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Uncertainty in Quantitative Risk Assessment

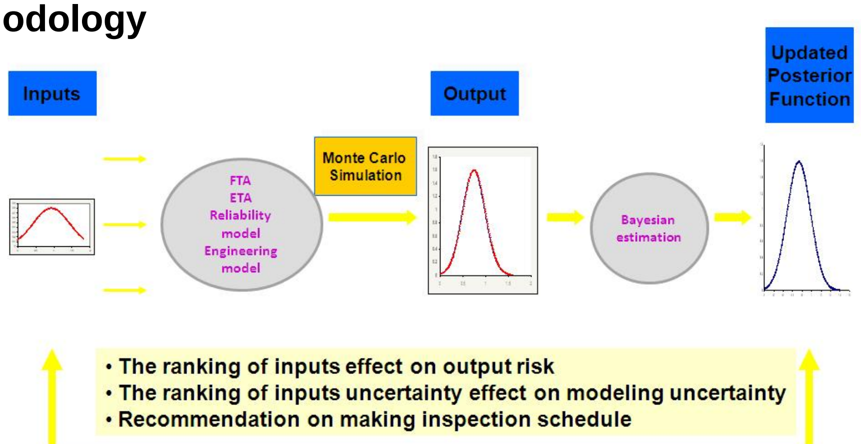
Motivation

In quantitative risk assessment, point values alone are often insufficient for decision makers, because they ignore the range of variability values. Data may be inadequate, so working with expected variable ranges helps guide where data are needed the most. For example, guidelines are needed for cost-effective inspection schedules to mitigate risk and estimate unit reliability.

What is Uncertainty?

In quantitative Risk Assessment, uncertainty is a term used to describe a variety of information, which can be objective, subjective, dubious, incomplete, fragmentary, imprecise, fluctuating, linguistic, data-based, or expert-specified. There are two types of uncertainty. Aleatory uncertainty is due to inherent, unpredictable variation in the performance of the system and cannot be reduced. Epistemic uncertainty is due to the quality of information about the behavior of the system and is reducible.

Methodology



Uncertainty in Quantitative Risk Assessment

In Quantitative Risk Assessment (QRA), point values from laboratory data or generic data are generally accepted by industry to estimate the safety integrity level. However, this practice may mislead the evaluation and subsequent decision-making. Overall process uncertainty consists of irreducible aleatory uncertainties together with reducible epistemic uncertainties. At all levels, the understanding of uncertainty associated with risk levels of major industrial hazards should be enhanced. Here we apply probabilistic approach to address uncertainty in process safety analysis. In fault tree analysis, the distribution of inputs can be represented either analytically or numerically, characterizing the uncertainty associated with the inputs. Using Monte Carlo simulation, the distribution of the probability of system failure as the output will be captured. Bayesian estimation is applied to update the distribution of probability of system failure using the test information on the certain top event if it is available or on earlier basic events. Sensitivity analysis is conducted to identify the largest contributors to the uncertainty of the final output. These uncertainty intervals replace point values in a risk matrix to guide decisions employing all of the available information rather than only point values using only input mean values as in the conventional approach. The resulting uncertainty intervals guide where more information or reduction of uncertainties is needed the most to avoid overlap with intolerable risk levels.

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