

Expert estimation of Probabilities

Aim

Aim of this estimation process is to identify the probabilities for basic events in connection with loss of or damage to the AUV REMUS 100, owned by NTNU. This probability estimates will be used in the risk assessment for the REMUS 100 AUV.

Procedure

Previous to the estimation the experts will be introduced to the method and pitfalls that might be connected with the elicitation. This introduction will be given by this document. For questions Christoph Thieme can be contacted. A detailed description of the events is given later in this document.

Two experts will be asked to evaluate each event with a probability and the confidence they have in this estimation. They are also asked to give a little comment on why they assessed the probability like this. If the two experts have a similar assessment, the probability will be used directly. Otherwise it will be tried to find consensus between the two estimations. A sheet for the elicitation can be found at the end of the document.

Measure of probability

To cover for uncertainty the probability is categorized in descriptive categories, which are associated with a certain probability, c.f. Figure 1. Except fifty-fifty which is the 50% probability mark, all categories are associated with a range of probabilities. The expert can as aid for the assessment express his probability assessment in verbal words first and then in a percent value. As additional help the scale was expanded by a frequency description.

It shall be noted that this scale is difficult for handling small probabilities, such as 0,1 % and 0,01 %. Thus there is a high uncertainty connected with this assessment. For this reason the Experts are also asked to indicate their level of certainty, c.f. Table 1.

Table 1 Certainty level of estimation

Confidence level	Probability range
High	Event probability is within ± 1 %
Medium	Event probability is within ± 2 %
Low	Event probability is within ± 5 %

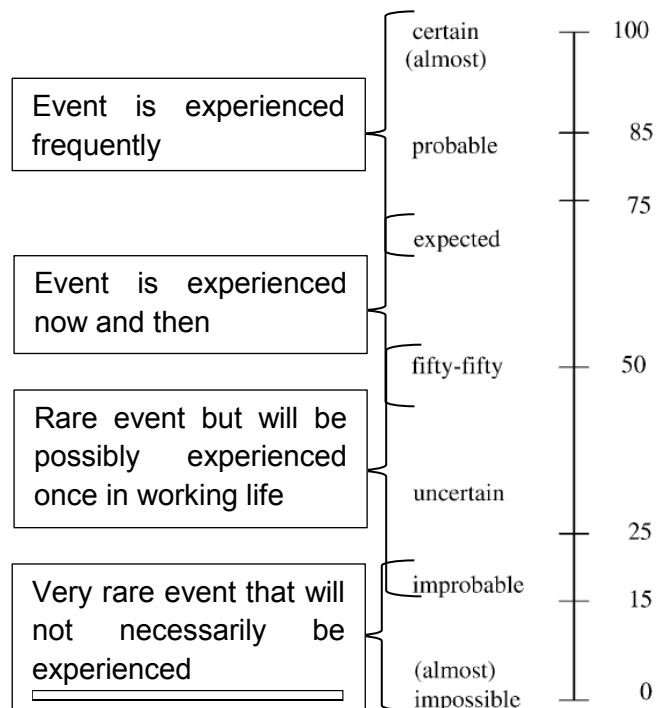


Figure 1 Probability Scale connected to verbal assessment

Experts

The experts assigned in this process are Martin Ludvigsen (Head of the AUR Lab) and Frode Volden (technician for the REMUS 100).

Expert judgement

Some problems that might arise with expert judgement are listed below, they derive mainly from psychological issues. These should be kept in mind when assessing probabilities, to avoid bias or overestimation of the probabilities.

- Perception and memory
 - Judgements can be influenced by the way a question is formulated
 - Events that already have occurred are often higher estimated than events the expert never experienced
 - Selective perception occurs when interpretation occurs with an expected way of seeing it, but biasing it with this pre-interpretation
- Framing
 - Choice can be influenced by the presentation of the question and choice alternatives, negative formulated choices are less likely to be chosen, even if they are the same the “positive formulated”
- Heuristics and biases
 - Often the interpretation of a problem leads to too much interpretation in the given data, thus leading to an overestimation/ false conclusion that cannot be drawn directly from the given data
 - Recent events also tend to influence the choice

- Anchoring happens if probabilities are associated to previously obtained data, from former assessments or suggestions
- Overconfidence
 - Occurs if the expert has more confidence than the accuracy allows
- Values and Attitudes
 - Expert judgement is flawed, this is influenced by values and attitudes of the expert
 - Values are expressions of preferences for goods/ activities and the moral or ethical beliefs that lead to these preferences
- Motivated reasoning, decision bias and distortion
 - Predetermined choices can lead to a distortion of the elicitation to justify this choice
 - A similar phenomena occurs when the experts has interest in the outcome from use of the data and thus tries to influence the outcome positively

Events

The events that shall be considered are listed in the Table 2 below.

Table 2 Events for expert elicitation

Abbr.	Event description
Basic events for Fault tree analysis	
CV	AUV has contact with deployment vessel in water after deployment or during retrieval and receives damage
TD	AUV is damaged during transport in a vehicle (e.g. truck, airplane,...) from TBS to mission location (e.g. Svalbard)
Concerning wrongly implemented ways and planning so that contact with land or seafloor is very likely	
1	AUV doesn't abort mission automatically if the AUV is set up wrongly for the mission (e.g. wrong map datum → high deviations, wrong ballasting, ...)
2	AUV is stuck in Seabed and cannot be recovered with wrongly implemented parameters given that the AUV doesn't abort mission because of the faulty mission planning
Concerning damages that can lead to a loss of the AUV, e.g. cracks (leakage), loose connections (failure of subsystems), etc.	
3	Self-tests do not detect damage and abort mission given that a critical damage is present
4	Vehicle is not able to surface again due to a damage given that the damage is not detected before deployment

Assessment of probabilities work sheet

Event Code	Probability		Confidence level	Comment/ Reasoning
	Verbal category (optional)	Percentage		
CV				
TD				
1				
2				
3				
4				