ESRA Webinar 17 March "What is Risk?" by Terje Aven

Thanks for attending the webinar and for many good comments and questions. I was happy to see that there were close to 100 participants. The slides used are attached to this email. A link to the recorded webinar is available at http://youtu.be/oWNA-lg1MyU

For some additional comments to some of the questions raised, see below.

I would like to emphasize that the ESRA webinars are open for all, although primarily aimed at ESRA members.

We will try to organize a series of ESRA webinars this year, testing also different forms on how to run them. Later I hope the various Technical Committees will follow this up and present more tailor-made webinars in topics of interest for their areas.

The next ESRA webinar will be hold by Professor Enrico Zio and is titled: Challenges and opportunities in reliability engineering: the big KID (Knowledge, Information, Data). The date is not yet decided. Information will be given later.

Terje Aven

Questions with some additional comments:

How can the knowledge dimension be taken into account in practical risk assessments?

Answer:

An example using strenght of knowledge judgments was outlined in the webinar.

In addition I would point to judgments specifically addressing issues like this:

i. Knowledge gaps
ii. What can be done to increase the knowledge?
iii. Are there relevant signals and warnings?
iv. Changes of knowledge over time
v. The possibility of unknown knowns (others have the knowledge, but not the analysis group)
vi. The possibility that events are disregarded because of very low probabilities, but these probabilities are based on critical assumptions

But how do you judge what to be red, yellow and green?

How to measure knowledge

Answer: Here is one concrete approach suggested:

Methods for assessing the strength of knowledge (based on Flage and Aven 2009, Aven 2014):

The knowledge is judged as weak if one or more of these conditions is true:

- w1) The assumptions made represent strong simplifications.
- w2) Data/information are/is non-existent or highly unreliable/irrelevant.
- w3) There is strong disagreement among experts.
- w4) The phenomena involved are poorly understood; models are non-existent or known/believed to give poor predictions.

If, on the other hand, all (whenever they are relevant) of the following conditions are met, the knowledge is considered strong:

- s1) The assumptions made are seen as very reasonable.
- s2) Large amounts of reliable and relevant data/information are available.
- s3) There is broad agreement among experts.
- s4) The phenomena involved are well understood; the models used are known to give predictions with the required accuracy.

Cases in between are classified as having a medium strength of knowledge. To obtain a wider strong knowledge category, the requirement that all of the criteria s1)-s4) need to be fulfilled (whenever they are relevant) could, for example, be replaced by a criterion saying that at least one (or two, or three) of the criteria s1)-s4) need to be fulfilled and, at the same time, none of the criteria w1)-w4) may be fulfilled.

A simplified version of these criteria is obtained by using the same score for strong but giving the medium and weak scores if a suitable number of conditions are not met, for example medium score if one or two of the conditions s1)-s4) are not met and weak score otherwise, i.e. when three or four of the conditions are not met.

The strength of knowledge may be illustrated in a risk matrix by coloured events: say red, yellow or green, depending on whether the background knowledge is considered to be weak, medium or strong, respectively.

Knowledge is about justified beliefs (SRA 2015)- building on data and information, and the knowledge is often formulated through assumptions. Justification is obtained by scientific methodology and peer-review, experience and testing.

Aven, T. (2014) Risk, Surprises and Black Swans: Fundamental Ideas and Concepts in Risk Assessment and Risk Management. London: Routledge.
Flage, R. and Aven, T. (2009) Expressing and communicating uncertainty in relation to quantitative risk analysis (QRA). Reliability and Risk Analysis: Theory and Applications, 2(13), 9-18.
SRA (2015) Glossary Society for Risk Analysis, www.sra.com/resources.

I see "K" as a prerequisite for quantifying C and P. If R=f(C,P,K) then K is re-imported in the assessment. Could you comment on that?

Answer: I agree, K is needed for C and P, and yes you can say that K is re-imported, in the sense that the risk picture covers also K, and judgments are made on the strength of this K.

P = f (K) ?

Answer: The probability P(A) of an event A can be written P(A|K) and is a judgment of A given K. It is not a function of K in the sense that there is a formula giving the probability on the basis of K. See discussion in Aven (2015):

The assigned probability expresses the assigner's uncertainty (degree of belief, confidence) given his/her background knowledge, and we have to acknowledge that if two persons have the same background knowledge they would not necessarily have the same probability. Lindley (2006) writes:

> Some people have put forward the argument that the only reason two persons differ in their beliefs about an event is that they have different knowledge bases, and that if these bases were shared, the two people would have the same beliefs, and therefore the same probability. This would remove the personal element from probability and it would logically follow that with knowledge base *K* for an uncertain event *E*, all would have the same uncertainty, and therefore the same probability *P*(*E*|*K*), called a logical probability. We do not share this view, partly because it is very difficult to say what is meant by two knowledge bases being the same. In particular it has proved impossible to say what is meant by being ignorant of an event, or having an empty knowledge base, and although special cases can be covered, the general concept of ignorance has not yielded to analysis

Acknowledging the subjective elements of this type of probabilities, it is essential to distinguish what is the evidence – the knowledge basis – and what is the assignment based on

it. The probabilistic analysis then becomes more a tool for argument, rather than an objective representation of the truth.

We may be uncertain about an event occurring or not, or a quantity (for example the number of fatalities next year due to terrorist attacks), and to measure or express the uncertainty, we use the tool (subjective) probability. It is important to make a distinction between this uncertainty, and the measurement of it, as there are different ways of representing or expressing this uncertainty (although probability is the most common, see below).

Aven, T. (2015) On the allegations that small risks are treated out of proportion to their importance. Reliability Engineering and System Safety, 140, 116-121. Open access.
Lindley, D.V. (2006) Understanding Uncertainty. Hoboken, NJ: Wiley.

Can we translate the knowledge in terms of the “uncertainties” in estimated probabilities? e.g., regarding your example, the geological expert is more certain about the his/her probability than a usual person.

Answer: The probabilities in this example were assigned subjective probabilities, and there is no underlying correct probability in this case to accurately estimate. The only thing we can do to reflect “confidence” is to address the knowledge that supports the probability assignment. We may address the strength of the knowledge and then we obtain a clear distinction between the two in this particular case.

Is there a difference between the term "degree of uncertainty" and (degree) of knowledge? (Last paragraph p.17 in your risk analysis book 2015 edition)
How to measure the uncertainty around K value?

Answer: See SRA glossary for definition of uncertainty and knowledge.

Here we have two possible outcomes 0 and 1, and two cases,

a) Probabilities 0.5 and 0.5
b) Probabilities 0.0001 and 0.9999

There is a higher degree of uncertainty in case a) than b); here the uncertainty is reflected by the probabilities alone. And the uncertainties are with respect to the outcomes, 1 or 0.

The (strength of) knowledge reflected by the probabilities says the same: with respect to the outcomes 1 or 0 the knowledge is stronger for case b) than a).

We need to clarify what we are uncertain about. And what the knowledge is about.

K can include justified beliefs and assumptions and as such we can talk about uncertainties related to these, and the strength of knowledge judgments of K is a way of addressing these uncertainties.

For a specific assumption we can talk about the uncertainty of it and it can be assessed as any unknown quantity, also using a subjective probability (with strength of knowledge judgments)

Aven (2013) Practical implications of the new risk perspectives. Reliability Engineering & System Safety.115, 136-145.

SRA (2015) Glossary Society for Risk Analysis, www.sra.com/resources.

In your example of throwing dice, wouldn't the assumption of a fair die be part of a system-description?

Answer: It should be established as a key assumption - which then should be assessed, or better it should be specifically addressed as a key contributor to risk. The example was only used to illustrate that all probabilistic risk assessments are based on assumptions, and they could cover important aspects of risk.

Can you comment on the use of predefined risk acceptance criteria associated with your perspective on risk?

Answer: Some references where this is discussed:

Aven (2015) Risk analysis. Wiley. 2nd ed.

Aven, T. and Vinnem, J.E. (2005) On the use of risk acceptance criteria in the offshore oil and gas industry. Reliability Engineering and System Safety, 90, 15-24.

Aven (2013) Practical implications of the new risk perspectives. Reliability Engineering & System Safety.115, 136-145.

If we can not know the "true" level of risk, how can we estimate the degree of uncertainty, i.e. how can we make judmgens esteem the strength of knowledge?

Answer: we can always use (subjective) probabilities (and interval probabilities) together with strength of knowledge judgments