The Royal Academy of Engineering

Government Policy on the Management of Risk

Response from the Royal Academy of Engineering to the House of Lords Economic Affairs Committee

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House of Lords Economic Affairs Committee

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0.1 Over the past two years, the Royal Academy of Engineering has pursued a number of activities on the topic of risk and risk management, and published a series of reports based on those activities. These have covered risk management methods, risks due to the effect of human operatives, and differences between technical calculations of risk and public perception. The answers below come in large part from findings and recommendations presented in those reports.[1]

1. By what practical means can the preferences and attitudes of the population towards risk be determined and, where appropriate, incorporated into public policy?

1.1 It is not within the Royal Academy of Engineering's area of competence to comment on the effectiveness of opinion surveying techniques, focus groups etc. However, a working party of the Academy has studied and reported on public attitudes to risks associated with technology. A number of conclusions about the population's attitude to risk were reached, and published in the report 'The Societal Aspects of Risk'.

1.2 The report showed that it is unhelpful to talk about the attitudes towards risk of 'the population' as such. Even when two events have similar mathematically calculated levels of risk, public perceptions of the significance of the risks may vary a great deal. Not everyone views the possibility of death from smoking with the same seriousness; generally, opinions about the acceptability of risks vary amongst the population according to political views, personal experience and other factors.

1.3 However, some general points can be made about the roots of different individuals' attitudes to risk, and the factors to which those attitudes are sensitive. A broad conclusion of the report was that views and attitudes are very complex and conditioned by emotional factors. Thus, 'fear of flying' is not reduced by reciting air travel safety statistics or by explaining the niceties of aeronautical engineering. (The answer to question 5 further outlines the issues that dictate the acceptability of a risk).

1.4 The Academy's report emphasises that the emotional factors that condition peoples' attitudes are real and hence as valid as the engineer's calculations of potential risks. Attitudes are modified according to how risks are presented and the ways in which people are involved in the issues surrounding the risk. This must unfortunately mean that attitude surveys will be extremely difficult to analyse in order to yield useful general conclusions.

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[1] The reports in the Risk series are *The Societal Aspects of Risk*, January 2003, http://www.raeng.org.uk/news/publications/list/reports/The_Societal_Aspects_of_Risk.pdf; *Common Methodologies for Risk Assessment and Management*, January 2003, http://www.raeng.org.uk/news/publications/list/reports/Common_Methodologies_for_Risk_Assessment.pdf; *Risks Posed by Humans in the Control Loop*, January 2003, http://www.raeng.org.uk/news/publications/list/reports/Risk_Posed_by_Humans.pdf; *The Risk Debate – Trust Me I'm an Engineer* (a transcript of the debate), June 2004, http://www.raeng.org.uk/news/publications/list/reports/RAE_risk_debate.pdf; *Humans in Complex Engineering Systems* (the proceedings of a workshop), January 2005, http://www.raeng.org.uk/news/publications/list/reports/Humans_in_Complex_Engineering_Systems.pdf.

2. Can appropriate monetary values be estimated and attached to risk-related factors? Is it appropriate and practical to use non-monetary measures of well-being? What is the scope for other methods of public consultation, in order to determine public attitudes to risk?

2.1 It is part and parcel of engineering practice to evaluate risks in economic terms, in respect of physical assets, business continuity, machine reliability and the insurance risk of death or injury. What is more controversial is the practice of putting a financial value on human life and limb and factoring this into risk assessments. Yet, in the absence of anything better, it needs to be recognised (especially by media, parliament and government) that economic assessment is necessary as an aid in deciding priorities. However, there is an urgent need to find a more practicable and societally-acceptable means of making decisions on acceptable levels of risk.

3. Is it possible to identify fundamental principles that should be applied across the public sector, and are the same principles equally applicable to the private sector?

3.1 It is certainly possible to identify fundamental, cross-sector principles regarding, in particular, risks posed by human operatives in complex systems. There is no reason to assume that there should be differences between public and private sectors in the identification and application of fundamental principles. The Royal Academy of Engineering held, as part of its ongoing risk activities, a workshop on the theme of 'Humans in Complex Engineering Systems'. This brought together representatives from a number of industries, to hear presentations from the medical, aviation and process sectors. It was felt in the course of that workshop that there were many lessons that could be transferred across sectors. The series of studies on risk also involved the working group visiting organisations in different sectors, and these too revealed lessons that could exported from one sector to another.

3.2 The working group found that there were three distinct *levels* at which these lessons apply. Firstly, at the strategic and organisational level there is a need for aims and objectives to be set out clearly by the company governing board or government department 'management council', and translated into relevant terms in order to provide guidance to the operative at the 'sharp end'. Secondly, at the management level, there has to be an honest and rigorous examination of the design of the control operative's job. This is because technological changes lead to more automation in industries that used to rely more on art and feel, and this has led to increased pressure and stress. Finally, at the workface, be it a cockpit, a nuclear power station control room or an operating theatre, systems have to be provided that make the operatives' repetitive and routine tasks meaningful and robust. In very general terms a well-designed system would be one in which all of the routine would be automated and the operative would only perform those tasks requiring experience, knowledge and awareness in extraordinary situations.

3.3 The reports in the risk series also identified the *kinds* of lessons that should be learnt. The first of these concerns the development and communication of a risk policy. All organisations and their constituent parts, whether public or private, must have an explicit risk policy. Everything we do involves risk, but we need to know whether we are expected to play safe even at the risk of missing beneficial opportunities, or whether the potential prize is so great that we can take risks in the attempt to gain it. Those working in a hospital responsible for hygiene should not take risks. The experienced cardiac surgeon faced with a critically ill patient whose condition requires pioneering surgery techniques is expected to take risks in order to save a life. The risk policy should explain what strategies operatives should employ to stay in line with the risk policy when things do not run smoothly. A bus driver needs to know whether strict adherence to speed limits is more or less important than punctuality. An air traffic controller needs to know how to function when the computer aids are not working reliably.

3.4 It is very important to ensure that the *whole* organisation is aware of the corporate vision and risk management strategy, and involved in its formulation. The risk management strategy needs to define the overall philosophy of the organisation in handling risk, and management has to be prepared to invest in this effort and to involve the work-face staff in the exercise. Failure to do this and then to communicate an imposed top-down strategy will lead to frustration and confusion in the control loop. The lesson is that operatives at all levels in all sectors need risk strategies expressed in terms relevant to their role.

3.5 Another set of lessons concerned the place of *training* in dealing with risk. For example, there should be regular re-training in areas where technological developments mean that tasks change a lot, rather than certification depending on a gate-system where an individual qualifies once and for all time. The 'Risks posed by Humans in the Control Loop' report noted that continuing training of already certified personnel was a key recommendation in the Bristol baby heart operation inquiry. Risks posed by human operatives should be managed with regard to the competency of not just the new operator but also the experienced operator who needs to keep up to date with the evolving working environment. Good uses of training were seen when industries were in the midst of substantial changes caused by technology or organisational development. When these large changes in the required job competencies had been recognised and large scale retraining schemes implemented, good practice often followed.

3.6 As regards types of training, simulator training was identified as being of great use and importance. Another example of good practice was the take up of Crew Resource Management (CRM) training in a number of industries, which have recognised that in addition to technical skills certain non-technical skills are required to secure a successful outcome. These include communication skills, workload management and team working.

3.7 A final lesson concerned error-reporting. Risk can be better controlled when there are effective error-reporting systems. It is necessary to avoid a blame culture which might result in suppression of concerns over safety. Also, it is important that errors are reported even when they do not result in an accident. It is a strength of the aviation industry that near-misses and potential accidents are investigated and corrected with as much seriousness as they would be if they had led to an accident.

3.8 In drawing these lessons from the workshops and visits, it was felt that the Civil Aviation Authority was exemplary in its treatment of risk. Since hazards in aviation tend to give rise to catastrophes that cause multiple fatalities, and seriously damage company profiles, the aviation sector has had to put a great deal of investment into risk management. They have felt the pressure more than the medical industry since, in medicine, fatalities occur one by one and, because they are offset against significant benefits (saving lives or ameliorating suffering), they are seen as less unacceptable. But the medical sector could learn some useful strategies from civil aviation practices.

3.9 Transferring these lessons about training is easier in some areas than others. The principles and basic processes for assessing human performance are highly transferable between industries. The processes of supervision and management (accident investigation, quality systems, etc.) are required in most industries and there should be no barrier to transferability. However, there are real and fundamental differences between sectors such as medicine and aviation, so some lessons will need adaptation in order to allow migration between sectors.

3.10 The 'Risks Posed by Humans in the Control Loop' report identified a number of bodies that could promote cross-sector learning due to their collaborative and co-ordinating role. These include the Human Factors National Advisory Committee; the Royal Academy of Engineering; the Royal Aeronautical Society; and European Union Thematic Networks – such as the Process Industries Safety Management Thematic Network.

4. Is there sufficient consistency and coherence in the application of risk assessment and management policies across government departments and agencies?

4.1 The Academy lacks the data to assess whether there is consistency and coherence across government departments and agencies. However, a superficial assessment of, for example, transport and energy policies and practice suggest a wide variation in approach. Recent implementation of a safety regime in the ship sector of the Ministry of Defence, due in part to the ongoing delegation of responsibility to industry, is an exemplar in a complex field.[2]

5. How should policy deal with cases where public perceptions of risks diverge significantly from expert assessments?

5.1 It is almost inevitable that public perceptions of risk will diverge from those of experts. To deal with this, it is helpful to know the genesis of public perceptions of risk and the reasons that people tend to find a risk more or less acceptable. Knowing why there is a divergence in the perception of risk may help to resolve tensions. The 'Societal Aspects of Risk' report identified some of the factors that make people more or less accepting of risks:

- Acts of God or nature are more acceptable than acts of people
- Failures of public or community enterprises are more acceptable than those of profit making enterprises
- Risks are more acceptable if we are in control or have been involved in the decisions leading to the presence of a risk
- Risks are unacceptable if there are no clear benefits for some 'deserving' group
- Familiarity makes a hazard more acceptable
- Dispersion of incidents over time and place makes a risk more acceptable
- We feel protective toward the innocent or vulnerable, the very young or old
- Recurrent incidents are less acceptable than the first occurrence
- Smaller incidents in a poorly understood operation cause more anxiety than larger incidents in a familiar operation – due to worry about the faults that might lie behind the incident
- Response to an incident affects acceptability – e.g. denial is detrimental to acceptability.

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[2] See 'Recent Developments in the Safety Regime for Naval Ship Design', forthcoming in *Quality and Reliability Engineering International*, 2006.

5.2 Looking at those of the above factors that it is possible to control, one lesson that suggests itself is that, in order to deal with situations where public and expert views differ, there is a need to make sure that there is *trust* and *understanding* between the public and experts. Trust can come with education, since often people see risks as more serious when they arise from unfamiliar sources. 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.

5.3 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 communications also need to start early – the problem of diverging views between public and experts is exacerbated when the 'experts' are allowed to go too deeply and too far into an issue before involving the public. Too often the public is presented with the solution before it knows what the problem is. The currently proposed energy review will be an interesting case to watch. Already we have 'nuclear' solutions, 'renewable' solutions, 'hydrogen fuels' etc. being proposed. What is needed first is a clear enunciation of the perceived issues, problems and opportunities so that the debate first focuses on the public's needs and how these may or may not be met unless we change course. Many members of the public will resist change unless they see a clear benefit.

5.4 It is important to note in debates between experts and the public that sometimes expert and public perceptions differ not because of a difference in attitude towards risks, but because of a difference in knowledge about the situation. Technical expertise is not the only expertise. When it comes to environmental issues, there is often important and useful local knowledge. When this is the case, local opinions should be solicited *proactively* to be incorporated into decision making.

5.5 Finally, the extent to which expert views are believed and trusted by the public will also depend on the following factors: whether there are any potential benefits an expert might receive for coming to a given decision; whether the experts appear to understand the concerns of the general population; the expert's track record; and whether they appear to be honest and will accept liability if things go wrong. Bringing these things out into the open should encourage trust where trust is appropriate, e.g. when it is clear that the expert is not giving an opinion that will benefit a few (including themselves) over the majority.

5.6 When there is a strong reaction to a potential risk, such as in the case of GM crops, it is important to present information in as unbiased a way as possible, and in a manner that can be comprehended by the public. In the case of GM crops, a lot of media coverage emphasised the risks without mention of the potential benefits. In these kinds of contentious cases it is important to encourage special interest groups not to seek to eliminate all risks in their area of concern without giving attention to the benefits those technologies could have for the wider community – such as the benefits of GM crops to third world countries. As well as having the right to minimise the risk, there is a responsibility for allowing others to benefit where possible.

5.7 However, for all of this discussion about the differences between expert and public perception of risk, it must be acknowledged that the conventional separation between the technical (the province of engineers and scientists) and the social (the province of managers, politicians and the public) cannot survive scrutiny. Engineering decisions inevitably include social considerations, just as many apparently political decisions require technical judgements. It is often hard to tell just where the 'technical' ends and the 'social' begins. This of course makes it especially difficult to make decisions which involve risk, since there are many conflicting, yet closely related aspects of this risk. The 'Societal Aspects of Risk' report gave a number of suggestions for dealing with complex decisions. One approach was 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, and should help to resolve many of the tensions that arise due to the presence of different perceptions of a risk. Such a balance sheet will also help to clarify who stands to gain and who might lose from a risky development. For example, even if the risk of an accident from a new chemical plant is very low, it still presents a dis-benefit for local inhabitants compared with no plant and no risk. On the other hand, there may be compensations such as increased employment opportunities, but these may be unevenly distributed and relevant to only some of the plant's neighbours.

6. How should policy deal with risks that are unknown or poorly understood, such as those associated with new technologies?

6.1 New technologies pose a serious problem for policy makers. Even those at the forefront of technology have difficulty in accurately assessing the potential impacts, good or bad, of emerging technologies. A technique used by engineers when faced by unknown and poorly understood risks is that of 'option analysis'. This requires engineers to develop and explain the actions they would take if a project developed in various ways, identifying the crucial stages in development where 'gates' should be set up. It is best practice in safety critical industries such as oil refining, nuclear or aerospace to set up such 'gates' in development programmes. The enthusiasts and project promoters are forced to submit to an audit by disinterested, but experienced and knowledgeable, third parties to ensure that the balance of potential benefits and hazards is still favourable. Such audits need to be especially mindful of the potential for political or business pressures to override sound technical and scientific judgement. Those prone to such overriding temptations need always to be made aware of the responsibilities for their actions. This needs to be done by an authoritative and robustly independent appointee (e.g. MoD safety advisors).

6.2 It is always the case that scientists' and engineers' expertise is limited by the current state of knowledge. Hence such experts can only comment on a risk as they currently understand the relevant subject. Yet society and the media often demand definitive, black or white answers, and if those answers are ultimately found incorrect the expert is deemed to have lied. To achieve a more balanced approach to risk, Government needs to work to temper what is expected of experts, and work toward recognition of the fact that science, technology and society itself must continue to move forward and that this cannot happen without an element of uncertainty and risk.

7. How should policy balance the health and safety interests of the current population against those of future generations?

7.1 Various concepts like 'sustainable development' or the 'precautionary principle' are proposed as means of safeguarding the interests of future generations. While these may be helpful in focusing the mind they are not substitutes for a rigorous risk assessment and management systems and the appropriate application of agreed and demonstrable processes.

8. Are there any particular or unusual problems arising in cases of rare but catastrophic risks?

8.1 Particular problems arise because these kinds of risks are likely to be perceived very differently by the specialists and non-specialists. In analysing public attitudes to risk it is clear that there is a 'dread factor' which affects any hazard that threatens the sudden death of many people in a localised area, and hence the public are more likely to resist anything that poses such a risk. Thus there is a quite different reaction to a few hundred passengers killed in a single jumbo jet crash, or major rail accident, and to the cumulative thousands who die in many separate accidents on the roads, in the health sector, or the continued loss of deep sea fishermen.

8.2 Policy makers have the responsibility to ensure that there are appropriate civil defence plans in place to deal with the aftermath of a catastrophe. However, they also have responsibilities for education and reassurance. The very rarity of catastrophe means that the risks can be managed. Secondly, great care should be taken in announcements that a catastrophe is on its way. If an official says that an Avian Flu pandemic is not a matter of 'if', but 'when' then panic should be expected. The mathematical models that predicted tens of thousands of cases of CJD as a result of BSE were probabilistic forecasts subject to all sorts of uncertainties. Language and presentation are all important. It seems hard for the media and politicians to deal with uncertainty and so education in this regard seems necessary for both school children and the wider public. This ought to be the role of government to sponsor but needs to be handled carefully to avoid the contrary messages of manipulation and spin.

Mr Philip Greenish CBE
Chief Executive
The Royal Academy of Engineering

Dr Natasha McCarthy
Policy Advisor
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