HISTORY AND PERCEPTION OF THE LANGUAGE USED IN THE SAFETY DOMAIN

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Abstract

There are several key words used throughout various industries when relating information important to safety. Modern safety practitioners may be unaware of the meaning these words have and the perception of them in the general public. The Engineering Council has suggested that public perception eventually results in regulation, in media treatment and in government decisions affecting industry. So it is vitally important that the engineering profession understands the impact it can have by using words such as risk, danger, safety, probability and chance. This paper presents the findings of public perception research into the meanings of these words and traces their actual historical meanings.

1 Introduction

The Engineering Council has published a set of guidelines on risk issues [3], this is not a particularly new document, but it does contain significant information on public awareness of risk. It cites that "… engineers should learn about how the public perceives risk and makes risk decisions. Conversely, engineers should inform the public about how the profession perceives risks and makes risk decisions."

This research aims to contrast and compare how these two bodies, "engineers" and "the public" view the meaning of certain key words and phrases in the field of safety engineering. This paper will also record and discuss the historical definitions of these words, this will give a reference for future use of them and may also lead to safety practitioners in general having more understanding of the words they regularly use.

2 Selection of research words.

The authors have read through many academic papers, standards and other guidance material for the most frequently used safety-related words. This selection process may be undertaken independently with a new choice of references, but it is likely that similar results would be found. The same set of words kept being repeated over and over. These were;

safe; reliable; fault; failure; hazard; danger; risk and chance.

In many instances these words were used across the texts to discuss the same properties of a system. There were also several occasions where they were interchanged throughout the same text. This is not necessarily a problem, or a negative attribute of the texts involved, but one is left wondering how the meanings that the authors wanted to communicate, have actually been interpreted.

The public and the safety practitioners may have different interpretations of the meanings of these words – indeed there is probably a great deal of debate in both sections of the community as to whether it is better to be safe or reliable and whether a fault is worse than a failure. This is the very reason behind the research of this paper and the results presented herein.

3 Research questions

These popular words do fall into three distinct categories – nouns, verbs and adjectives. The nouns are 'Fault', 'Failure' and 'Hazard'; the verbs are 'Risk', 'Chance' and 'Danger' (all actually verbs or nouns); and the adjectives

are ‘Safe’ and ‘Reliable’. This leads onto three types of question in order to determine the relative perceptions of their meaning and use. These questions are currently being asked of the public and of persons working in the safety field. These are as follows;

1). When considering the severity of an event, which of these three options do you consider to be the worst?

a) A fault
b) A failure
c) A hazard

2) When considering the likelihood of an event, which of these three options do you consider to be the most likely?

a) There is the chance of an accident
b) There is the danger of an accident
c) There is the risk of an accident

3) When considering avoiding accidents, which of these two options do you consider to be the best to have?

a) Safety
b) Reliability

It is the intention of the rest of this paper to present the findings of the research questions and to compare the findings from the two research groups – the public and the safety practitioners.

4 Researching human perception

Researching the human perception of risk and safety has gone on for many years, notably in the UK in the health and safety at work domains and in wider nuclear domains. Many Governments have also supported research into how the public perceives risk and safety issues [4], [5]. These have suggested that the language of risk is used to cover a wide range of types of issues[5]:

- Direct threats from terrorism
- Safety issues (BSE, MMR, flooding)
- Risks to the environment
- Transfer of risk to and from the private sector
- Risk of damage to government’s reputation

The language itself can also be confusing. People often give different meanings to key terms so it is important to develop a commonly understood language, which should be capable of being understood by those outside as well as inside government [5]. These comments are from the UK government, but the Australian government is in similar agreement. Risk is central to policy response to drought and quarantine restrictions, terms like ‘risk management’ and ‘acceptable levels of protection’ assume a degree of understanding of the concept of risk, risk acceptance and how risk is measured. These are bold assumptions [4]. Understanding how stakeholders and the broader community perceive risk will assist policy makers in developing better policy and more effective means for communicating in areas involving risk and safety management [4].

It has been suggested that human societies select particular risks for popular attention, and that risks are therefore ‘exaggerated or minimised according to the social, cultural and moral acceptability of the underlying activities’ [6]. These social factors clearly have an important impact on how to communicate about risk, and therefore on the ability of policy makers to communicate effectively about risk and safety decisions. The human perception of risk and safety varies across several demographics, traditionally summarised as ‘technical experts’ vs. ‘lay public’. Research by the US Nuclear Regulatory Commission [7] gives an indication of how risk attribute evaluation differs between these two social groups. This is shown in Table 1.

These findings are supported by HSE research into public perception of risk and stakeholder engagement [8], where similar findings are expressed; “Long standing evidence from the psychometric approach to risk perception indicates that acceptance of a hazard is related to the qualitative characteristics of that hazard. The accepted range of characteristics includes;

- The nature of the hazard – familiarity and experience of the risk; understanding of the cause-effect mechanism; uncertainty; voluntary exposure to the risk; violation of equity of benefits arising from hazard.
- The risk’s consequences – ubiquity of the consequences of the risk; fear of the risk consequences; delay effects; reversibility; impact on the individual.

- Management of the risk – personal control over the risk; trust and distrust in perceived institutional control of the risk."

The authors would like the reader to note the way the above author has transferred between use of the word hazard and risk in their text. Have you the reader read and understood them as the same? Are they the same anyway?

Risk attribute	**Treatment by experts**	**Treatment by lay public**
Low frequency risks	Objective assessment	Exaggerate or ignore
Newness of risks	Open minded with high and low risk	Exaggerate or ignore
Large single vs. small many	Gives equal weight	Focuses on 'large' events
Immediate vs. delayed	Diverse views; use of discount rate	Focuses on 'now' events
Prediction vs. historical	Gives equal weight	Biased to historical events
Dread factor	Generally ignores	Biased to 'dread' factors
Voluntary vs. involuntary	Gives equal weight	Biased to involuntary risk

Table 1: Extract from US Nuclear Regulation Commission research into risk perception [7].

The final recommendation from the HSE work cited above [8], states that; "There is a cleavage between stakeholders and public who are informed and involved in these (risk/hazard) issues, and those who are not. Communication strategies need to be based on this differentiation between familiarity and unfamiliarity, as a universal approach for both groups is not appropriate."

This research on perception of risk and safety etc. does have an implicit assumption that everyone has the same mental model of what risk, safety, chance, hazard etc. actually mean. It is of no value to have research about risk and safety perception if the research subjects and the researchers are working with different mental models of definition.

5 Historical definitions – safety and reliability

Aside from the 21st Century perception of the meaning of all these words, they have been in use for centuries. Their original meanings do give value to the context of their use in modern academic research, guidance and reporting.

For example, consider the word 'safe'. Safety and safe are derived from the Latin 'salvus' meaning 'uninjured'. The same root has also given us 'salvage', 'salvation' and 'solid', all of which are obviously related to being rescued and sound. The word has reached English from the French via word 'sauf'. The Latin salvus itself goes back even further to ancient Indo-European languages with 'solwos' meaning 'whole'. Another derivative of salvus has led to the herb name 'sage', which has the etymological definition [1] of 'healing or saving plant', due to its medicinal properties.

The modern definition of safety is given in one of our dictionaries [2] as;

> "**Safety: a 1** the condition of being exempt from suffering hurt, injury or loss."

This is a definition that has striking similarities to many modern engineering, industrial and military standards on the subject. The Oxford English Dictionary (OED) gives 11 contexts for the use of the word safety as an adjective and a further context for its use as a verb. This paper will not go through each one, but there are some interesting highlights.

The early Bibles cite being able to "Dwell in safetye" [9], and there are some striking commentaries on safety and duty of care going back 200 years, with "It is his duty not to hazard the safety of the Community" [10]. These uses fall from the primary context, but additional uses were still being made nearly 500 years ago, with using safety as a description of a protection mechanism "Besides, the pargetting or seeling is a good safetie against fyre" [11]. An additional use was in the expression of the quality of being unlikely to cause hurt or injury, "The safety of the lamp is easily proved by taking them into any part of a mine charged with fire-damp" [12]. Although this type of direct testing would be unlikely to pass a modern trials review board.

Further use contexts come from sport and engineering. Rankine wrote about safety factors, the original London taxi automobiles were called "Hansom's Patent Safety Cabs", which were fitted with a "contrivance" to prevent an upset if the cab tilted up or down too much. North American Football and snooker fans will also be aware of the use of terms relating to "playing a safety".

Since around the 1800s the word safety has been used freely as a specific designation for machines, implements etc. to express the protectiveness or relationship to safety of the object for example; "Arch, bar, barrier, bell, buoy, car, carabiner, cartridge, device, equipment, gun, harness, hook, inkstand, keel, line, lintel, lock, -mechanism, plug, rail, rein, rope, seat, sling, snap, spring, strap" [13], and also many others including "cage, committee, engineer, island, lamp, net, paper, switch, valve". Indeed the earliest safety committee explicitly called as such was one back in 1659 set up by the parliament army to conduct government of England following the deposition of Cromwell. You see safety is taken seriously right at the top!!

The use of safety as a verb has the meaning of making safe and secure against failure. This is a much more modern use and is related to aeronautics and weapon use e.g. "Cables and lights must be triple safetied" [13].
In comparison, the word 'reliable' has only two contexts of use, firstly as "That in which confidence may be put; trustworthy, safe, sure" [13]. Second in the field of statistics where some practice or test may be classed as reliable when it "yields concordant results when repeated" [13]. These uses can cause great debate among scientists, when comparing a reliable quality with that of safety. The first definition of reliable in use since around 1850, appears to be equivalent to safety, not in contradiction with it. The second appears not to relate to safety in a strong way.

With these definitions in mind the debate on safety vs. reliability can, and will, go on. All we would like to say is please be aware of the historical context of the use of the words before trying to compare them.

5 Historical definitions – failure and hazard

The modern definitions of 'failure' given in our dictionary are as follows [2];

"**Failure n** 1 a non-occurrence or non-performance, **2** lack of success, **3** a deficiency, deterioration, **4** something or somebody unsuccessful."

The OED also gives four contexts – omitting to perform; giving way under trial; want of success; and in finance and bankruptcy. The origins of 'failure' go back to the 17th century from France and it took a while to settle on the spelling, having various endings of –er, -or, -our and –ure. Early use in 1643 refers to "a fayler of Justice…" [14].

These definitions and description do point towards a failure being something negative and having a definite impact, for example "The house had become uninhabitable through the failure of the water-supply" [15], and "The Bankers of Geneva were utterly ruined by the failure of Mr Bernard." [16]. So a failure may be considered as something that has occurred and that has caused detriment to something, often quite a severe detriment i.e. not something trivial.

Hazard has several quite diverse meanings, both as a noun and a verb. As a noun its origins relate to a dice game supposedly invented during the siege of a Palestinian castle around the 13th century. The past-time developed into a notorious gambling game with high stakes and often catastrophic financial losses. Two games developed "The principal game played was Hazard, of which there were two kinds: French Hazard, in which the players staked against the bank, and English, or Chicken Hazard, in which they played against each other." [14]. The 'French' version of the game is still played today at casinos under the name 'Craps'. Please don't let the safety domain make that similar naming change.

Over the following centuries the word became used as a label for anything related to risk of loss or harm e.g. from Pepys in 1701 "I should not fear the hazard of sending him abroad". It also developed into a parallel use meaning

‘without design or fore-planning’ and even, more interestingly, and rather positive sounding ‘fortuitously’ [13], e.g. “Some choose, and some at hazard, seize their mate” [17].
The sporting/gaming relevance also continued over the centuries, particularly in real tennis, golf and billiards. Meanings also developed relating to making a guess or some venture. The severity of the hazard in these instances does not appear to be quite so bad as those cited in ‘failure’.

Hazard also has five definitions of use as a verb, related to but quite different from the uses as a noun. The OED gives the primary definition as “to expose to the risk of being lost”, and follows with “to run or take the risk of penalty or misfortune” [13]. In these senses, hazard, has been in use for nearly 500 years, for example from 1530 [18]; “It is great folye for a man to hazarde his lyfe for the mucke of this world”. And from 1581 [19]; “Who that otherwise hazardeth to enter into it, exposeth hiselfe to a great danger.”

These definitions and uses highlight an extra factor missing from earlier notes. There appears to be some selection involved in running or exposing oneself to the hazard. It is not a random thing, you actually have to “enter into it”, whereas a failure appears to occur with little or no influence from the subject. So the concept of voluntary and involuntary risk is starting to be made explicit, and a failure, which appears to be involuntary appears to have the worst impact.
This may well be true from a historical perspective, but modern use does not seem to make the distinction. A hazard or a failure can have either minor, or catastrophic, outcomes.

6 Historical definitions – risk and chance

Chance originally meant 'that which befalls', it has come to modern language use from a Latin root 'cadere' meaning 'fall' and via Old French as the word 'cheoir' whose noun derivative includes 'chaunce' [1]. Chance has a 'God's will' aspect to it, as if the person involved has no influence over the outcome, perhaps as in an earthquake. There seems to be a completely random element to chance – that is perhaps why dice and cards are sometimes referred to as games of chance. Although, having stated that, there is always the option of not taking part in the game at all, one of the classic arguments for safety.

The modern definitions of chance have 13 uses as a noun and 5 as a verb. The main definitions are concerned with [13]; “The happening of events; the way in which things fall out; that which befalls a person”; “A possibility or probability of something happening: as distinct from a certainty”; “To submit to whatever may happen”, and “To come about; to happen, occur, come to pass”.

Early use was in all these contexts dating back to the 14th century, with c1300 from Beket “Al his cheances that he hadde by Tywesdai hi come” and later in 1641 from Brome “I ha’ not so much wealth to weigh me down, Nor so little (I thank chance) as to daunce naked” [20].

Another of its uses relates to the positive nature of chance, as a fortuitous event or related to luck and gain, rather than loss and injury. Communication about risk and safety using the word chance may be fraught with easy mis-interpretation.

The ultimate origins of 'risk' have not yet been satisfactorily explained. Its recent history is sure, English acquired it via the French word 'risque' and the Italian 'risco', which is a derivative of the word 'riscare' meaning 'to run into danger'. One potential origin might be related to an earlier meaning of 'sail into danger' perhaps by sailing too close to rocks ('rhiza' being Greek for cliff), but this has yet to be proven [1].

Risk again has noun and verb derivatives. The noun version appears to be equivalent to many of the other words we have already used. The OED gives their main definition as [13]; “Risk, n 1.a. Hazard, Danger, Mischance or Peril”, and subsequent uses as being equivalent to; “The chance or hazard of commercial loss”.

Again, it has been used for centuries, for example, “Rather than run their risque or incur his displeasure they oft-times condescend to a reasonable mart” [21]. Right up to modern day with, “Soon nearly half our elms will be dead and the remainder all at risk” [22].

Often the risk component of a commercial operation is seen as the source of profit [13]. Risk has been used in this sense since industrialisation, in 1776 it was noted in The Wealth of Nations that “The rate of profit always rises more or less with the risk”. This starts to bring out the concept of a relationship between risk and benefit. This use is brought out clearly in the next two quotations from 1757 and 1766 respectively; “That no person could appear

with advantage in military actions who risked nothing by doing so" [23], and "Men risque only in proportion to the advantage expected" [24].

This use of the word risk has developed into the modern domain of risk-benefit analysis, and further into the use of that analysis in ALARP (As Low As Reasonably Practicable) assessments. Without these early uses, it is unlikely that these modern risk and safety concepts would have matured in the way that we have seen.

Several things are important with these two words, one is the difference between chance and risk – at least from their origins, risk is something the person involved has definitely chosen to do. Running or sailing into danger contains a positive decision to accept the danger involved, to go and run the risk. This would be in return for some benefit – getting to port quicker for example.

Another is the opposite view of some of the uses of the words – risk certainly has negative overtones, whereas chance always has something of the opportunity of a lottery win about it. This difference needs to be kept in mind when anticipating the perception of these words when they are used, especially when they are inter-changed.

The last interesting note is the concept of exchange. With a chance, there is no exchange, you get that which befalls. With a risk there is the definite idea of putting something to the potential of loss, in exchange for a greater return, the advantage expected.

7. Research results - demographics

The research was carried out over winter 2005/06 in the form of a questionnaire comprising the three research questions and four requests for demographic information. The questionnaire was publicised on the SE Validation Ltd. website pointed to by direct mail. It was also taken to two gatherings – one of alumni of London University and one of an Amesbury Parent and Toddler Group. It was felt that this would give a broad selection of members of the public.

The demographic questions were arrived at after some considerable thought, as to what we believed were likely to be factors that gave differing perceptions of safety and risk. Age was the first, and was split into under 30, 30 to 50 and over 50. Level of qualification was the next, with PhD, degree and diploma at the top, 'A' and 'O' level in the middle and none of the above as the third option. Experience in the safety domain was the third demographic, with past or present safety practitioner; [having] taken part in some safety work and no safety experience as the three categories. Finally, as the research was concerned with language and interpretation of terms, the last question concerned natural language, with options of English, American, European and other.

The demographic split was very interesting, and to some extent disappointing. There were 30 voluntary respondents and it was surprising how many were collected within a single band in many of our demographic classes. Of the 30, 25 were aged 30 to 50, 4 were over 50 and one was under 30. This sample does not allow for statistically relevant analysis to be done on this class. 27 of the respondents specified English as their natural language. There were no Americans or others – the three European languages were one German, one French and one Welsh. Again, the sample split does not allow useful statistical analysis.

The level of qualification was more evenly spread with 20 being of degree level and 10 specifying an 'A' and 'O' level education. The level of safety experience was also usefully spread with 13 having no safety experience, 14 having some safety experience and 3 being current or past safety practitioners, NB. these last two groups have been added together in the analysis to form a single group of 17.

It was interesting to note that although the Amesbury Parent and Toddler Group had been originally chosen to act as a 'lay public' group, several of the parents recorded demographics in the degree class and also as having some safety experience.

8. Research results – findings

The following tables are summaries of the research results for the three research questions. They show the breakdown of results from all respondents together, and then a breakdown in the two demographic areas where the results were considered useful.

Question 1: When considering the severity of an event, which of these three options do you consider to be the worst?			
	a) Fault	b) Failure	c) Hazard
All	2	11	17
Degree level	2	8	10
Non-degree	0	3	7
With safety	2	7	8
No safety	0	4	9

Question 2: When considering the likelihood of an event, which of these three options do you consider to be the most likely?			
	a) Chance	b) Danger	c) Risk
All	7	13	10
Degree level	6	8	6
Non-degree	1	5	4
With safety	4	6	7
No safety	3	7	3

Question 3: When considering avoiding accidents, which of these two options do you consider to be the best to have?		
	a) Safety	b) Reliability
All	22	8
Degree level	13	7
Non-degree	9	1
With safety	13	4
No safety	9	4

9 Research results – discussion

With such a small sample size, only gross differences may point to a real difference in perception. Even so, with the sample we have, some of these gross differences are present.

In question one, the safety experience demographic shows most interest. Less than half of those with safety experience voted ‘hazard’ as the worst sounding event, whilst nearly three-quarters of those with no safety experience voted this way. The education demographic gave little difference. This would appear to show that ‘hazard’, with its gaming history and the linking in the modern definitions to there being some choice of running the hazard, is perceived worse than failure, even though a failure is a definite deficiency or breakdown.

In question two, the safety experience demographic has the main interest with over half of those with no safety experience citing ‘danger of an event’ as sounding the most likely and only a third of those with safety experience agreeing. The most popular perception from this group was that ‘risk of an event’ was the most likely. Both classes in the education demographic followed the no-safety experience trend. This does point to a definite difference in the level of understanding and perception about the ‘risk’ word.
In strict safety terms the word ‘risk’ is viewed as some combination of likelihood and impact together, and not just referring to a likelihood concept. Chance and danger do not have this association with them, even in the safety domain.

It does seem likely that those with safety experience understand that a risk, as noted in the definitions and historical use, is taken with a view to some gain, and that risks can be managed. Danger on the other hand, may be viewed as

imprecise, maybe even trivial, after all, safety work is very focussed on risk analysis and risk assessment, not on danger analysis.

In question 3 on avoiding accidents, the safety experience demographic does not show a gross difference – both classes being around the three-quarters perceiving that safety is best. Even both the education demographic classes agreed with this, but the non-degree class agrees with more force at 9 out of 10, compared to those with degrees at just two thirds. This appears to suggest that safety is more related to avoidance of accidents than being reliable. It may be that the respondents were aware of the meanings of reliable as trustworthy and confidence related, rather than being exempt from suffering hurt, injury or loss.

It may just be that the respondents had already been influenced by the first two questions and had become 'safety-biased'.

Conclusions

A small sample of public opinion has been gathered to highlight differences in perception in the language used when communicating about risk and safety. The differences may well be related to historical meanings and uses that have developed over time in common language, but there does seem to be a gap in perception relating to the level of experience and knowledge concerning safety matters.

As highlighted in government level research [4] [5], this gap in perception in the public will need to be addressed if successful communication about risk matters is to be achieved.

Recommendations

It is recommended that a larger survey be carried out with more respondents over the demographic classes. There is probably a case for splitting the safety experience demographic into more classes, and even splitting the educational demographic into degree subject areas. The order of the questions should be varied in any larger sample to offset the possibility of learning and bias.

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References

[1] J. Ayto. "Dictionary of Word Origins", Bloomsbury, (1993).

[2] Longman. "English Dictionary and Roget's Thesaurus", Longman Group UK Ltd, (1986).

[3] The Engineering Council. "Guidelines on Rick Issues", The Engineering Council, London. pp. 25, (1993).

[4] Botterill & Mazur "Risk and risk perception – A literature review", Australian Rural Industries Research and Development Corporation, (2004).

[5] Strategy Unit "Risk: Improving government's capability to handle risk and uncertainty", The Cabinet Office, London, (2002). Crown copyright.

[6] Covello & Johnson "The social and cultural construction of risk: Issues, methods, and case studies", D Reidel Publishing Company, (1987).

[7] M.B. Spangler "Policy Issues Related to Worst Case Risk Analyses and the Establishment of Acceptable Standards of De-Minimis Risk", US Nuclear Regulatory Commission, (1984)

[8] J Williamson & A Weyman "Review of the Public Perception of Risk, and Stakeholder Engagement HSL/2005/16", Health and Safety Laboratory, (2005).

[9] "Bible (Great)" Ps. iv. 8, (1539)

[10] Junius "Letters lxii", (1771)

[11] B Googe "Heresbach's Husbandry I", (1577).

[12] Buddle “Letter 1st June”, (1816)

[13] Oxford English Dictionary, (2006).

[14] Prynne “Sovereign Power of Parliament I”, (1643).

[15] Unattrib. “Weekly Notes 28 March” 67/2, (1885).

[16] Steele “Tatler No 5”, (1709).

[17] Dryden “Ovid’s Art Love Works IV”, (a1700)

[18] Palsgr “582/2”, (1530)

[19] G. Pettie “Guazzo’s Civ. Conv. I”, (1581)

[20] Brome Joy “Crew II works” (1641).

[21] Herbert Sir T. “Travels”, (1665).

[22] National Trust “National Trust – Spring 1977”, (1977).

[23] Wilkie W, “Epigonaid (preface)”, (1757).

[24] Beccaria, “Essay on Crimes xxxiii”, (1766).