Introduction to Risk Acceptance Criteria

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Is the risk acceptable?

A question relevant for the maintenance and development
of Engineering Systems:

- ▶ related to a decision context
- ▶ related to live safety,

- ▶ from a societal perspective.
- ▶ not to economic venture.

Risk Acceptance is a Decision!

▶ Acceptable or not? (to do or not to do?)

▶ Which risk mitigation measure or combination of risk measures to choose? (what to do?)

▶ Risk acceptance becomes also an attribute of the decision about mitigation!

Risk = Expectation of consequences

$$R(\text{Activity with mitigation}_j) = \Sigma_i C(\text{Event}_i) \cdot \Pr(\text{Event}_i) \tag{1}$$

Example: The risk associated to a roof beam (the activity) with design d (the mitigation). The events are *failure* and *no failure*.

The probability in the risk definition is a representation of uncertainty !

… uncertainty related to the realisation of events (and sub events).

Beamexample:

▶ The probability of failure.
▶ The probability to get a load effect larger than a value, say, 120 *kNm*.
▶ The probability of the beam having a moment capacity less the a value, say, 50 *kNm*.

Uncertainty/probability is subjective !

Uncertainty is always a mix of epistemic and aleatory uncertainty.

Beamexample:

- ▶ The bending capacity of the beam depends on the material, material grade, dimension, etc. and the (my) knowledge about it.
- ▶ A beam in an existing structure is realized, as ita bending capacity. But we don't know it / are uncertain about it.

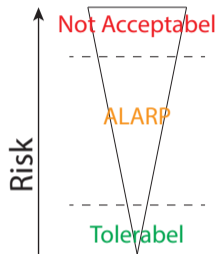$\rightarrow$ …based on "the best knowledge".

Risk (estimate) is subjective !

Problematic in the context of standardisation - how to relate to a fixed risk-criterion?

ALARP -
As Low As Reasonably Practical

… is a relative criterion!

HSE:
Tolerable only if cost of reduction would exceed the improvement gained.

Relative Comparison of Risk:
Marginal live-saving principle.

Example:
The introduction of a risk reduction measure *a* is
reducing the fatality risk by $\Delta R_{0,a} = R_0 - R_a$
Considering the cost of the measure C_a the reduction effectiveness can be assessed based on the Societal Willingness to Pay (*SWTP*) that is expressed in monetary units as:

$$\Delta R_{0,a} \lesseqgtr \frac{C_a}{SWTP} \text{(Relative lifesaving costs)} \tag{2}$$

Which implies that one has to invest into additional risk mitigation as long as $>$ holds.

Example:

If done consequently, this is the acceptable risk level
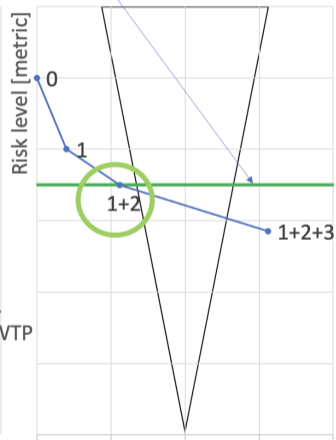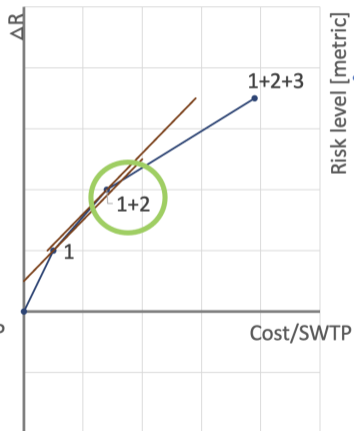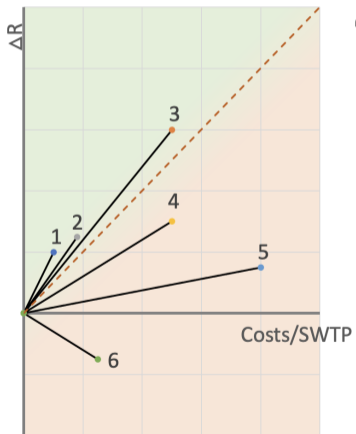
# Marginal live-saving principle
Implications:

▶ All relevant actions are identified (best practice).
▶ Probabilities and risks are assessed for all actions and action combinations.
▶ Cost for mitigation is considered, economic risks are not considered.

Upper limits?

▶ If only very inefficient risk mitigation is available absolute upper limits become relevant.

▶ Absolute limits are hard to relate to due to the subjective nature of the risk assessment.

▶ Absolute limits can be seen as reality checks: are activities feasible at all.
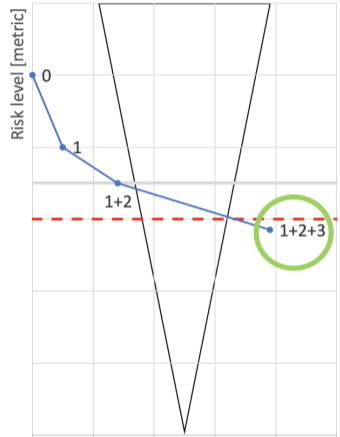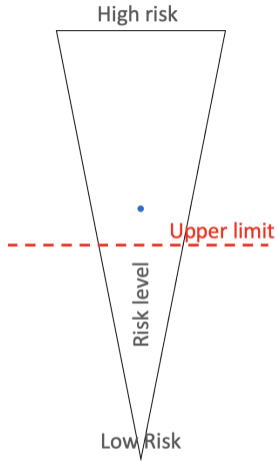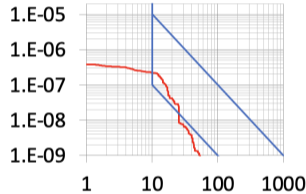
Simplified methods

- Matrix
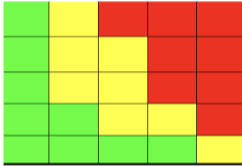
Suitable for ranking a large number of hazards, not for decision

- F-N criterion lines

F-N curves are excellent for illustration, but criterion lines are not ideal for evaluation of acceptance

Other obscure methodologies may violate basic principles

On the other hand, simplifications are useful when the respect the principles. The methodology can be adapted to the decision problem at hand.

Summary and discussion

▶ Acceptance is a decision
▶ Risk $=$ Expected consequences
▶ Risk estimate is subjective
▶ ALARP: Relative comparison of risk
▶ Absolute limit for live-safety $=$ reality check
▶ Simplified criteria: often inconsistent