The definition of risk (at least in technical applications) has always been a probabilistics one:

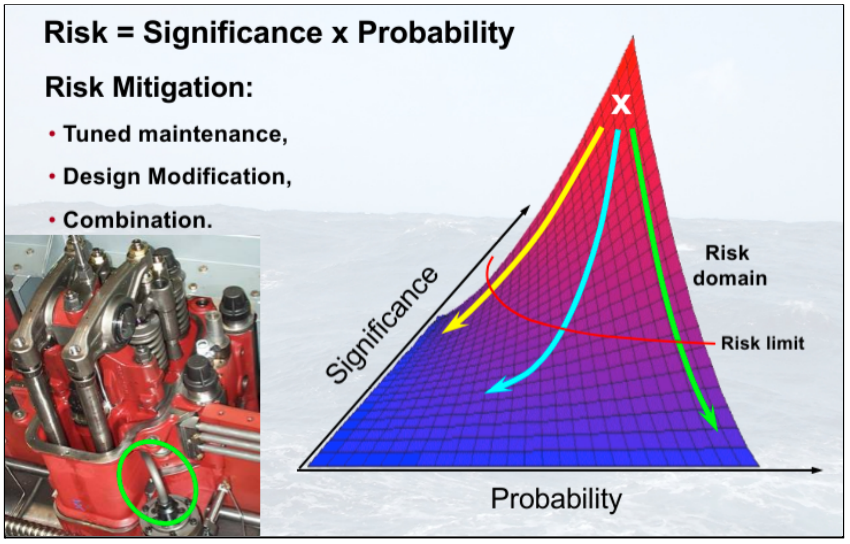
Risk

In order to manage risk, we define it as *the expected loss associated with the occurrence of an unwanted event*. Functionally, this is

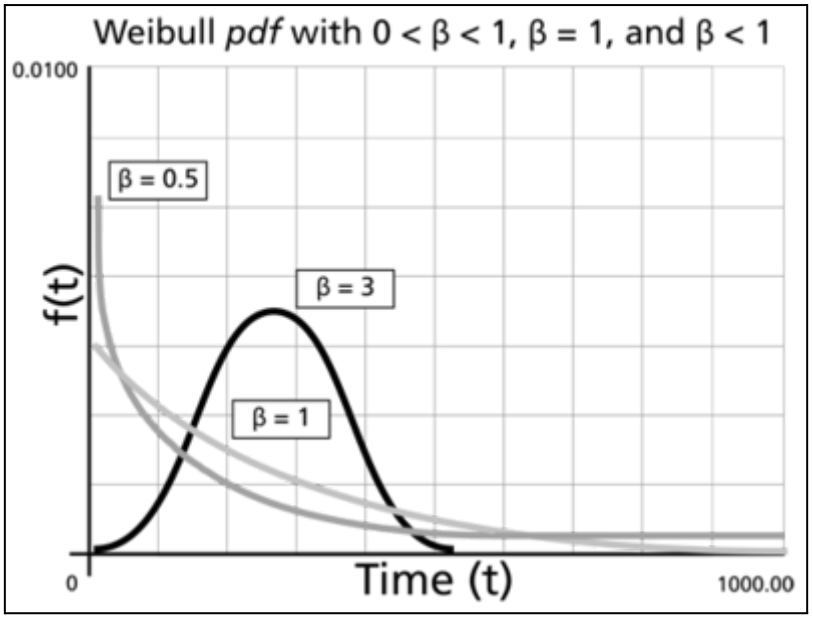
$$\mathfrak{R} = \sigma \cdot \varepsilon$$

$\mathfrak{R}$ – Risk Index
σ – Significance Index
ε – Expected Life Failure Frequency (propability).

In other words, the measured *consequence* of an unwanted event has always been multiplied by a *probability* to obtain the **Risk**:



The measured **Risk** would then be controlled by modifying maintenance or changing the design which would then in turn act mostly on the *probability* component. This probability is based on the statistical analysis of the available failure data. In the optimal case that sufficient data is available and that we are able to fit to this data a statistical distribution, for example the Weibull distribution:



In that case, we will be able to estimate the probability of occurrence and in turn the risk of the unwanted event.

This Risk evolution was visible also through the standards used, so in HAZOP we had the *hazard risk index*:

A similar index, called the *hazard risk index* for safety effects, has been defined in HAZOP, and MIL-STD-882 [42], Table 29.

94

Chapter 10: Maintenance concept design

Table 29: The hazard risk index

		CRITICALITY MAGNITUDE			
		Catastrophic	Critical	Marginal	Negligible
PROBABILITY OF OCCURRENCE	Frequent	UNACCEPTABLE			A w. R
	Probable				
	Occasional		UNDESIRABLE		ACCEPTABLE
	Remote				
	Improbable	ACCEPTABLE WITH REVIEW (A w. R)			

Recently, the second edition from October 2018, of **ISO 20815** (Petroleum, petrochemical and natural gas industries - Production assurance and reliability management)**,** defines Risk as:

3.1.54
risk
combination of the probability of an event and the consequences of the event

Note 1 to entry: This definition is based on ISO/IEC Guide 51:2014, 3.9 that defines risk as combination of the probability of occurrence of harm and the severity of that harm, where the probability of occurrence includes the exposure to a hazardous situation, the occurrence of a hazardous event and the possibility to avoid or limit the harm. "Harm" has been replaced by "event" in the definition to cope with production assurance purpose. It is also similar to the definition of the "level of risk" given in ISO Guide 73:2009, 3.6.1.8 (i.e. "combination of consequences and their likelihood").

Note 2 to entry: Events leading to production losses are considered within the production assurance field.

Which is once again based on the *probability*!

This probabilistic approach, quite obviously, needs lots of data of good quality. We all know the difficulties to obtain such data, evenmore, for our particular make, model, etc. of the asset under consideration. In general, as such data is seldom available we will use an average or mean of the data with all the consequences we can expect from such approximations. One distinctive example of such an approach is OREDA (the Offshore Reliability Database) in which for all failures, the exponential distribution was assumed. In other words, we are using the means (MTBF) of failure data.

Summarizing, this probabilistic approach to risk is a well established and industry-proven method. However, the framework is reaching its limits and the fine tuning of it, regardless of the effort we put into it, will produce limited improvements.

In my opinion, the next step cannot be an evolutionary one, no, it must be a revolutionary one asking for a fundamental change in the approach to risk.

One such promising approach is a disruptive technology proposed by Kelony: