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The truth of Murphy's Law

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The truth of Murphy's Law

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In my previous article in this series in the EMC Journal, "Absence of proof is not proof of absence", I said:

> The necessary methodology to deal with complex devices, equipment and systems is known as Safety Risk Management, and I hope to write about it in a future article that will also discuss its relationship to – and the engineering reality behind – Murphy's Law.

Of course, Murphy's Law applies in many other fields than simply safety risk management – it applies to everything that we do (or try to do) in our lives.

Wikipedia [1] (at the time of writing), introduces Murphy's Law as follows:

> Murphy's law is an adage in Western culture that broadly states, "if anything can go wrong, it will." It is also cited as: "If there's more than one possible outcome of a job or task, and one of those outcomes will result in disaster or an undesirable consequence, then somebody will do it that way"; "Anything that can go wrong, will," the similar "Whatever can go wrong, will go wrong," or, "Whatever can go wrong will go wrong, and at the worst possible time, in the worst possible way." In a less dramatic fashion, the law can be expressed as "Anything that has a probability of happening greater than 0 can and will happen. No exceptions." The saying is sometimes referred to as Sod's law or Finagle's law.

Some think that this is just an engineer's 'in joke', that helps us make light of the fact that we don't know as much as we like to think that we do, so reality sometimes catches us out.

I hope to show in this little article that it is actually an important way of describing a very important and fundamental principle in all engineering (and science, for that matter) – the lack of absolute precision, which leads to quantifiable probabilities that what we are doing will give us a different result from that which we intend.

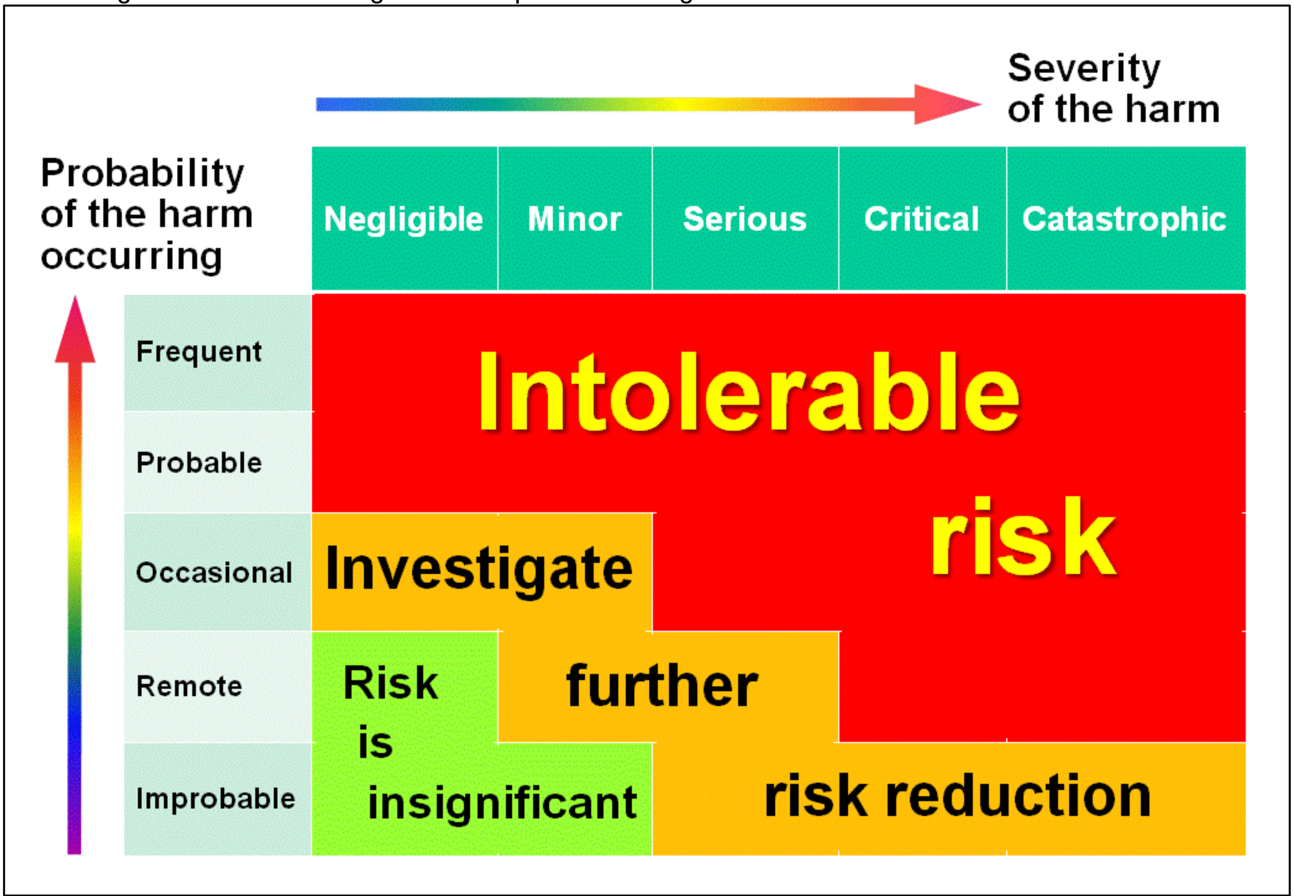
In metrology, a lack of absolute precision results in measurement uncertainty – we can never know perfectly know the quantity of any measurand, to any arbitrary level of precision. Accredited EMC test laboratories have in recent years been made to become very familiar with this fact, because their Accreditation Bodies (such as UKAS, [2]) have insisted that they calculate their measurement uncertainty and ensure that it is not excessive.

To take this issue to the extremes of quantum physics, Heisenberg's Uncertainty Principle places limits on how well we can measure (know) anything in this reality. According to Wikipedia [3] (at the time of writing):

> In quantum physics, the Heisenberg uncertainty principle states that the values of certain pairs of conjugate variables (position and momentum, for instance) cannot both be known with arbitrary precision. That is, the more precisely one variable is known, the less precisely the other is known. This is not a statement about the limitations of a researcher's ability to measure particular quantities of a system, but rather about the nature of the system itself.

In safety engineering, we do what is called 'risk analysis'. Having determined what types of harm could possibly arise from whatever it is we are planning to make or do, we then establish their likelihoods, or probabilities, of occurrence. By multiplying the severity of the harms (e.g. bruise, broken bone, amputation, etc.) with the probability of their occurrences we end up with what we call 'The Risk'.

If the Risk is great enough (usually determined with the aid of a 'risk graph' such as the one in Figure 1, from the medical equipment Risk Management standard ISO 14971), we can then apply a monetary value to it, and determine how much time and money we should spend to reduce the risk to 'tolerable' levels. The 'monetary value' we use is typically the amount that a court might award in damages to the person or organisation that has suffered from the harm



in question – multiplied by the number of times such damages might be awarded against us.

Figure 1: Example of a Risk Graph

The above is my interpretation of the general approach adopted by the UK's Health and Safety Executive in their guidance documents on controlling hazards and risks in the workplace [4]. (I apologise in advance to any safety experts who find my summary just a little bit over-simplified!)

It seems that some large organisations use a similar approach, but instead of using it to decide how much time and money to spend reducing the risk, they instead use it to estimate how much to allow for the expected legal costs of defending themselves against claims that what they made or did caused some harm. It appears that, for them, maintaining the impression that they never cause any harm is more important than protecting people from the harm that they do in fact cause. This is an ethical or moral issue on which I could not possibly comment, other than to point out that it seems to me to be completely at variance with how Professional Institutions such as the IET and IEEE require their members to behave.

Anyway, to get back to the issue I was originally intending to cover in this short article – there are many ways of assessing the probability of occurrence of a harm. The IET's new (free) guide on how to do EMC for Functional Safety [5] includes a good summary of such methods and how to use them, in its sections 3 and 4.

It is impossible to make anything totally safe. Anything can cause harm, for example a small number of injuries or deaths in the UK each year are officially attributed to being caused by a 'tea cosy' [6]. And each possibility for harm has an associated probability of occurring.

It helps no-one if we try to pretend that risks do not exist in the real world. It does not protect the people or organisations who suffer from the harm, and neither does it protect the people or organisations who caused it to happen – whether or not they understood that they were causing such risks.

To communicate the fact that risks are real, and need to be dealt with to avoid unpleasant consequences, we might say: "**If anything can go wrong, it will**" – *which is exactly the statement of Murphy's Law expressed in* [1].

So we can see that as far as safety risk management is concerned, Murphy's Law is simply a statement that if we have conducted our risk analysis correctly, then we must expect that the consequences it predicts will come to pass.

This links us back to my previous article, "Absence of proof is not proof of absence", in which I showed that just because a risk has not yet manifested itself in real life, does not mean that it never will.

That article's example of the space shuttle and the foam chunks falling off its booster and hitting its thermal tiles is a case in point – a proper risk analysis would have shown that some of the shuttle missions would result in the deaths of the crew during re-entry, due to damage to the tiles during launch. Instead, NASA chose to believe that because they had not seen any such problems so far, they would continue not to see them.

I have discussed safety risk management issues above, but of course risk management can be applied to any non-safety risk outcome, for example timescale or financial risks. Where engineering is concerned, the same methods that are used for safety risk management can often be adapted for use in controlling any types of risks.

So I hope I have shown that Murphy's Law always applies in real life. It is simply an expression of the fact that if there is a real risk of something occurring, then it will occur, sooner or later.

We now need to discuss the extended version of Murphy's Law, which is included in my earlier quote from [1]:

> "Whatever can go wrong will go wrong, and at the worst possible time, in the worst possible way."

The addition of the additional requirements: "...at the worst possible time, in the worst possible way" is sometimes expressed as "...and at the most embarrassing moment". If we accept that the inanimate universe is not *intrinsically* malevolent to us, then we must also accept that this addition to the basic Murphy's Law cannot be true *in fact*.

Of course, it *feels* like it is true, for the same reason that we always feel that the weather is always worse on our days off. What is going on here, is that it is human nature to remember bad events more strongly than good ones. This could in fact be some sort of survival mechanism that has been a feature of humankind since we first started banging rocks together and discovered tools – good things are nice when you can get them, but bad things can be deadly. So we have learned to remember bad things more clearly than good.

So, even though the probability distribution of bad weather, or of failures in our designs, might be perfectly random – over time we remember the events that caused us the most aggravation, more than the ones that caused less. Hence there is a *sort of* 'truth', in terms of the persistence of human memory, in the above addition to the basic Murphy's Law – it does seem to us, looking back on our experiences, that when things go wrong, they do so at the worst possible time, and in the worst possible way.

However, this is just our perception, and it should not distract us from the fact that if anything can go wrong, it will, sooner or later.

References:

[1] http://en.wikipedia.org/wiki/Murphy's_law

[2] UKAS: the United Kingdom's Accreditation Service, www.ukas.org.uk/

[3] http://en.wikipedia.org/wiki/Uncertainty_principle

[4] "Reducing risks, Protecting people" (the HSE's decision-making process): http://www.hse.gov.uk/risk/theory/r2p2.pdf

[5] www.theiet.org/factfiles/emc/index.cfm, see especially subsections 3.4, 3.5, 3.7 and 4.2

[6] http://en.wikipedia.org/wiki/Tea_cosy

[7] "Absence of proof is not proof of absence (and the "proven in use" fallacy)", Keith Armstrong, The EMC Journal (www.theemcjournal.com), Sept/Oct 2008 Edition.