How Much Risk Reduction is Enough?[1]

by Felix Redmill
Redmill Consultancy
Email: Felix.Redmill@ncl.ac.uk

We used to think of things being safe or unsafe. So the question was asked, "How can we make it safe?" But now we recognise that it is not so simple, that safety is not a binary attribute but a spectrum, and that this spectrum is a scale of risk. So now we ask, "How safe is safe enough?" or "How much risk reduction is enough?" This article enquires into the implications of such questions.

Are Numbers Sufficient?

In order to arrive at practical results, the assumption is made (often implicitly) that risk is measurable and that its assessment is objective. But risk assessment is dependent on the techniques used, and on human variables such as concentration, skill, teamwork, management, and judgement. Their results are therefore not consistent across a number of practitioners, and questions about risk are not precisely answerable.

What then is the likely variation in answers? If small, our calculations could be assumed to be accurate in most instances; moreover, they would necessarily be seen to be accurate by everyone with an interest in the results. But if the variation in answers were large, no such assumptions could be made.

In fact, the possible variation is huge because there are many influential factors. In the first place, our perception of risk is highly dependent on who we are. Our culture, training, experience, beliefs, and other aspects of our background and personality determine what risks we seek, how we seek them, and how we perceive them, both in absolute terms and relative to other risks. Moreover, they influence what values we attribute to probabilities and outcomes in cases where we need to make judgements.

So our risk assessments are not objective and accurate but depend on numerous variables. Let us now consider some of the factors which affect judgements of the adequacy of risk reduction.

How Much is Enough — Relative to What?

The reason for accepting risk is to derive some benefit, so the accepted risk will depend on the expected gain. But, beyond the criterion of utility, how do we

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[1] Journal of System Safety, 36, 1, First Quarter 2000
Also included (in Japanese) on website of JICOSH, the Japanese International Centre for Occupational Safety and Health, http://www.jicosh.gr.jp/, July 2000

determine the level of risk reduction? Should it be against some absolute value of risk? Should we compare it to the level that we have tolerated in the past? Or perhaps against a target value which it is hoped we will achieve in the future? If so, how much short of the future target is tolerable now? Or we might seek to achieve the level which applies in some other place; or which was achieved here or somewhere else at some other time. Or, being pragmatic, we might try to discover what a regulator would allow us to get away with.

Of course, there are those who say that all this is irrelevant because we must simply make our system completely safe. But this is an anachronistic illusion — zero risk is not an option. There is always a trade-off between risk and benefit and there are always options as to which trade-off to make. The decision-making process involves an attempt to understand the options and to find a way of choosing between them.

How Much Should We Spend?

The extent to which we can reduce risk depends not only on our ingenuity but also on our purse. But which version of our purse? Infinite resources might achieve infinite risk reduction, but in their absence what expenditure is appropriate? Should we spend only the resources that we had previously set aside? Or those we now think we can afford? Should we allow conscience to dictate a 'fair' expenditure on risk reduction, or should we concentrate on minimising our costs? If we want public sympathy if something goes wrong, should we spend what we think would impress the public?

How Much is Enough — In Whose Opinion?

Who decides how much risk reduction is enough? They who benefit (the winners)? Or they who are exposed to the risk (the potential losers)? Or they who arbitrate (the regulators)? Or they who are concerned for the environment? And against whose values should the decision be made? Those of big business? Those of the government? Those of the public (and if so, who speaks for the public)?

It would be convenient if all parties held the same opinion, but they don't. On the assumption that it would not be right for one party to make a decision in the absence of all others, the ideal is to bring them together and help them to understand each other's viewpoints. It is not easy to achieve consensus on which risks should be accepted in a given situation, particularly if all parties do not share the same enthusiasm for the intended benefits.

Judgement Depends on the Nature of the Risk

There are a number of factors which might be associated with the 'nature' of the risk. We will consider two as examples: the level of uncertainty and whether the risk can be reversed. These can have considerable influence on how risks are perceived and how their acceptance is judged.

In some engineering cases, for example of machinery, we might know with fair accuracy what could go wrong and what the consequence would be if it did — uncertainty is low. Moreover, in the event of one accident, we may have confidence that the problem could be fixed before another occurred — the risk is reversible. But in many scientific cases, for example of genetically modified organisms, the existence of risk may only be a suspicion based on indirect evidence — uncertainty is high. And it may be considered that once something went wrong the path to catastrophe would be inexorable — the risk is thought to be irreversible.

Typically, feeling against the latter type of risk is greater than that against the former. Moral values influence judgement. In some cases, only a reduction to zero (the precautionary principle) would be considered enough. But zero risk offers no access to benefits, so if we want progress we must confront the question again.

How Much is Enough — As Determined When?

If the perception and assessment of risk depend on the level of uncertainty, they must also depend on time. As our knowledge or beliefs change, we may come to think we know more than we did, or we may recognise that we know less than we previously thought. Additional information may become available, technology may throw up additional options, our values may change. New parties with previously unheard views may enter the debate. Our judgement will vary accordingly.

What now seems a perfectly reasonable balance between risk and resources, or between risk and benefits, may later seem repugnant to us, to the public, or to a jury. When a court of law decides, it does so with hindsight, so should we attempt to view our question, our evidence, and our decision-making process from the vantage point of the future? Should we ask not "How do I feel now?" but "How will I feel then?"

Where Does All This Leave Us?

In the engineering field we tend to think of risk as objective and measurable. But although the variables mentioned above may be considered to be on the periphery of engineering, they influence which risks we perceive, how we perceive them, and the values that we attribute to the risks we assess. Moreover, they also influence the public's and the courts' perceptions of the risks and what we have done to reduce them.

The question "How much risk reduction is enough?" depends not only on objective assessment of available information, but also on our values, beliefs, and reasons for seeking an answer, all of which are subjective. It is not possible to answer the question in absolute terms, but only to arrive at a preferred option in given circumstances — and to do this we must address subsidiary questions such as those raised above.

Taking one step further back, we must also confront the question of what confidence we have in our 'objective' measurements anyway.

Postscript

Decisions involving risk are not restricted to engineers and scientists. Political and public debate surrounds numerous subjects, such as low level radiation, genetically modified organisms, nuclear waste, global warming, and food additives, all of which hinge on judgements or beliefs about risk.

Public debate is informed by our assessments, but we should not take public trust for granted. We cannot get away with being patronizing or with asserting that the public are wrong. Research has shown that risk perception and acceptance is strongly affected by a person's culture and way of thinking — and this is so for engineers as for others. The views of different people are likely to be different, and none is necessarily wrong. If we wish our assessments to inform public acceptance of risk, we must take the various 'soft' factors into account in arriving at them. What is more, we need to recognise the importance of appropriate communication of risk information if we want it to be received with trust. This article has raised a few of the questions that we might usefully ask ourselves.