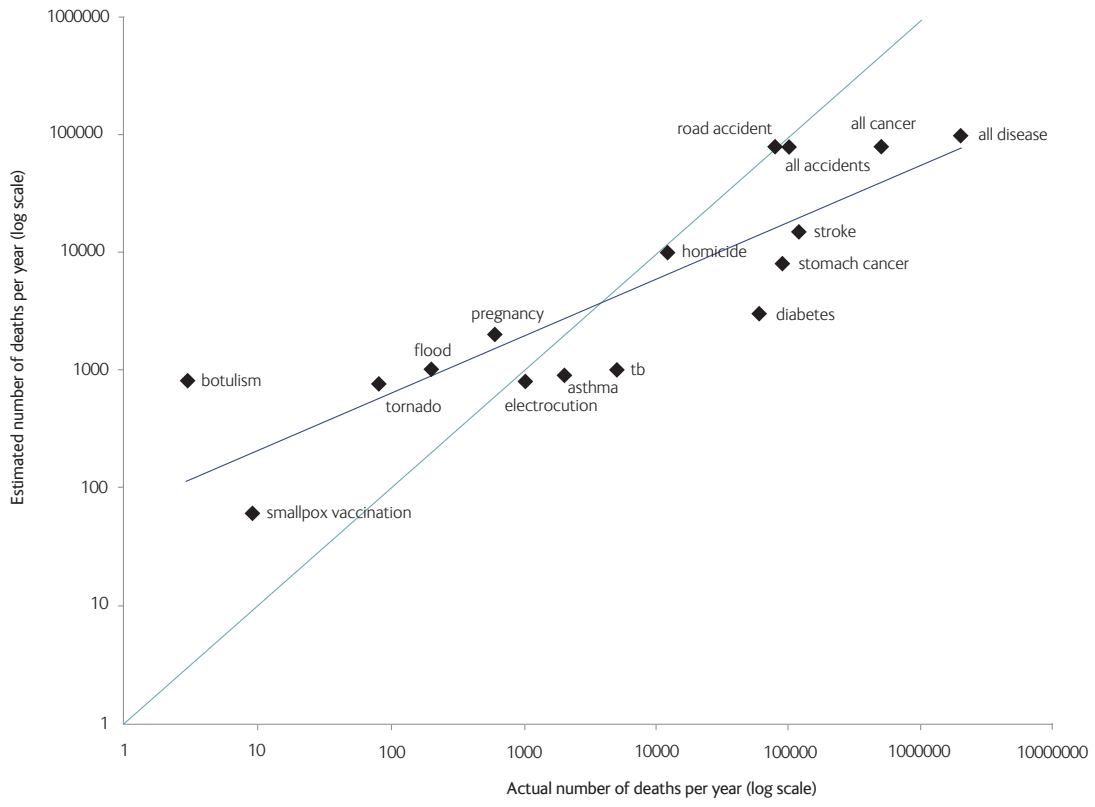
To return to the scientists lament about the public "if only they were better informed etc", there is some truth in the proposition that the public do not follow the standard procedures underlying rational choice, nor do they follow the axioms of probability. How can some people smoke, a demonstrable risk, but then complain about GM foods when their worries about them have no basis in science? Empirical research shows that intuitive judgements of risk do not match actuarial assessments, that the nature of the risk affects its acceptability with the public, and that when considering benefits and costs, the latter loom disproportionately large in the public mind.

Intuitive risk perception

Work in this area, initiated by Paul Slovic and his colleagues, was stimulated by the growing public disaffection with nuclear power during the late 1960s and 1970s. Why were the public opposed to nuclear power when expert assessment showed that it was, relatively speaking, a safe technology? Slovic and his colleagues showed that public, so–called "lay estimates" of the number of fatalities per year attributed to various kinds of hazard departed systematically from objective or expert estimates (Slovic, Flynn, Mertz, Mays & Poumadere, 1996; Slovic, Lichtenstein, & Fischoff, 1979; Slovic, Lichtenstein, & Fischoff, 1980; Slovic, Malmfors, Mertz, Neil & Purchase, 1997). See below.

As can be seen there is a dramatic tendency to compress the range of probability estimates. At the same time people tend to overestimate the number of fatalities from low probability hazards, tornadoes and floods and underestimate those that have high incidence of fatalities, strokes and diabetes. The scatter of particular hazards above and below the line also needs explanantion. Tversky and Kahneman account for this by suggesting that people do not follow the principles of probability theory when assessing the likelihood of uncertain events but instead employ various shortcuts or heuristics (Kahneman, Slovic, & Tversky, 1982). Often these heuristics lead to fairly good estimates of the probability of an event. But sometimes they do not.

Judged frequency of lethal events (adapted from Lichtenstein et al ,1978)



The availability heuristic and media amplification

One way of judging the probability or frequency of an event is to reflect on the ease with which instances can be retrieved from memory or imagined (Tversky & Kahneman, 1973). Events that are more easily retrieved are assumed to be more frequent. Thus research shows that fires and explosions are judged as more probable causes of death than drowning, although actuarially they carry the same probability. Equally, death from firearms in the US is judged more common than death from machinery, although these are also the same actuarially. Here, differential media interest and amplification of events is implicated. Those causes of death that are frequently covered or are more spectacular (road accidents) will be easier to bring to mind, and hence will be perceived as more probable than the less well covered and more mundane causes of death (diabetes). Interestingly research has shown that the frequency of newspaper reporting of homicides correlates around 0.7 with the public's estimate of risks, a case of media amplification (Slovic et al., 1980).

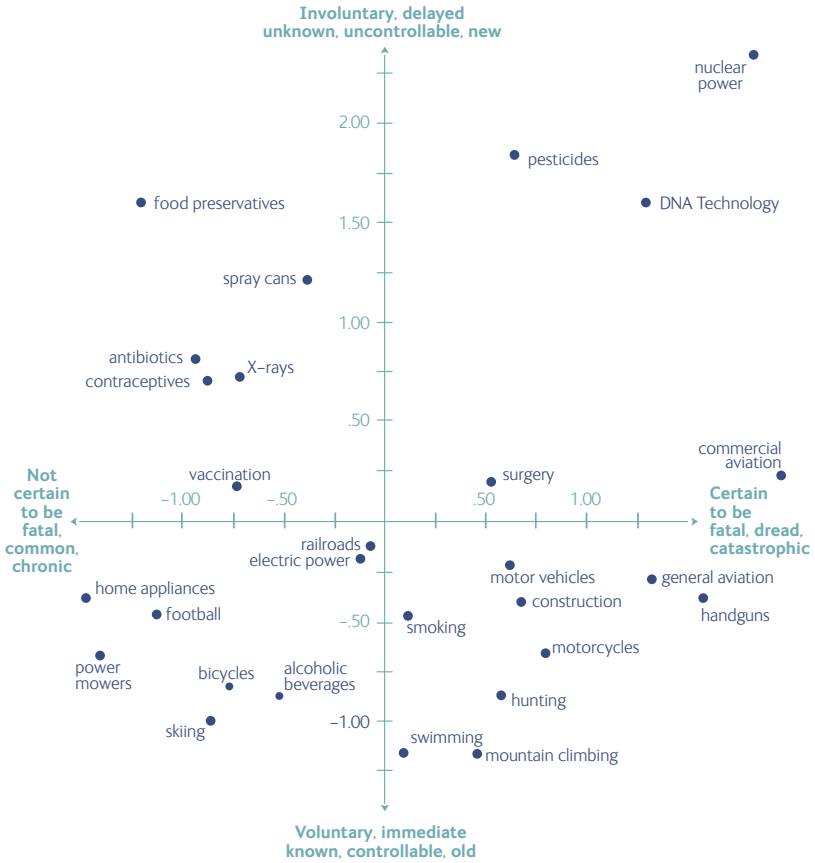
Some risks are more equal than others

Beyond the issue of intuitive risk assessments Slovic, Lichtenstein and others have studied the way in which different types of hazards are perceived and understood (Slovic, 1987). Why, when it is safer to fly in an aeroplane than to take a car journey do people feel anxious about the former, but generally unconcerned about the latter? Essentially it is because people see different hazards as having qualitatively different characteristics, and these characteristics seem to influence people's estimates of the likelihood of an accident occurring.

This research was sparked off by Chauncey Starr's (1969) paper 'Social benefit versus technological risk'. Based on the method of revealed preferences and some heroic assumptions, Starr shows that the public is willing to accept voluntary risks, such as hunting, smoking and skiing, roughly 1000 times greater than involuntary risks, such as electricity generation. As Starr notes, "we are loath to let others do unto us what we happily do to ourselves". Hence risk acceptability for technologies does not simply depend on the presumed magnitude or the seriousness of the consequences but on a number of other factors; the judged benefits and whether or not a risk is taken voluntarily or involuntarily. Mobile phones are a good case in point.

Slovic took this idea further and asked respondents to assess ninety hazards on eighteen characteristics including Starr's voluntary/involuntary distinction, familiar/unfamiliar, dread/calm and catastrophic/non–catastrophic.

Qualitative dimensions of risk perception (adapted from Fischoff, Slovic, Lichtenstein, Read & Combs, 1978)



What this shows is that the concept of risk means more to people than an estimate of its probability of occurrence; it is much more complex than this. Hence the widely accepted method of measuring risk magnitudes in terms of the number of fatalities per year is argued to be inadequate (Royal Society for the Prevention of Accidents, 1983); Slovic, 1987 #17] as it fails to capture the way people actually understand the term. Based on multivariate statistical procedures the diagrammatic representation shows that different types of risks are judged according to quite a complex set of qualitative dimensions, which can be reduced to two principle axes, known vs. unknown and dread vs. non–dread.

As Starr had already noted, whether exposure to a risk is voluntary or involuntary is related to its acceptability. But here it can be seen that a much wider range of risk qualities is significant. The two factors shown have been labelled as 'dread' risk and 'unknown' risk by Slovic et al. 'Dread' risk is constituted by the perception of uncontrollability and the idea that the danger might be of a global, catastrophic nature; fatal; a high risk to future generations; an involuntary risk that is a personal hazard. Also significant for this factor is whether or not the risk is seen as increasing, not easily reduced and inequitable. Hazards that score highly on this factor are, amongst others, nerve gas, nuclear weapons and terrorism; those at the other end of the scale include home appliances, sunbathing and cosmetics. The second factor, 'unknown' risk is composed of qualities such as observability, whether a risk is known to those exposed or to science and whether the effect of a hazard is delayed or immediate. DNA research and space exploration are high on this factor, while handguns and fire fighting are low. Slovic and colleagues also found that, contrary to Starr's assumption, for many hazards, people considered the risks to be unacceptable and that there was a strong demand for mitigation of the risks.

Critical events as signals

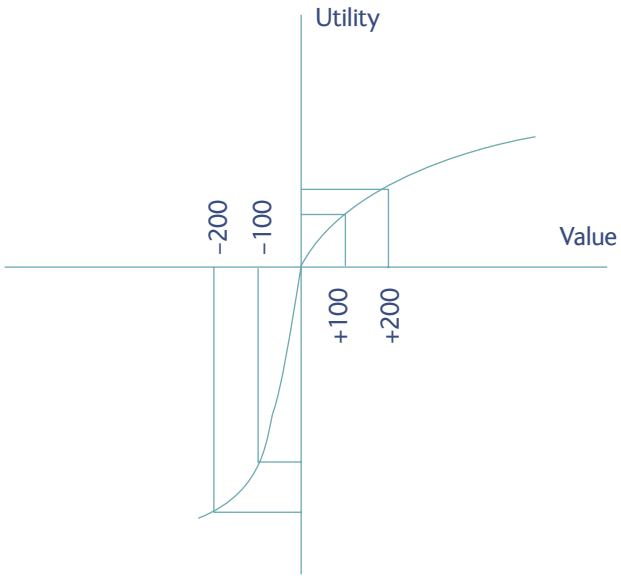
A practical implication of these findings concerns the 'signal potential' carried by unfortunate events. Slovic, Lichtenstein and Fischoff (1984) investigated the extent to which accidents involving various hazards were viewed as "a warning signal for society, providing new information about the probability that similar or even more destructive mishaps might occur within this type of activity". They found that the location of the hazard in the factor space was correlated with the signal potential of the event. Events with high signal potential tend to be those in the upper right quadrant of the factor space. This finding makes public reaction to, for example, the 1979 Three Mile Island nuclear reactor incident easier to explain. If the perception of nuclear reactor accidents is that they portend more dangerous future risks, then the public outcry and its calamitous results for the civil nuclear energy industry was eminently predictable. That the risks of DNA technology were seen as 'dreaded' and 'unfamiliar' as early as 1978 should have rung the warning bells.

Weighing up gains and losses: Prospect Theory

Behavioural decision theory and in particular the model of subjective expected utility introduced rational choice models, the idea of decision taking on the basis of maximising utility, into psychology. However, empirical research raised some objections to this formulation. In response, Kahneman and Tversky's 'Prospect Theory' (Kahneman & Tversky, 1979) elaborated a general framework for understanding why people's actual behaviour, in relation to risky decision making, departs from the predictions of rational choice theory. Prospect theory includes weighting functions for both probabilities and utilities. The probability function captures the findings on systematic biases of estimates of fatalities. We tend to over–estimate (weight) low probability events and underestimate those with a high probability, essentially a regression effect. Although the availability or vividness bias is one possible explanation, in Prospect theory it is proposed that over weighting of low probability events occurs regardless.

That something is conceivable appears to be sufficient to give it a reality beyond its objective probability. The implications for new technologies are that even a hint of potential problems may loom significantly in the public mind. In this sense one can see why experts stuck to the claim that "British beef is safe".

Prospect Theory's value function



The value function is defined in terms of gains and losses from a reference point or adaptation level. For gains the function is concave and while the same holds for losses, in this context the slope of the curve is much steeper.

In other words the utility weighting leads to an asymmetry between 'objectively' equivalent gains and losses. The pain from a small loss from one's current position will far outweigh the pleasure from an equivalent small gain. In terms of the way people think about gene technology, it follows from Prospect Theory that the potential harm caused by genetic modification of crop plants might loom larger for the public even if weighed against 'equivalent' (in terms of its formal expected value) gains in efficiency, reduction in price, or whatever. That is to say, the benefits need to be great in order to justify taking any risks.

Risks and values

In a philosophical paper calling for conceptual clarity, Thompson and Dean (1996) propose a distinction between probabilistic and contextualist formulations of risk. They suggest that current models of risk fall on a continuum between two extreme versions of these formulations. What we have called the scientific approach is an exemplar of the probabilistic formulation and the proposals to include biases and utility weighting functions are a weaker form. By contrast, the contextualist formulations embrace a fuzzier definition of risk allowing for the inclusion of characteristics that are unrelated to probabilistic assessment, for example social and cultural values. Cultural theory is the exemplar of the contextualist formulation.

Cultural theory

Douglas and Wildavsky (1982)offer an explanation for why different social groups have different attitudes towards technological and natural dangers. In her earlier work, anthropologist Mary Douglas claims that the content of beliefs about purity, danger and taboo in any given culture are essentially arbitrary (Douglas, 1966). Within a particular culture these arbitrary beliefs become fixed and henceforth serve to organise and reinforce social relations according to hierarchies of power. For instance, the Hima of Africa think that it is risky for women to come into contact with cattle. This belief functions to maintain a set of hierarchical relations in that culture regarding the role of women rather than reflecting any objective risks. In Western societies the picture is necessarily more complex but, according to Douglas and Wildavsky, the same principles apply. An individual's beliefs about what constitutes an important risk is in part indicative of their place in society, or in a weaker form is constructed though social processes. At a recent meeting in the Netherlands an American was shocked to see so many Dutch people on bicycles without helmets. In the context of a discussion on the possible risks of GM foods, this observation persuaded him that the Dutch were simply irrational.

Rayner (1992) argues that the social construction of risk occurs not only at the societal level but can also be observed within smaller organisations such as firms, political parties and non–governmental organisations. The implication of this for the social study of risk is rather important because it shifts the emphasis away from differences or biases in perception of objective risks towards more fundamental types of interpersonal or intergroup cleavages. In the cultural theory view, people's conception of what constitutes danger, or a risk, varies according to the way their social relations are organised. People select risks as being important or trivial because in so doing they reinforce the established social relations within the culture in which they are located. Douglas and Wildavsky proposed four prototypical cultural types within modern industrialised societies. These are located along two dimensions that describe firstly the degree of social incorporation constituted within the culture and secondly the nature of these social interactions. While attempts to corroborate this approach empirically have met with limited success, it offers a provocative analogy of the history of debates around biotechnology. It suggests that for different actor groups in society; in industry, government and public interest groups, the specific arguments for and against biotechnology arise from different, and in some cases incommensurate "world views".

Four stereotypes from 'Cultural Theory'

Fatalist The 'cynic' Nature capricious In the lap of the gods	**Bureaucrat** Regulators and government Nature is tolerant within limits Managing 'risks' Bridging the cultures?
Entrepreneur Industrialists and venture capitalists Nature benign Scientific risk Familiarity principle	**Egalitarian** Prince Charles and the 'Greens' Nature is fragile/ venerated Risk unknown Precautionary principle

Let us explore the debate with the help of the figure. For the entrepreneur (the industrialist and venture capitalist) nature is seen as bountiful, benign and malleable; biotechnology with its promise to improve on what nature has provided, is seen as a golden opportunity. With the increasing commercialisation of science this may also typify parts of the scientific and research community. In this worldview, the concept of risk is defined in terms of sound science and regulation, based exclusively on the familiarity principle.

By contrast the egalitarians, exemplified by Prince Charles and the Greens, see nature as a delicate and precarious system and fear that any interventions may lead to unforeseen and potentially dreadful consequences. For them sound science is irrelevant, because it is the risks of biotechnology that are unknown and even unknowable which are of concern. Hence they argue for the precautionary principle.

This typology, while suggestive of more polarised positions, does not capture the reality of the public. The evidence of survey research and of qualitative studies we have conducted suggest that people are ambivalent; they view biotechnology through both the entrepreneurial and egalitarian perspectives. As entrepreneurs, they welcome progress and recognise the many contributions of science and technology to everyday life. But as egalitarians, they are deeply troubled by some aspects of modern biotechnology. They are fearful of the consequences of tampering with nature, they worry that science and technology are rushing ahead without adequate understanding of the longer term consequences, they see GM foods as an unnecessary and involuntary risk imposed upon them without consultation, and they wonder what is coming next from this unnatural science. These concerns are not considered in terms of the relative acceptability of discreet risks. Rather, they inform a wider moral judgment about the extent to which society should be involved in certain aspects of biotechnology, who is to decide, and on which criteria. In an ideal world, perhaps the bureaucrats (regulators and politicians) would hold the ring between these positions institutionalising the ways in which the competing parties are represented, the public interest served and safety ensured. What some would argue, and many in the public feel, is that biotechnology has been developed and regulated within the entrepreneurial worldview at the expense of other values and conceptions of risk. In the belief that these other values have been side–lined and ignored, people's confidence and trust in the technology and in the regulatory processes has been called into question. And, in the absence of trust, fears and concerns multiply.

Lessons for risk management

The first general conclusion is that recent times have seen the emergence of a second hurdle to application of new technologies. If the first hurdle is the established regulatory process based on sound science, the second and potentially more problematic hurdle is public opinion, informed by considerations and values beyond those of the probabilistic formulation of risk. Those who ignore the second hurdle invite the possibility of political conflicts and public resistance.

Of late the British government has recognised that the conflict between the two cultures of risk threatens public confidence in new technologies. As a result there are now moves to encourage dialogue and to extend public participation in science and technology. The social scientific literature points to some aspects of the second hurdle that need to be addressed. Firstly, if as is evident from the research literature involuntary risks are assessed very negatively, then the absence of product labelling of GM foods will continue to generate public concern. Secondly, with losses looming larger than gains, there is no future for GM foods without tangible and significant consumer benefits. Thirdly, as stated by the Royal Society for the Prevention of Accidents "the public's viewpoint must be considered not as error but as an essential datum" (Royal Society for the Prevention of Accidents, 1992). This is not merely a matter of the public's perception of specified risks, but the worldviews from which they construct representations of risks. Acknowledging this and building bridges between the two cultures of risk is one of the key practical challenges for industry and government, and a conceptual and empirical challenge for the social sciences.

References

Douglas, M. (1966). Purity and danger: concepts of pollution and taboo. London: Routledge & Kegan Paul.

Douglas, M., & Wildavsky, A. (1982). Risk and culture: an essay on the selection of technical and environmental dangers. Berkeley: University of California Press.

Durant, J., Bauer, M. W., & Gaskell, G. (1998). Biotechnology in the public sphere : a European sourcebook. London: Science Museum.

Fischoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. Policy Sciences, 9, 127–152.

Gaskell, G., Allum, N., Bauer, M., Durant, J., Allansdottir, A., Bonfadelli, H., Boy, D., de Cheveigne, S., Fjaestad, B., Gutteling, J. M., Hampel, J., Jelsoe, E., Jesuino, J. C., Kohring, M., Kronberger, N., Midden, C., Nielsen, T. H., Przestalski, A., Rusanen, T., Sakellaris, G., Torgersen, H., Twardowski, T., & Wagner, W. (2000). Biotechnology and the European public. Nature Biotechnology, 18(9), 935–938.

Gaskell, G., Durant, J., Wagner, W., Torgerson, H., Einsiedel, E., Jelsoe, E., Fredrickson, H., Lassen, J., Rusanen, T., Boy, D., deCheveigne, S., Hampel, J., Stathopoulou, A., Allansdottir, A., Midden, C., Nielsen, T., Przestalski, A., Twardowski, T., Fjaestad, B., Olsson, S., Olofsson, A., Bauer, M., & Liakopoulos, M. (1997). Europe ambivalent on biotechnology. Nature, 387(6636), 845–847.

Kahneman, D., Slovic, P., & Tversky, A. (Eds.). (1982). Judgment under uncertainty: heuristics and biases. Cambridge: Cambridge University Press.

Kahneman, D., & Tversky, A. (1979). Prospect theory: analysis of decision under risk. Econometrica, 47(2), 263–291.

Liakopoulos, M. (2000). The debate on biotechnology in Britain: a social psychological analysis of arguments, images and public perceptions. PhD: University of London.

Rayner, S. (1992). Cultural theory and risk analysis. In S. Krimsky & D. Golding (Eds.), Social theories of risk. Westport: Praeger.

Royal Society for the Prevention of Accidents. (1983). Risk assessment: a study group report. London: Royal Society.

Royal Society for the Prevention of Accidents. (1992). Risk: analysis, perception and management. London: Royal Society.

Slovic, P. (1987). Perception of risk. Science, Vol 236, 280–285.

Slovic, P., Flynn, J., Mertz, C., Mays, C., & Poumadere, M. (1996). Nuclear power and the public: a comparative study of risk perception in France and the United States (96–6). Eugene: Decision Research.

Slovic, P., Lichtenstein, S., & Fischoff, B. (1979). Which risks are acceptable? Environment, 21(4), 17–20.

Slovic, P., Lichtenstein, S., & Fischoff, B. (1980). Facts and fears: understanding perceived risk. In R. C. Schwing & W. A. Albers (Eds.), Societal risk assessment: how safe is safe enough? New York: Plenum.

Slovic, P., Lichtenstein, S., & Fischoff, B. (1984). Modeling the societal impact of fatal accidents. Management Science, 30, 464–474.

Slovic, P., Malmfors, T., Mertz, C., Neil, N., & Purchase, I. (1997). Evaluating chemical risks: results of a survey of the British Toxicology Society. Human and Experimental Toxicology, 16, 289–304.

Starr, C. (1969). Social benefit versus technological risk. Science, 165, 1232–1238.

The Royal Society. (1999). Science, technology and social responsibility. London: The Royal Society.

Thompson, P., & Dean, W. (1996). Competing conceptions of risk. Risk: Health, Safety and Environment 7. 361.

Tversky, A., & Kahneman, D. (1973). Availability: a heuristic for judging frequency and probability. Cognitive Psychology(4), 207–232.

For further information contact the
Risk Research Institute on
+ 44 (0) 20 7955 6577 or email: risk@lse.ac.uk

Sponsored by
PRICEWATERHOUSECOOPERS

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE