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The Academy was founded in 1976 as The Fellowship of Engineering on the initiative of HRH The Duke of Edinburgh and a group of distinguished engineers. It was granted its Royal Charter in 1983 and, with the gracious consent of HM The Queen, adopted the present title in 1992.

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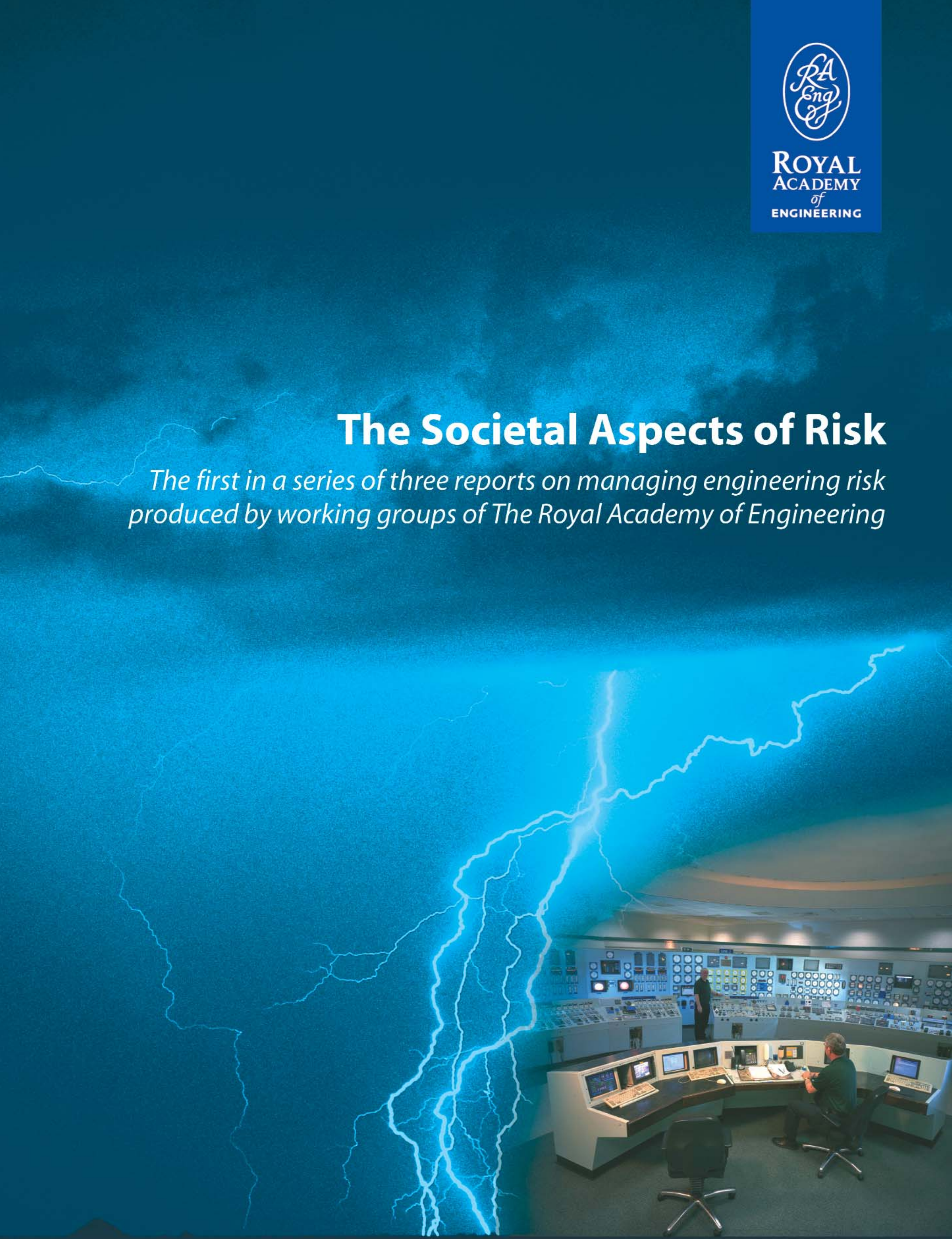
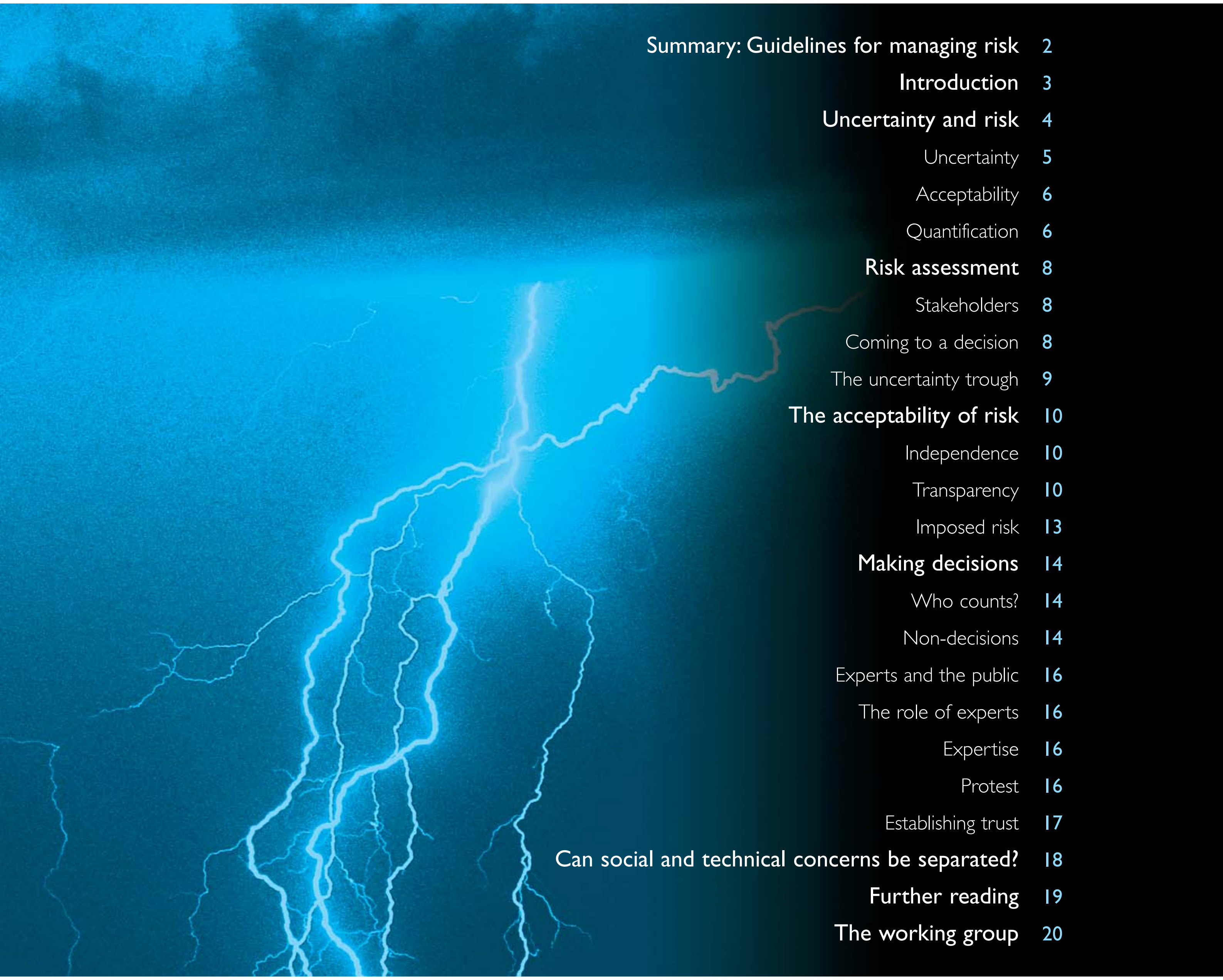


The Societal Aspects of Risk

The first in a series of three reports on managing engineering risk produced by working groups of The Royal Academy of Engineering

Contents



Summary: Guidelines for managing risk

Engineers need to understand how groups in society develop perceptions about the riskiness of engineering projects and processes and what these perceptions depend on. The perceptions will generally be quite different from the qualitative and quantitative assessments made according to traditional engineering methodologies. This document summarises current thinking, informed by both engineering best practice and social science research.

It is recommended that the following guidelines should be considered in all engineering activities:

- At an early stage, identify the interest groups that might have a stake in the project.
- Define the boundaries of the system which you are considering and ensure that your decisions about the appropriate boundaries are understood and accepted by interest groups.
- Aim to quantify the risks with as much precision as is relevant and achievable.
- Do not attribute a greater degree of precision to your risk assessment than it deserves
- Recognise the social, political and economic implications in your risk assessment and acknowledge them publicly.
- Stimulate public debate on the perceived risks and benefits.
- Establish a consultation and feedback process about risks with stakeholders, including the public and local community.

Introduction

This document was written by a group convened by the Royal Academy of Engineering in 2002. Its members are listed in the Appendix. Fellows of the Academy have been concerned that recent approaches to the management of risk should be reflected in the work of engineers. This document should be of interest to those directing and managing engineering projects, practising engineers and students, and involved members of the community.

One of the reasons that the subject of risk is so complicated and important is that it brings together technical issues with social ones. If risk is regarded as a purely technical matter, mistakes are likely to be made. If the technical issues are ignored, this is also dangerous. Ideally, one needs to have a clear appreciation of both the technical components and the social aspects of a risk in order to manage that risk successfully. Often, the issues need to be examined in a way that might seem surprising or departs from common sense. However, this is true of much of engineering — engineers would not be skilled professionals if following common sense were all that is required.

In this guide, we shall illustrate this with a number of real examples where failures to manage risk have had unexpected or catastrophic consequences and we shall show how an understanding of the social and technical issues could have alleviated or avoided the problems. It is not possible within a short guide such as this to cover all the aspects of risk that a good engineer needs to consider. Instead, the aim is to show the general principles that might be applied in particular cases.

Risk is already a major concern of engineers and over the last couple of centuries the engineering disciplines have developed a battery of techniques to minimise technical risks. Many of these techniques are fundamental to the way that engineering is practised. However, it has only been relatively recently that the interaction between technical and social issues has come to the fore. Increasingly, it is recognised that successful engineering, which almost by definition makes a difference to the lives of people in society, needs to put the social implications of engineering practice at the centre of its concerns.

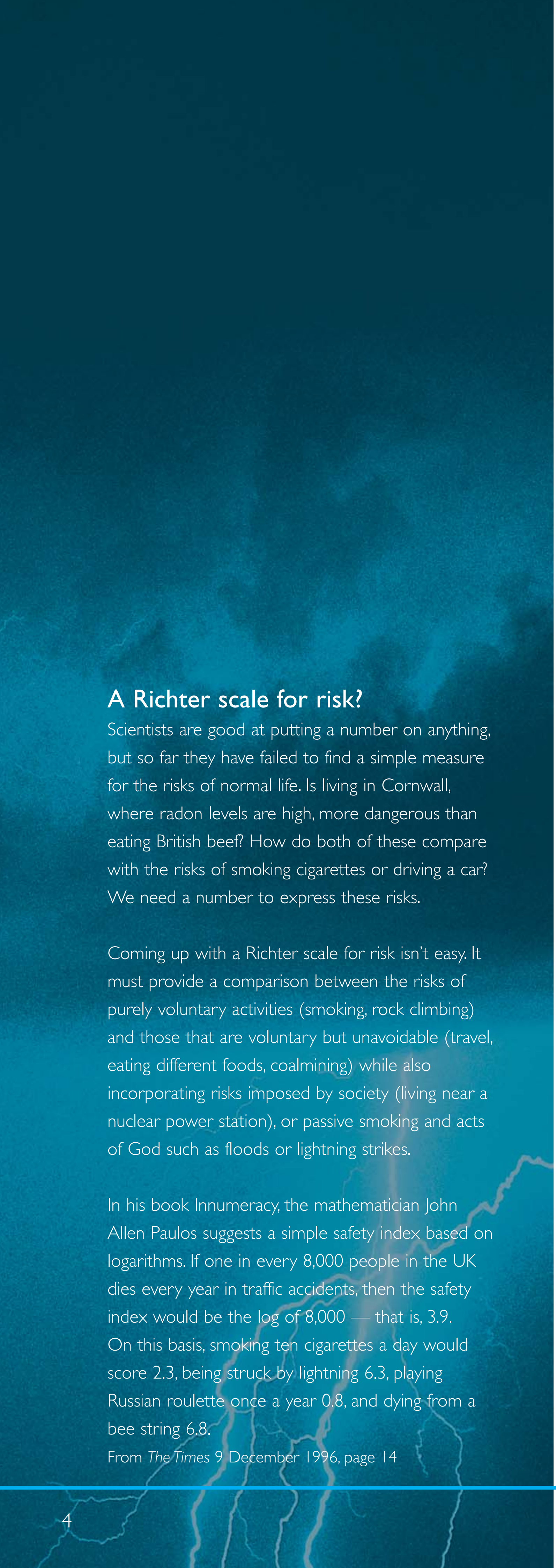
Engineering is essentially about proactively improving the environment in which we live. The provision of roads, buildings, telecommunications, plastics and medicines are all directed at this. Thus, engineering is first and foremost an activity that interacts deeply with society. It requires a profound understanding of society's needs and aspirations and an ability to communicate and debate with the community how best to meet those needs. It is an economic activity concerned with the optimum use of scarce resources. It is a cultural activity that impacts on lifestyle and behaviour. It does all of this within a disciplined technical framework able to deliver the devices and artefacts best suited to meet society's needs.

Uncertainty and risk

Risk is often defined as the probability that an untoward event will happen, multiplied by the impact it could have if it did happen. So, the risk of a hurricane destroying a town is obtained by multiplying the probability of it occurring by the amount of damage that it could cause. This is an example of an acute risk: the catastrophe happens very quickly and affects many people simultaneously, but there are also many examples of chronic risks, where the consequences build up slowly, but no less seriously. Many cases of environmental pollution are chronic risks.

It might seem that it would be possible to arrange risks on a scale from the most risky to the least. It is this kind of argument that is made when it is suggested that rail transport is safer than travelling by car. While engineers strive to reduce all risks, it would seem wise to spend most of the effort devoted to risk reduction on the worst risks. The risks of various events have sometimes been ranked on a 'risk ladder', so that one risk can be compared with another.

However, there are a number of fundamental problems that get in the way of ranking risks neatly like this.



A Richter scale for risk?

Scientists are good at putting a number on anything, but so far they have failed to find a simple measure for the risks of normal life. Is living in Cornwall, where radon levels are high, more dangerous than eating British beef? How do both of these compare with the risks of smoking cigarettes or driving a car? We need a number to express these risks.

Coming up with a Richter scale for risk isn't easy. It must provide a comparison between the risks of purely voluntary activities (smoking, rock climbing) and those that are voluntary but unavoidable (travel, eating different foods, coalmining) while also incorporating risks imposed by society (living near a nuclear power station), or passive smoking and acts of God such as floods or lightning strikes.

In his book Innumeracy, the mathematician John Allen Paulos suggests a simple safety index based on logarithms. If one in every 8,000 people in the UK dies every year in traffic accidents, then the safety index would be the log of 8,000 — that is, 3.9. On this basis, smoking ten cigarettes a day would score 2.3, being struck by lightning 6.3, playing Russian roulette once a year 0.8, and dying from a bee string 6.8.

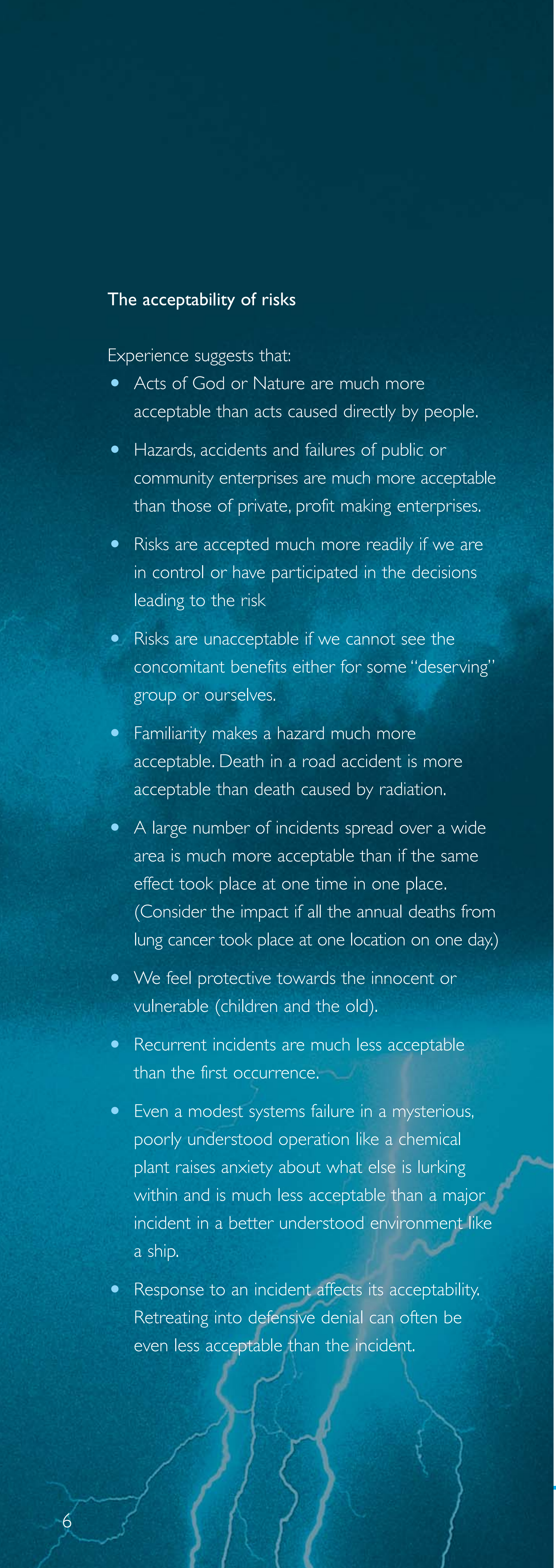
From *The Times* 9 December 1996, page 14

Uncertainty

While for some risks the probability of the event happening is easily calculated from past history, there are many events that either occur very infrequently or have never yet occurred, and for these there is no experience on which to base an assessment of the probability of occurrence. For example, while the probability that you will be killed in a car crash is quite easy to determine, given some assumptions about your age, sex and driving record, the probability of a nuclear power station blowing up cannot, fortunately, be assessed from the history of previous disasters. Similarly, the probability of a disaster on the US East Coast occurring because of a major land slip in the Canary Islands creating a tsunami (a giant wave) cannot be evaluated from past experience because it depends on a sequence of possible events that have never occurred.

In these cases of rare events, it is sometimes possible to calculate probabilities from the likelihood of the conjunction of many components. For example, a nuclear power station might explode if the reactor overheats and the safety system is faulty and the station controllers are not alert. If the probability of each of these is known and the chance of each of the component events happening is independent of the others, the joint probability of an explosion is readily calculated. However, in practice the situation is likely to be much more complex; an assumption of independence is almost certainly unjustified. The problem is further!compounded by the difficulty of ensuring that all the relevant components have been identified.

If a figure for the probability of a rare accident is calculated, it is sometimes presented without the necessary qualifications indicating just how uncertain the probability actually is. However, if the degree of uncertainty is shown, it can make the probability difficult to understand or to use as the basis for decisions. There is no easy solution to this dilemma. Calculations of risk of these kinds do implicitly assume that all the risks have been identified, even if their probability of occurrence is not known with precision or at all. However, there is always the possibility that processes and events that are completely unforeseen will occur, as for example happened with the destruction of the World Trade Centre on 11 September 2001.



The acceptability of risks

Experience suggests that:

- Acts of God or Nature are much more acceptable than acts caused directly by people.
- Hazards, accidents and failures of public or community enterprises are much more acceptable than those of private, profit making enterprises.
- Risks are accepted much more readily if we are in control or have participated in the decisions leading to the risk
- Risks are unacceptable if we cannot see the concomitant benefits either for some "deserving" group or ourselves.
- Familiarity makes a hazard much more acceptable. Death in a road accident is more acceptable than death caused by radiation.
- A large number of incidents spread over a wide area is much more acceptable than if the same effect took place at one time in one place. (Consider the impact if all the annual deaths from lung cancer took place at one location on one day.)
- We feel protective towards the innocent or vulnerable (children and the old).
- Recurrent incidents are much less acceptable than the first occurrence.
- Even a modest systems failure in a mysterious, poorly understood operation like a chemical plant raises anxiety about what else is lurking within and is much less acceptable than a major incident in a better understood environment like a ship.
- Response to an incident affects its acceptability. Retreating into defensive denial can often be even less acceptable than the incident.

Acceptability

Even when two events appear at a similar location on a risk ladder, public perceptions of the significance of the risks may be very different. The risk of death from smoking or from a car accident is much greater than the risk of death from a train crash, yet the former receive almost no public notice while recent rail accidents in the UK have resulted in weeks of press coverage, public enquiries and the bankruptcy of Railtrack. Not everyone views the possibility of death from smoking, for example, with the same degree of seriousness; generally, opinions about the acceptability of risks vary according to political views, personal experience and other factors.

Quantification

Recall that risk is the product of the probability of an event and its impact. 'Impact' is sometimes simplistically measured in terms of monetary value. However, that often leaves out much of the actual impact. If one insures one's house against flood damage, all one is actually insuring is the cost OF repair, not the unquantifiable costs of disturbance, anxiety, and the loss of one's mementos.

Some events are almost entirely unquantifiable. For example, how much does one value a human life? This was the problem faced by those who advised the government on whether to install advanced and extremely expensive signalling systems to stop trains when they passed stop signals. On the one side, the equipment would cost £X; on the other, it was estimated that Y lives would be saved each year. Is the cost worth it? If human life had a generally accepted monetary value, the question could be answered easily, but of course it doesn't. Nevertheless, insurance companies, courts of law, and those making decisions about how much to spend on what kinds of health care all have somehow to weigh up the value of human life in order to get their jobs done.

The Pinto

In the late 1960s, Ford Motor Company encountered a design problem with its new vehicle, the Ford Pinto. The Pinto represented an important new product for Ford since it would allow the company to compete in the emerging small car market. However, the car's fuel tank was located between the rear bumper and the back axle in such a way that the differential could puncture the tank. It would later be alleged that Ford identified this problem late in the production schedule when assembly-line machinery was already tooled. Meanwhile, and despite this problem, the Pinto complied with all US safety standards.

In May 1972, a teenage boy was given a lift in a new Pinto by a family friend. As they headed across southern California, the Pinto stalled and was hit in the rear by a following vehicle at 28mph. The petrol tank ruptured and a spark ignited the fuel. The vehicle was enveloped in flames. The driver died in hospital two days later. The teenager suffered 90 per cent burns and lost his nose, left ear and four fingers. When the case came to court in 1977, he was at one point awarded $128 million in punitive damages (this was later reduced on appeal).

One piece of evidence was particularly crucial in the case against Ford: a 1972 Ford internal memorandum presenting a cost-benefit analysis of the Pinto's safety. The analysis assumed that 180 people were likely to be burned to death in one year in Pinto accidents, and calculated the benefits of saving those lives (at a value of $200,000 per life) plus 180 serious burn injuries (at $67, 000 per injury) plus 2100 burned vehicles ($700 each). The total of $49.5 million was balanced against the cost to Ford of making safety improvements at $11 per car and truck. With anticipated sales of 11 million cars and 1.5 million light trucks, that would cost Ford $137 million with 'benefits' of only $49.5 million. This led Ford to reject fuel tank improvement. It later transpired that a $1 plastic baffle on the differential housing would prevent fuel tank perforation.

Ford's calculation of the value of a human life at $200, 000 was based on a 1972 US government agency study. The major component was $173,000 for future productivity losses. $10,000 was allocated for the victim's pain and suffering. Other components included 'insurance administration', 'property damage', 'legal and court' and 'medical costs'. Of course, and as the court treatment of this case suggests, there is a very different public and social reaction to an actual case of human suffering compared to the valuation of a hypothetical life.

The use of cost benefit analysis in reaching risk decisions raises many ethical and philosophical issues. Fundamentally, one must ask whether human life can be reduced to a cash value. How much would any of us pay for our mother, son or sister? Put in such terms, the whole activity seems immoral and misguided. However, and this takes us to the core of risk decisions, some trade-off must be made between costs and benefits since otherwise no risks would ever be deliberately taken. Whilst the US court was appalled at what appeared to be a cynical calculation, one equally undesirable alternative would be to ignore risk and rely on implicit judgement. The former safety chief of the NASA space programme stated at the time that 'the release to production of the Pinto was the most reprehensible decision in the history of American engineering'. Nevertheless, the lingering challenge of the Pinto episode is to find a more practicable and societally-acceptable means of taking risk decisions.

Risk assessment

Stakeholders

Today, most decisions involving risk involve a number of different bodies, called 'stakeholders'. The list includes not only national government and businesses, but also expert advisory bodies, regulatory bodies, nongovernmental organisations (NGOs), pressure groups and lobbying organisations. Each of these is likely to have its own agenda for action, which can result in a confused debate. Furthermore, some groups may not be represented at all. For example, it has been observed that there is a tendency for unpleasant facilities such as waste disposal sites to be built in poor areas, probably because the local inhabitants are not well enough organised to participate in the debate about where they are to be located. There is a responsibility on those making decisions to bring underrepresented sections of the public into the decision-making process through consultation procedures and by encouraging participation.

Despite everyone's best efforts, stakeholders may remain polarised, with greatly different views on what the right decision should be. There several things that can be done in this situation. First, it is worth considering whether the scope of the issue could be broadened to introduce additional matters that might break the deadlock. Second, while stakeholders may not be prepared to 'sign up' to a decision that appears to be against their interests or opinions, they may be able to accept the outcome of a decision-making process that follows a procedure that they consider to be fair. For example, in environmental decision-making, it is becoming more common to hold conferences or public debates where each 'side' can put its point of view, with the understanding that this opportunity to present its arguments also carries with it the responsibility to accept the eventual decision, even if it is not the desired one.

Coming to a decision

Taking account of a range of views and arguments is not easy. One way that seems obvious is to weigh the costs and benefits in monetary terms. However, it is often quite difficult to assign monetary values even to technical issues – particularly when they are interrelated (e.g. a reduction in public exposure to a carcinogen which leads to workers experiencing an increased exposure). It is still more difficult, if not impossible, to place an explicit monetary value on socio-political factors.

It is important, however, that these different elements of the decision making process are not confused. If a particular decision is made because political factors are judged to outweigh the technical or economic arguments, then this should be explicit. Life Cycle Analysis (LCA) is a developing technique that attempts to weigh all the factors that should be considered in decision making. Another related approach is the 'Regulatory Balance Sheet'. With this, the best scientific and technical analysis (with uncertainties properly exposed) is first presented. An agreed balance sheet of other factors that should be taken into account in the decision (preferably with the involvement of key stakeholders) is then provided. The final decision can then be explained in terms of a judgement about the balance of these factors. This conceptually simple presentation ensures greater transparency in the decision making process.

If resources are to be expended on reducing certain risks at the expense of others, there is a need to be clear that this is appropriate, justified and best represents the wishes of the majority. Recent debates about committing resources to rail safety at the potential expense of saving more lives on the roads is a good example of the issue. Another example is the debate about committing major resources to reduce very minor radioactive discharges from the nuclear industry, when the same resources could provide a more effective return in cleaning up the legacy of radioactive wastes arising from the early decades of the civil and military nuclear programmes. If there is not a consistent, clear process for making decisions of this type or if regulatory bodies operate with different assessment criteria, scarce resources may be committed in ways which do not provide the best value for money and also fail to reflect the wishes of the community.

The uncertainty trough

The 'uncertainty trough' refers to the observation that those closest to the management of a risk are often the most ready to recognise the uncertainty of their knowledge about those risks. For example, environmental managers in city councils throughout Britain are now required to use computer models to simulate local air-quality conditions. These computer models produce highly 'realistic'-looking maps showing the distribution of local air pollution. Members of the public and other users of this information frequently interpret the maps as an accurate snap-shot of air quality. However, amongst modellers and some well informed critics, it is acknowledged that the maps are imperfect: the modelling is known to be highly simplified, the maps are based on periodic traffic surveys rather than on hour-by-hour data on actual traffic conditions, and factories or power stations may on occasions be far more polluting than the model assumes. The outsider's sense of the maps' realism is not shared by insiders, although of course insiders do view the maps as a reasonable overall representation of patterns in local air quality.

As one gets still further away, those who are not at all involved also tend to assume that little or nothing is known about the extent of pollution and therefore consider the issue to be highly uncertain. Thus, those who are the least and most closely connected with the risk perceive the highest degree of uncertainty, while those in the middle have the most optimistic view of the risk assessment process.

The acceptability of risk

In assessing degrees of risk, everyone would like the calculation to be rational and made in a straightforward and clear way. Unfortunately, it is often the case that not everyone agrees what these terms mean when applied to a particular calculation.

Independence

Independence implies that those making risk assessments stand above the issues and simply apply standardised methods to the calculation. But in most actual cases, there is no one who is not affected in some way or another by decisions about risk. For example, while the interests of pressure groups and NGOs may be very clear to all, scientists and engineers also have interests or at least may be perceived to have interests in particular outcomes. Engineers are often keen to ensure that the latest technology is used; engineers and engineering firms want opportunities for continued involvement (and potentially, continued salaries and profits), and so on. In practice, it is better to assume that no one is completely independent, although some people may be more swayed by particular interests than others. This means that engineers need to be self-critical and aware of how they appear to others.

Transparency

Setting aside issues of independence, there may still be legitimate arguments about the methods used to calculate risks and the conclusions to be drawn from the answers. For example, cost-benefit analysis is largely impenetrable to lay people and is often regarded with suspicion for that reason alone. Another common failing of quantitative and statistical methods is that they assume that everyone is the same, that is, they treat the public as though they are all identical average individuals. This is done because otherwise the methods would be unworkable, but on the other hand, everyone has their own life history, desires and quirks.

Multi-Criterion Decision Analysis

Multi-Criterion Decision Analysis [MCDA] is an approach that attempts to make explicit the priorities and trade-offs which must be made in reaching a decision in the face of complex and possible competing requirements. MCDA should be seen as more than a variant on cost-benefit analysis: it deliberately attempts to avoid the loss of transparency that results from combining completely different objectives or criteria into a single number (whether monetary or other). A number of different approaches to MCDA have been advocated, but most involve the following steps:

1. Identify and Structure the Decision Criteria

For decisions taken within some closed organisation, such as a commercial company, the criteria against which alternatives are to be assessed may be well established (although it will still be necessary to articulate them clearly). For public decisions, which typically involve a range of disparate stakeholders, identifying and articulating the objectives is the most important and most difficult part of the decision process. The criteria are then usually organised into a decision tree that identifies the distinct top-level criteria, with the lower-level criteria contributing to each toplevel criterion. The decision tree may break the decision down into criteria at more than two levels.

2. Evaluate the Criteria

Each of the criteria identified in Step 1 is then evaluated for each of the options being considered. This is done even for essentially qualitative criteria: e.g. "yes/no" criteria can be represented as "maximum score" (e.g. 100) vs. "minimum score" (e.g. zero). Participants in the process may do this individually or together in a decision conference.

3. Assign Relative Weights

Each of the criteria identified in Step 1 is assigned a weight that indicates its importance in determining the final decision. Where the criteria have been structured into a decision tree, the weighting is applied to criteria at the lowest level, and the weights aggregated to give the relative weights of the top-level criteria. The weights can be established by discussion in a decision conference; alternatively, in the widely used Analytic Hierarchy Process, each individual or takeholder is asked to express their concerns by comparing the importance of criteria in a structured way which enables the relative weights to be inferred.

4. Determine Preferred Option

The preferred option then emerges as the one with the largest weighted score across all criteria.

It must be emphasised that, although this process reduces the decision to finding the largest value of a single aggregated number, it differs fundamentally from cost-benefit analysis in two important respects:

- The process by which the design is structured and the criteria evaluated is explicit and shared by all participants;
- There is no claim that the weights attached to the criteria have any meaning outside the specific decision process.

5. Analyse Sensitivity

The sensitivity of the outcome is tested by varying the scores and weights of the different criteria, to investigate by how much they must be changed before the outcome is changed. Experience shows that this step can be used constructively to reveal where possible conflicts and dissensions from the decision arise, and hence help acceptance of the decision.

The above account refers to decisions that require selection between discrete options. Essentially the same process can be used for decisions based on or optimising continuous variables, using an approach described as 'Pareto optimisation' in economics, 'finding the decision frontier' in systems analysis and 'data envelope analysis' in business theory.

What is rational for society as a whole is not necessarily rational for individuals. For example, for society as a whole, it is generally believed to be best if every child is vaccinated with the MMR vaccine. Only if the vaccination rate is close to 100 per cent will measles be eliminated. Looking at it from the point of view of an individual child, however, so long as everyone else gets the vaccine, they can minimise their own risk of suffering from possible side effects of the vaccine by refusing to be vaccinated. This is an example of a classic problem, the so-called 'free rider' effect, where it is not in any individual's best interests to accept a risk, but if no one does so, everybody is worse off.

While the published risks of side effects are inevitably averages over a wide population, individuals making decisions about whether to have their child vaccinated are likely to consider their own knowledge of factors such as family history, past record of illness, and so on, as well as the general advice of experts. Thus individuals may make decisions not to have their child vaccinated, not only because they distrust experts or selfishly want to 'freeride', but because they do not believe the expert risk assessments are relevant for the specific circumstances of their child.

A more extreme version of the "free-rider" problem is shown by the strictly rational but equally clearly inequitable approach of attempting to ensure that risks due to behaviour of many people – e.g. consumption, travel or waste generation – affect only a limited group. For example, the risks of climate change impinge disproportionately on countries, such as Bangladesh and some island states, where the per capita emissions of greenhouse gases are relatively low. Equitable distribution of risks and benefits is an important part of the sustainable development agenda.

Imposed risk

People tend to react against risks that are imposed on them without consultation or choice. Even if the risks are small, people do not willingly accept additional risks that give them no benefit. This is one reason for NIMBYism (Not In My Back Yard), when people campaign against, for example, waste incinerators or airports being built in their locality. Even if the risk to their lives or property seems to be very small, people see no reason why they should accept it if they do not personally benefit. On the other hand, people are often prepared to accept high risks if they also get enjoyment from them and are able to volunteer for them. For example, the risk of death from extreme sports or even from skiing is much larger than the risk of dying from a nuclear power station accident; yet, people pay money to go on skiing trips and mobilise against plans to build nuclear power stations in their locality.

Making decisions

Who counts?

A decision is more likely to be acceptable if you feel you have had a hand in its making. This is the basis of democracy. On the other hand, modern science and engineering have been successful, not because they have sought the widest public consensus, but because highly trained specialists have spent four centuries refining knowledge and expertise. These two currents find themselves in opposition when decisions have to be made that involve both technical knowledge and wide participation.

Ultimately, decisions have to be made in a political arena where engineering is just one of a number of voices, some of which have much simpler messages to impart and which can therefore be more persuasive. Some participants, such as industry, may find it difficult to be convincing, even though they are technically expert, because they are assumed to be pushing a particular point of view. For example, the chemical industry has problems in putting forward its opinions because people assume that the industry is always pursuing its own interests.

Non-decisions

In any political system, those who have the most power win the day. In a modern democracy, the winners should be those who have the most compelling arguments (and this is not always those who are 'right'). But this applies only when decisions are being made; sometimes issues that should be decided through the democratic process never get onto the political agenda and happen by default. Such decisions are called 'non-decisions' and can store up trouble for later when they do eventually become controversial. For example, nobody decided that British animal husbandry regulations would be formulated to permit transportation of live animals for sale all over the country. The practice just gradually evolved and since it was in tune with the prevailing idea of the efficiency of 'free markets', nobody created a fuss about it until in the year 2001 it provided the conditions for the spread of the worst outbreak of foot and mouth disease ever seen. This kind of mistake is often the result of focusing too narrowly on easily identifiable risks and failing to consider the properties of the system as a whole.

Waste Management

Decisions over waste management represent an area that reveals most clearly the limitations of purely technological approaches to decisions. These decisions – for example, how much of a waste stream should be burned and where energy-from-waste plants should be located – require public agreement through statutory planning processes. Engineers may argue that costs, both financial and in terms of environmental impact and resource use, favour treating low-value combustible waste as an energy source. Others, including many environmental NGOs, argue that all waste should be recycled; they frequently invoke possible health impacts of emissions from incinerators in ways that are in turn disputed by many expert toxicologists. Siting possible incinerators encounters the additional complication of confronting the objections of people living near a proposed site, particularly people who would be affected by traffic.

It is generally accepted that the current licensing process for waste management facilities in the UK exacerbates the problem of reaching decisions over waste management. *Experience shows that decisions are helped by:*

- Posing the problem as "How best to deal with the problem of waste" rather than "Where should an energy-from-waste plant be located", emphasising that this is not a problem that will go away;
- Presenting a number of different options or scenarios, and incorporating technical assessment by showing their comparative advantages and disadvantages in a way that is comprehensible to non-experts;
- Treating the identification of the important criteria as part of the decision process.

Waste management also illustrates the different assessments of risk by different groups of people: while there is widespread opposition to using waste as an energy source in some countries (including the UK), there are other countries (such as Switzerland and the Nordic countries) where it is regarded as inexcusably wasteful not to recover energy from low-value waste.

To show what this might mean in practice, consider the following fictitious example:

A company is proposing to build a waste incineration plant close to a rural village. The plant would

- Reduce the local demand for landfill which is projected to run out in 10 years
- Give employment to 30 people in an area of high unemployment
- Operate to the best available safety standards
- Operate to the lowest practicable levels of emissions.

A local meeting is held between company scientists and engineers, company management, local farmers, local school teachers, governors and parents, the local MP, local councillors, trade union representatives, public health representatives, and environmental pressure groups.

- What factors would you expect each group bring to the table?
- What quantitative calculations could be presented by the various groups?
- Would any of these figures alter the way in which each of the groups would vote?

If you were the company's chief executive, what policies would you propose to help ensure that the plant gets built?

Experts and the public

The role of experts

Experts (engineers, scientists and medics) often have a very important part to play in establishing perceptions of risk. Such experts are frequently called upon to declare publicly — in an inquiry, public hearing or to the press — their views on the risks associated with technical decisions. The extent to which their views are believed by the public depends on factors such as:

- What if any benefits do the experts themselves and their employers obtain from the decision? Are they being paid by those likely to benefit (or get research contracts, or additional status etc.)?
- Do the experts seem to understand the concerns of the general population, or do they seem to inhabit a world of their own?
- What about the experts' track record? Have their opinions been right previously? For example, veterinary experts and the government's scientific advisors had a difficult time being believed after they had failed to recommend the right decisions to deal with BSE.
- Are the experts themselves at risk? Do they accept liability for the consequences if something does go wrong?

Expertise

Technical specialists do not have the only access to expertise. There are many kinds of expertise in addition to that learned from books, and it is easy for engineers to forget or ignore 'local' expertise. For example, in drawing up plans to combat air pollution, there needs to be input from air quality surveys and other technical sources. But people who have been living in the area for many years might have important knowledge that would be very hard and time-consuming for outsiders to obtain directly.

Getting hold of such local knowledge can involve using methods that proactively solicit local opinions, such as running focus groups and inviting views through local newsletters and from local community groups. The kind of knowledge that is obtained might be anecdotal and based on everyday observation, but nevertheless be crucial for a proper assessment of risk.

There is a further more pragmatic point about consulting those in the locality who may be affected by risky decisions: they are much more likely to back the eventual decision if they think that their own opinions and beliefs have been considered than if they think that 'outsiders' have just imposed their own views.

Protest

The 'public' are generally reluctant to get involved in decision-making. They may feel that they have many more urgent, important, or interesting things to do. In general, they prefer to leave the task to the professionals: politicians, councillors, engineers and all the others whose job it is to make decisions on the public's behalf. This applies so long as the decision makers maintain the public's trust. But if it becomes apparent that these trusted authorities have failed in their 'duty', and have made a decision that is contrary to the public interest, the situation can change completely. If there is no trust, people want to become involved personally and that can mean protests, demonstrations and controversy.

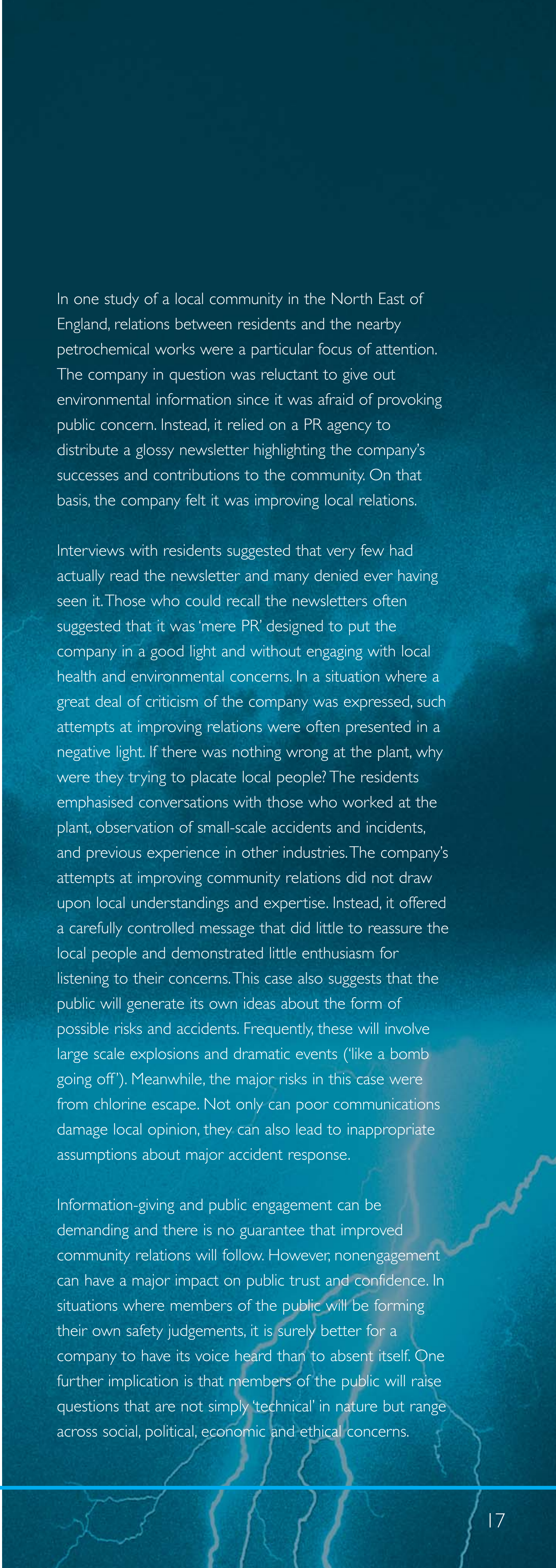
For this reason, maintaining public trust is vital. This can best be done by being as open as possible in providing information and explaining the reasons for decisions, even if no one seems very interested. This is a lesson that many large companies have learned, some the hard way.

Establishing trust

Risks that are familiar tend to be much more acceptable to people than those that are unusual or not understood. For example, one of the difficulties that the nuclear and chemical industries face in managing public perceptions of nuclear and chemical risks is that their activities and processes are so remote from everyday knowledge. So one way to promote trust is simply to do everything one can to educate people about the science and engineering involved.

Another way of developing trust is to ensure that there are good communications between those making decisions and those whom the decisions will affect. This needs to be two-way: the decision-makers need to know what those potentially affected think of them, as well as the affected knowing, personally if possible, those who are making the decisions.

The communication process must be conducted with integrity and consistency over a long period; trust that has been built up over years can disappear very quickly if people come to think that something is being concealed from them.



In one study of a local community in the North East of England, relations between residents and the nearby petrochemical works were a particular focus of attention. The company in question was reluctant to give out environmental information since it was afraid of provoking public concern. Instead, it relied on a PR agency to distribute a glossy newsletter highlighting the company's successes and contributions to the community. On that basis, the company felt it was improving local relations.

Interviews with residents suggested that very few had actually read the newsletter and many denied ever having seen it. Those who could recall the newsletters often suggested that it was 'mere PR' designed to put the company in a good light and without engaging with local health and environmental concerns. In a situation where a great deal of criticism of the company was expressed, such attempts at improving relations were often presented in a negative light. If there was nothing wrong at the plant, why were they trying to placate local people? The residents emphasised conversations with those who worked at the plant, observation of small-scale accidents and incidents, and previous experience in other industries. The company's attempts at improving community relations did not draw upon local understandings and expertise. Instead, it offered a carefully controlled message that did little to reassure the local people and demonstrated little enthusiasm for listening to their concerns. This case also suggests that the public will generate its own ideas about the form of possible risks and accidents. Frequently, these will involve large scale explosions and dramatic events ('like a bomb going off'). Meanwhile, the major risks in this case were from chlorine escape. Not only can poor communications damage local opinion, they can also lead to inappropriate assumptions about major accident response.

Information-giving and public engagement can be demanding and there is no guarantee that improved community relations will follow. However, nonengagement can have a major impact on public trust and confidence. In situations where members of the public will be forming their own safety judgements, it is surely better for a company to have its voice heard than to absent itself. One further implication is that members of the public will raise questions that are not simply 'technical' in nature but range across social, political, economic and ethical concerns.

Can social and technical concerns be separated?

The discussion and illustrations above should begin to indicate that the conventional separation between the technical (the province of engineers) and the social (the province of managers, politicians and the public) cannot survive scrutiny. Engineering decisions are inevitably shot through with social considerations, just as many apparently political decisions depend on technical judgements. Indeed, it is often hard to tell just where the 'technical' ends and the 'social' begins.

This means that engineers need to be as adept at functioning in a wider political environment as they are in a technical one if they are to fulfil their role. This report and the readings listed in the next section should assist in achieving this.

Further reading

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