



Overview of Risk Assessment

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1. I want to begin by defining some terms. I shall then refer to a number of technical and other difficulties. Finally I shall try to set out why risk assessment is important and what its purposes are.
2. First, risk and risk assessment – what are they?
3. Risk is a subject of universal significance. Life is very uncertain, and we can achieve no object or benefit in it except by approaching nearer to particular hazards which lie between us and our objects. **That approach** represents acceptance of risk.
4. Risk assessment is a way of systematising our approach to hazard with a view to determining what is more and what is less risky. It helps us in the end to diminish our exposure while obtaining whatever benefits we have in mind, or to optimise the risks and the benefits.

Risk and hazard

5. The words “risk” and “hazard” are both French in origin. I believe the French language makes only a partial, if any, distinction between the two ideas. Perhaps “risque” originally conveyed the idea of a flirtation with danger for purposes of play, while “hasarder” meant something more fundamental.
6. But the English language, with its obsession with things or facts, and methods, found different meanings for the two words. “Risk” was probably used in its technical modern sense for purposes of conducting insurance business in the London market nearly three hundred years ago. The word implies a strict definition of a hazard to which the risk relates – for example, the loss of a ship at sea, and then some calculation of the chance of this happening, for the purpose of writing an insurance policy. “Hazard” was probably first used in English in its modern sense in relation to the game of golf, where it relates to a physical obstacle or trap into which the unlucky golfer may drive his ball.
7. So we may say that “hazard” represents a thing; risk, a calculation; and risk assessment, a method. **Risk**, we may say, is the **chance** that some **thing adverse** may happen. To be quite accurate, we must say that the concept of risk includes three linked components; first a probability, second an event and third the severity of the adverse effects attached to the event. These *may* themselves entail a further calculation of probabilities. Greater knowledge of these matters can affect our behaviour.
8. These adverse effects are given names. They are respectively “harm” and “detriment”. It is convenient to employ the word “**harm**” in relation to something living, usually man or the natural environment. Thus “harm” is something we would seek to avoid even if no definite economic cost could be attributed to it, or if it were not possible to define and measure all its implications, e.g. emotional or aesthetic. It is in fact, something about which there can be

disagreement on ethical grounds – some people think certain effects “harmful” that other people do not, the area of agreement being greater in relation to man than in relation to nature.

9. The word “detriment” may be taken to apply to some form of economic loss, which might indeed include a valuation of harm to living things but which might also include damage of a much wider kind, as for example from the accident at Chernobyl which rendered land uninhabitable. “Detriment” can apply either (1) to the quantum of damage which might be caused by the chance realisation of a hazard multiplied by the probability of this happening in a particular time period, or (2) to the quantum of damage attributable over a period of time to some existing source of continuous damage.

10. I will refer finally to one other word: “Consequence”. This word is used to refer to effects flowing directly from a hazardous event, some of which may be mitigated by appropriate action such as the evacuation of the local population. The idea of “consequence” does not include whatever steps may be taken to reduce or contain the event itself.

11. So much for definitions. I come now to the second, and I fear much longer part of my disquisition. I now approach the difficulties, disputes and ambiguities which we encounter in making those concepts useful allies in the impious task of achieving greater certainty in the world’s affairs.

Acceptability of risks, or hazard

12. We accept many risks, that is to say, we approach many hazards, in our daily lives. Most of those who have studied the subject agree we are prepared to accept higher risks where the acceptance is voluntary. Indeed, one student⁽¹⁾ made calculations suggesting that people are prepared to accept sporting risks (such as skiing) roughly a thousand times greater than from involuntary hazards, for example food preservatives. If this is so, two reasons may predominate. First, voluntary acceptance of risk usually implies that the benefit of doing the risky thing accrues to the individual taking the risk. Second, an individual may think himself better able to calculate his chances of avoiding harm from a hazard he knows well.

13. So the acceptability of a risk is a very **personal** matter. And yet in modern society there are many species of risk that the individual can scarcely refuse – for example, the risks attached to living near some hazardous installation. In such cases, individuals are entitled to expect that steps will be taken for their protection; to know what those steps are, and what is the extent of the remaining risk. In relation to such “involuntary” hazards, a given level of risk could scarcely be thought fully “acceptable” unless it had been reduced its due proportion in to the kind of background level that individuals accept for life generally, and before they begin to consider taking particularly high risks for particular objects and benefits – as for example going skiing or suffering medical treatment. At this “background” level, the risks may not be negligible; but they will be low. We can call this level the region of acceptable, or broadly acceptable, risk.

Perception of risk

14. The public’s perception of risk is a subject we shall be debating at length later this week. The

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 (1) S. Starr. “Social Behaviour versus Technological Risk”, Science, 1969, 165: 1232.

problem of perception begins with the fact that when non-experts are asked how they rate risks, they gave different answers from experts.⁽²⁾ When the reasons for this are examined, they seem to concern the fact that people generally attach less importance to probabilities and chances than they do to consequences. When, for example, people see a horseman approaching a high fence they may say “that’s risky” meaning not so much that there is a high probability of his striking the fence, as that the consequence will be nasty if he does.

15. In other words, of the three components of risk which I referred to a moment ago, the public look first at the second and third components that is to say the event and the consequence, while the experts begin with the first, that is to say the probability. The attitude of the non-expert may partly arise because most people may think they know the probability better than in fact they do. There are studies⁽³⁾ for example which seem to show that people under-estimate familiar risks and over-estimate unfamiliar ones, including those the media choose to portray more frequently or dramatically.

16. There may be another reason, belonging unfortunately to the vexed dimension of psychology. People have a tendency to detach particular objects of worry from their place in reality. Nature offers us this facility for purposes of calculation and also for purposes of flight⁽⁴⁾; but if we can neither calculate nor flee, if in short we think there is nothing we can do, we have the choice only of forgetting or of fretting – of allowing the thing too great a significance. It then becomes a scar on our mind’s eye, a neurosis.

17. However, we must not make the mistake of over-estimating the irrational elements in public perception, or under-estimating the irresponsibility on the part of politicians, experts, businessmen, who have sometimes found it convenient to deny the existence of risks that palpably do exist. If the public sometimes seem to hanker after zero risk, who first taught them that zero risk is possible? Today, and this week we are confronting a real need for understanding and communication on this subject, for we cannot flee from all the hazards that surround us. Some we must tolerate – but which and to what extent? To know that better is the underlying aim of this Conference.

18. We must also acknowledge an ethical dimension in the public’s attitude. There will always be some people who judge that certain hazards should not be entertained at all, no matter how low the risk: some people feel this, for example, in relation to nuclear power. And why do they feel it? Partly because of an association, however badly founded, with the bomb. There is a dread, too of the old fear conjured up by Dr. Faustus: the fear of mankind messing about with too much power. And there is its opposite, now being brought about by some of the ecological questions that confront us – that we may have too little power to restrain ourselves from irreparably damaging our only habitat, earth.

19. For all these reasons we must assume that we shall never achieve complete agreement about relative risk: the best we can do is to inject the greatest degree of objectivity we can into a subject

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 (2) P. Slovic, B. Fischhoff, S. Lichtenstein “Rating the Risks – The structure of Expert and Lay Perception, Environmental Impact Assessment and Risk Analysis” NATO-ASI Series Eds Springer-Verlog 1985.

(3) S. Lichtenstein et al “Judged frequency of lethal events” *Journal of Experimental Psychology: Human learning and memory* 1978, 4: 557.

(4) P. Slovic, B. Fischhoff, S. Lichtenstein “Facts and Fears: Understanding Perceived Risk” in R. Schwing and W. Albers (eds) “Societal Risk Assessments: How safe is safe enough?” Plenum Press NY 1980.

where fear and emotion will always play a large part. But to do that would be no negligible achievement. And the first step is to concentrate attention on those aspects of risk that the non-expert tends to neglect — the actual level of each risk and the benefits if any of running it. This is the heart of risk assessment.

The political aspect

20. Of course, no one, Governments or otherwise, incurs risks except for some major benefit or unless by doing so, some greater risk can be avoided. The question of the balance of risk and benefit in imposing on people particular risks above the “background” level is one for society as a whole, not for experts. It is a political decision, which like others, needs to be taken in the light of the best possible information.

21. There is another reason why major risks undertaken by society for a benefit represent a political question, and that is because many such risks are of a nature where one group in society accepts most of the risks, but most of the benefits go to others. This is of course fundamentally the reason for what we call in the UK the “Nimby” syndrome — “not in my backyard”. And risks may also be shifted through time so that they fall to future generations, giving rise to ethical questions. Like all questions of redistribution, these can only be settled through our political institutions.

Tolerable risk

22. It seems evident that a considerable “grey area” exists between what is a normally acceptable or background level of risk, and levels we might for practical purposes regard as unacceptable. In this “grey area” people will accept risks in order to secure benefits. But in doing so, they may reasonably want to know what the nature and level of the risk is, so that they can compare it with the benefit; and to be confident that the risk is being controlled and where possible reduced.

23. It is this “grey area” that is the most interesting to us. For the principal benefits for which anyone will undertake a risk which he himself does not control are his livelihood, and the maintenance of his social infrastructure — for example, the production of electricity or the maintenance of food or water supplies on which all our comforts and lives depend.

24. In the UK we have called this “grey area” the region of “risk tolerability”. Tolerability does not mean “acceptability”. It refers to a willingness to live with a particular hazard so as to secure certain benefits and in the confidence that it is being controlled. To tolerate a risk means that we do not regard it as negligible, or as something we might ignore, but rather as something we need to keep under review and reduce still further if and as we can. To **accept** a risk by contrast, means that for purposes of life or work we are prepared to take it pretty well as it is.

25. There is no need for me to delve into all the implications of the concept of “tolerability”. They are fully explored in the revised document “the Tolerability of the Risk from Nuclear Power Stations” which is before this Conference. Suffice it to say that the concept depends upon our ability to quantify and compare risks in such a way that people, and Governments, can make informed judgements about them, and to decide in particular whether the available benefits are worth the risk. It also provides a basis for legitimising social and political decisions to accept

significant risks from which some people receive greater benefit than others. It involves a statement of the standards and limits that society undertakes to apply as part of this process.

26. There is no implication that these standards will be the same the world over, for the reason that some societies may unhappily be forced to pay a higher price for benefits that others can take for granted. But the geometry, and the basic reasoning is the same wherever the citizens' voice determines the policy of the Government.

Risk assessment: basic terms

27. So far, I have spoken of standards and levels of risk as though it were self evident that the extent of any risk can be assessed in some objective manner and compared with other risks. But there are many difficulties about this which this Conference will need to explore, and which I had better begin to describe. Some of the difficulties arise from the need to give precision and analytical depth to something, namely the consideration of hazard, which is innately personal and instinctive. Risk is about fear, and fear is a shapeless and emotional fact about the human condition. In order to study it, we have to pretend that this is not so; and say instead, as we have done, that risk is about the probability of particular things happening. In order to analyse and measure that, we have to state precisely which things we have in mind, and to whom the risk attaches. We have to find proxies which express for comparative purpose matters which do not normally lie within the rational parts of our mind.

28. It is this that makes some experts despair about the problems of risk communication. To them, I will simply say, what's new? All thinking is about giving structure and predictive weight to things that we would otherwise settle by instinctive means. What's new is the need to apply to the subject of risk some of the methods by which the human race has given order and rationality to so many of its affairs. So now I come to the rules, the proxies that we need to apply to give this great subject a structure, first warning that nothing I can say has final value.

29. The first and cardinal structural point is that the measurement of risk depends upon complete clarity as to the hazard, whom it affects, and what consequences are in view.

30. **Individual risk.** To the individual the first question is always, what is the risk to me or my family from the realisation of the hazard in question. To answer this, we have to construct a hypothetical individual who is in some fixed relation to the hazard — let us say, the person most exposed to it, or a person living at some fixed point or with some assumed pattern of life. Other individuals can then, as it were “aim off” and reckon that they or their family have more or less risk than the hypothetical person.

31. The second step that is then necessary is to find a means of comparing the risk to which the hypothetical person is exposed with other risks that are within people's understanding — risks that they already accept and know about, like the risks of childbirth, or the annual risk of death from driving — both of these, by the way, are similar — of the order of 1 in 10,000 or 1 in 10^4 per event or per annum. Those are very useful datum points.

32. This, then, is “**individual risk**”, the level of risk to an individual or for that matter to any group of individuals placed in a similar relation to some hazard. We must of course recognise that not all hazards will appear to individuals to be identical, either in themselves or in relation to any benefits they may perceive. People may regard the hazard of death in childbirth as very

different from the hazard of death from cancer due to a source of radiation that brings someone else a profit. We may have to decide that there is a general aversion to particular risks, and to factor this into any calculation. A statement of the comparative risk levels is nonetheless an important contribution to rationality.

33. **Societal risk.** Calculation of the risk of harm to an individual is not free from technical complication. But I now come to a subject of much greater conceptual as well as technical difficulty, namely the risk to society as a whole from particular hazards.

34. This is what the modern risk debate is all about. In recent years, we have become more and more conscious of major risks the extent of which we have few present means of assessing. Some of them are on an ecological scale – like the hazard of greenhouse gases. Some are from hazards of a continuing nature affecting the natural environment on a smaller scale – the risks from chemical wastes or residues for example. Some are concerned with the possibility of major events, such as nuclear accidents or other catastrophes resulting from the uses of technology. Some concern the risks of major accidents in connection with transport.

35. One might of course ask – why bother to assess these? After all we live not just with technological threats, but with political ones – of war, or of the breakdown of social order or from the movement of populations and so on. Let us nevertheless try to do so, since the risks from the uses of technology are risks which in principle we can control and about which we have choices. It is the fact of these choices that is the significant point. Risks from technology are risks flowing from the investment of resources; alternative investments, or self denial as to the benefits, are usually possible. The reason why we should assess the risks is to help us optimise our investments or withdraw from those that are potentially too harmful. What we are looking for is a rational basis for those decisions.

36. But there are difficulties about identifying the concept of societal risk and about measuring it. In the case of really big risks created by major investments and political decisions, we have to analyse all three elements that make up risk, remembering that there may be two sets of probabilities piled on each other – the probability of an event and the probabilities that particular consequences will flow from it. What in principle we are looking for is a **quantity** that can be compared at least roughly with the net benefits for society undertaking the risk or with the net benefits from running alternative risks. An example might be the risks and benefits from a nuclear programme as compared with those from generating power from fossil fuels.

37. Such a **quantity** of adverse consequences we have already referred to as a **detriment**. We can in principle categorise the detriment associated with some major hazard as falling into three categories (a) the price put on the loss of life (b) the cost of coping with the emergency, loss of plant destroyed or rendered unproductive and opportunities or other investments forgone and (c) the costs if they can be estimated of the disruption to social and political life. We can refer to those, if we like, as respectively the human, monetary and political costs of a major event should it occur. These (putative) costs have then to be combined with the probability that the event will occur to give the quantity “detriment”.

38. So much for the geometry. It is when we come to assign money values to various factors in this equation that the difficulties arise. It becomes obvious that many conventions, some of them perhaps artificial, would have to be agreed upon to give an idea of the sums involved, including answers to questions about discounting the values through time. And this is before we consider

that there is not one, but many shapes that the consequences of an accident can take, and that each shape has a different probability. All the same, if the conventions could be agreed, the prize would be considerable. We would be in a position, at least roughly, to compare and contrast different investments and different social burdens, either of risk or of continuous damage from known, existing sources of detriment.

Uses of risk assessment

39. In considering the uses of risk assessment we must not of course confine ourselves to these very large issues of major industrial hazards, global ecology and the like. On the contrary, any disciplined approach to hazard, for example hazards met with in work places, needs to be preceded by some form of identification and an assessment, however rough and ready, of the extent of the risk and the need for further precaution. This in fact is the present tendency of European legislation on worker safety. For example, European law, through the Seveso Directive lays down that operators of hazardous plant must make a safety report to the regulator; a report which is of course an expression of the hazards and if possible of the relative risks.

40. Such reports, recording the structure of the risks present in the plant, form a framework for later inspection both by the regulator and the operator. A good safety report is a classical expression of risk assessment, since it enables those responsible to **prioritise their subsequent actions**.

41. A further use of risk assessment is to enable one risk to be balanced against another for purposes of investment in safety. A recent evaluation of the risks on the London Underground showed for example that the hazard which was attracting the largest investment – fire – represented given existing precautions only 1% of the remaining risk. But balancing of risks is important for other reasons also. It is no use in constructing a safe system to have ten strong points and one weak one. A very strong room with a weak lock on the door is a waste of **all** the money lavished on it. The balancing of risk in this way is thus a feature of the design of all hazardous plant.

42. Again, the underlying principle is of risk assessment assisting us to prioritise action, on the basis that resources are not finite, and that many hazards need to be tolerated and controlled. We can expect this approach to govern the risk assessment of chemicals which will in turn govern the principles of control applying to each. In this as in other uses of risk assessment, it will be important not to bias the approach by ignoring certain forms of risk because others are momentarily more fashionable, or of assuming that consequences whatever they are cannot be mitigated through proper forms of control. Risk assessment is about benefits and alternatives as well as about hazards. It is always about giving proper structure and weight to any detriments so that we can compare them with the benefits.

43. Talking about risk is of course one of the riskiest things one can do. There are so many experts about. May I conclude therefore by expressing the hope that my attempt to describe the achieved position on risk and risk assessment will not awaken sterile controversies about unimportant matters. The Conference hopefully, is about the progress we can now make, not an opportunity for further discussion about matters on which there is already sufficient agreement. So, finally, may I set out one or two questions on which I hope we shall be able to make progress.

44. **First**, I hope we shall all be able to get a clearer view of the **concept of societal risk**, that is to say how to structure and evaluate the **detriment** attached to **sources of damage, actual and potential** which are widespread and important enough for society to want to regulate.

45. **Second**. I hope we shall be able to agree on some of the principles that should attach to **communication about risk**, recognising the difficulty of the subject arising from acceptance of risk being ultimately a deeply personal as well as political matter on which full agreement will never be possible.

46. **Third**. I think it would be very convenient if we would make a start towards better understanding, even agreement as to some of the factors that will need to be used in **quantifying and weighting** risks, if the subject is to make real progress. For example, if it is true that society is more averse to catastrophes involving the death of many people at once than to an equivalent number of death seriatim from a single hazard, how should we express this in our calculations? And can a value be given to life? And is there such a thing as a "political risk" from a major event or should we ignore this aspect? Is there a world view about levels of risk, for example of death from particular major hazards, that are acceptable, unacceptable or tolerable under particular conditions?

There I conclude, with the wish that our Conference should at least be interesting and provocative.