Hazards forum

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Improving our Understanding of Public Concerns about Risk

Neil Carhart

On **Tuesday 12th June 2012** the Hazards Forum hosted an **evening event.** The event was co-sponsored by Centrica, The Royal Academy of Engineering, the Engineering Council and the Institution of Civil Engineers. The event was held at the Institution of Civil Engineers at One Great George Street, Westminster, London.

This was the first in a series of events on risk perception and risk communication. This timely series builds on a number of recent developments in this area. It follows the publication of the Löfstedt Report[1] into health and safety legislation which made the point that the consideration of risk requires an inclusion of the 'social context' and recognition that the public, stakeholders and regulators perceive risks differently. This topic has been the subject of discussion by The Royal Academy of Engineering and earlier by the Royal Society. In addition to this The Engineering Council highlighted the importance of good communication as one of six principles in its 'Guidance on Risk for the Engineering Profession'[2] published in 2011.

The evening event began with a few brief words from **Hazards Forum Chairman** Rear Admiral (retd) **Paul Thomas CB**, who welcomed the audience and thanked Centrica and the Institution of Civil Engineers for co-sponsoring and hosting the event. He then introduced the **chair for the evening Professor Sue Cox OBE, Dean** of the **Management School** at **Lancaster University**. Prof. Cox highlighted the significance of this event and the eminence of the presenters for the evening. She also mentioned the upcoming second event in this series looking at perspectives from industry and finance, and the third event looking at consistency and inconsistency of understanding. She then introduced each of the evening's speakers.

The event's first speaker was **Professor Nick Pidgeon, Head** of the **Understanding Risk Research Group** at the **University of Cardiff**. His talk, which was titled *"Risk Perception and the Future for the Energy System*" introduced the current thinking on risk and risk perceptions, using as the main case study, energy technologies and system wide changes in current policy. He drew on work from a major project for the UK Energy Research Centre on public acceptability of whole energy system change. Professor Pidgeon revisited earlier research outcomes on risk perception in relation to existing energy system technologies, before outlining the issues which might arise using newer and emerging technologies.

The second speaker was **Professor Brian Wynne**, **Professor** of **Science Studies** at the **ESRC Centre for Economic and Social Aspects of Genomics** (Cesagen) and **Centre for the Study of Environmental Change** (CESC) both at **Lancaster University**. In his talk, titled *"Putting hazard and risk in context – understanding public concerns"*, he looked at how contextual factors in technological risk processes affect public attitudes through differential framing of 'what is at stake'. He described how public mistrust or ambivalence about expert-led and risk-centred policies often arise from authorities neglect of this more fundamental difference.

The final talk of the evening was given by **Professor Dick Eiser, Emeritus**

Professor of **Psychology** at **Sheffield University.** Prof. Eiser's presentation, "*Risk Perception by experts and non-experts: What counts as 'learning from experience?*", looked at the differences in perception between those two groups. In his talk he discussed the differences in information available to experts and non-experts, and the ways in which they process such information. He explained how even expert estimates of risk typically involve a subjective or judgemental element, and that recognising the selectivity of one's own experience is a challenge both for risk communicators and their intended audience.

Prof. Nick Pidgeon began by explaining some of the theory behind the public perceptions of risk. The effects of volcanic ash clouds on European aviation routes, flu pandemics, climate change and the events at Fukushima in Japan have all raised questions about risk, its perception and communication. Prof. Pidgeon highlighted that the lay concept of risk goes beyond the engineering concept of probability and consequence, to involve qualitative factors, distrust of risk managers and underlying science, social amplification and 'affect' or feeling. With reference to the work of Paul Slovic he explained that several qualitative factors (e.g. involuntariness, irreversibility, danger to children, 'dread' or discomfort, etc.) can make novel or technological risks seem less acceptable. Distrust in risk managers or regulators are known to be strongly related to negative perceptions of risk and this has shown to have a material basis in the undermining of promises by human or organisational failures.

The promises of nuclear energy led to a generally positive perception of its early use for electricity generation, but this changed through the cold war and its association with weaponry. In this way, risk perceptions are dynamic, they move around in time, and are influenced by many sources, including the media. Prof. Pidgeon presented information from an Ipsos Mori poll from April 2011 which demonstrated the effects of the events at Fukushima on support for nuclear energy as a means for electricity generation. It showed different effects in different countries such as a strong opposition to nuclear energy in Germany and Italy compared to Great Britain and the USA. He suggested that understanding these differences requires looking at the history and culture of the technology in those countries. Additionally, the perception of risk is also subject to the intuitive response to a situation or technology.

Prof. Pidgeon then went on to discuss some new data regarding one of the big challenges in engineering - the transformation of the UK energy system. The transformation will require changes on both the supply and demand side, as well as consideration of a range of new technologies. The data raises important questions in terms of public values, attitudes and acceptability. There are many different potential scenarios and many different views on which is most likely or most desirable.

He described a series of workshops (three pilot workshops in Cardiff and six main workshops across the UK) introducing participants to the reasons for whole energy system change, creating scenarios though the Department of Energy and Climate Change My2050 web tool[3] among others, before guided discussions and reflection on the potential scenarios. These workshops revealed a generally positive view on change, particularly in terms of renewable energy. There was resistance to Biomass which was seen as an old technology - a return to burning something for energy and fossil fuels.

The geographic location for building projects can affect the politics of the situation, for example, when a wind-farm is sited in a place of particular natural beauty. This would suggest the consultation process had gone wrong and the context had been mismanaged. Carbon Capture and Storage were also seen negatively, blighted by an association with the use of fossil fuels which has been negatively portrayed.

Prof. Pidgeon concluded that this transition in the energy sector is not going to be simple from a human point of view and engineers and scientists must learn the lessons from studies of risk perceptions towards previous technologies.

The next talk was given by **Prof. Brian Wynne**, who began by differentiating between understanding public concerns, and understanding public concerns about risk. Public trust has been an issue in risk perception going right back to the 1970s or 1980s. There are well established ideas on this in the social sciences. He talked about public ambivalence, and how people recognise the positive and negative sides of new technologies. He elaborated on this ambivalence and developed the idea of the dynamic nature of opinions and perceptions. He described the concept of 'Revealed Preferences' as an early approach to understanding public attitudes and risk perceptions, whereby the purchases or behaviours of people were seen as reflections of their opinions, while the reality could be more complex. This simplification was historically the dominant approach.

He explained how his background in materials science and not social science, had led to him wanting to understand the relationship between the science as it is being practiced and promoted, how it is used and how it is perceived by the public.

Prof. Wynne described a study from the 1990s on major chemical hazards (relating to the Seveso directive and its framework for risk assessment, including communicating with the public). In this study members of the public residing near an industrial facility were asked about their attitudes to the plant managers and the company running the site; they were asked who they trusted and why. Many respondents implied their trust was dependent on the organisations being well policed. This is a form of ambivalence, reflected in the accumulated attitudes of the public response. This agrees with earlier studies looking at attitudes to nuclear power events and other controversies that indicate attempts from the public to communicate more subtleties than captured in the classical risk concept. In particular, people were trying to convey concern over uncertainties.

He went on to describe a further study into public attitudes to Genetically Modified Organisms (GMOs). This work took the form of lengthy focus group studies which resulted in a great deal of qualitative information. The focus groups were conducted in Britain, Spain, Italy, France and Germany. Despite hypothesising cultural differences, they were surprised to find similar responses between countries. He explained that the respondents likened the issues surrounding GMOs to previous controversies involving CFCs and Thalidomide. The respondents were trying to express, in their own terms, that these previous chemicals had been through the regulatory processes and had been approved. For example, CFCs had been through risk assessments based on the understanding that they were inert in the atmosphere, but the risk assessments had not considered the effects should they

percolate to the stratosphere. In other words, the respondents were trying to communicate the uncertainty and ignorance that goes beyond the risk assessment. They were trying to convey the idea that GMOs had also been assessed in an independent, honest and rigorous way, but that they still might not be safe. They were not saying that they thought GMOs were unsafe or that they shouldn't be used; they were asking 'where is the acknowledgement of the uncertainty and the contingent back-up plan?'

Prof. Wynne explained that not acknowledging that there might even need to be a back-up plan is not a good basis on which to build trust. He postulated that despite the efforts of the best people in conducting regulated risk assessments, the terms of reference to which they were working may have a tendency to discourage them from acknowledging any residual uncertainty. The process, handed down by policy makers, may discourage them from explicitly emphasising the possibility of options existing beyond the current levels of comprehension.

The underlying concern is that if we explicitly acknowledge the uncertainties, the general public won't accept the risks, which could result in innovation being stifled. However, Prof. Wynne suggested that if this is done in the right way, people would be realistic and accept the need for a trade off, but they need the information to discriminate between when it is or isn't worth it. The public are not necessarily disagreeing with scientists over the risks, but rather they are concerned with the risk assessment process. There needs to be a better way of dealing with this challenge.

In addition to this, while there is a belief that the rational thing to do is to trade off the risks against the benefits, the regulatory processes don't usually ask what the benefits are. With many technologies, such as GMOs, the early developments were not necessarily designed with consumer benefit in mind. The benefit question may not have been a topic of public debate until, some would say, it became too late. In some cases, such as GM food, scientists can assume the benefits are obvious and overlook the need for public debate. This is coupled with an assumption shared by many in modern, democratic, capitalist economic systems that if an entrepreneur can find a market for their product then there must be a public benefit as it is an aggregation of individual benefits.

Prof. Wynne concluded by stating that most of the ordinary members of the public he has encountered as part of his research are willing to defer to the specialists, but they often have further questions where the original specialists might not be the best people to answer. The challenge remains: what are the right questions to ask, and how do we frame them correctly?

The final talk of the evening was given by **Prof. Dick Eiser** on risk perception and learning from experience in experts and non-experts.

He posed the question: *Is risk perception a type of attitude*? We tend to think of risk perception in terms of how probabilities are perceived or misperceived and how they may impact on decision making. The alternative belief is that preference or disapproval is evaluated on the basis of attitudes formed from past experience, motivations and emotions. Prof. Eiser argued that these processes are linked by how people use their experience. While attitudes guide behaviour and consequences of behaviour provide feedback, experiences shape probabilistic and evaluative expectancies about the consequences of behaviour.

Key theoretical concepts.

- Attitudes – how we *evaluate* issues, people and events.
- Information processing – how we make sense of (typically *uncertain*) information.
- Learning – how we *update* our evaluations and expectations based on our experience and what others tell us.
- Trust – whom we *rely* on and for what.

Traditional definitions of risk are quantitative and probabilistic notions. These probability assessments are usually derived from data about events and put into rational choice theory frameworks. These assume preferences and decisions are determined by subjective expected utility (that is to say, a combination of the estimated probability and the evaluated outcome). However, as Prof. Eiser went on to explain, there is a lot of research that challenges this assumption and instead suggests judgements are often irrational and inconsistent. For example, heuristics relating to the amount of available information may produce a tendency for rare risks to be overestimated and more common risks to be underestimated.

He discussed some examples of apparent irrationality such as the neglect of risk comparisons (e.g. why are people more concerned about GM food than alcohol abuse?), the continuation of health-damaging behaviours in the light of evidence (potentially due to a tendency to discount long-term costs for short term benefits) and some 'Health and Safety' fears (surrounding issues such as vaccines) where the costs of the alternatives are ignored.

Thinking of probability in purely data-driven epidemiological terms presents particular problems when there is a paucity of data, such as nuclear risks. In these instances it is necessary to estimate risks, and this requires a level of expertise. Often this is related to the relative understanding of the causal processes involved. These estimates also involve more than just probability- they involve certainty and uncertainty.

Difficulties arise when it is necessary to make decisions. Prof. Eiser discussed Signal Detection Theory, derived from the psychology of perception, in the context of deciding between safety and danger. These two exist at opposite extremes, but the reasoning behind the placing of the limits of acceptability can be complex with no right or wrong. It is a matter of the trade off between costs and benefits.

He went on to talk about how information is used to learn and how expectations can develop from experience. Much of the way in which we use experience can be misleading. For example, falsely categorising a safe situation as dangerous can lead to the adoption of risk-averse beliefs that are never tested. Ambiguous feedback can be interpreted as confirming prior beliefs. Avoidance behaviour, in particular, can eliminate informative feedback.

Decision / Actual risk	Dangerous	Safe
Danger	Hit	Miss
Safety	False Alarm	Correct All Clear
Learning	*May be difficult to distinguish false alarms from hits*	*Misses may be fatal, or consequences sporadic*

In situations where people lack direct personal experience it must be drawn from others and there is a tendency to trust friends over strangers. Groups of friends are likely to have similar beliefs, which leads to social reinforcing. The media can create a similar process of amplifying feedback. In terms of deferring to the judgement of others, Prof. Eiser explained that trust can depend on implicit estimates of competence, partiality and honesty. Trust is broadly correlated with knowledge though industrial experts may be perceived to have a vested interest.

Prof. Eiser concluded by saying that human behaviour is partly what is meant by risk. Risk arises from interactions between people and their social and physical environment. When we are judging risk, we are partly judging behaviour. When looking for misperceptions, it is not a case of people just not understanding the technology; risk perception partly involves implicit judgements of the quality of decision-making by human actors.

Prof. Cox thanked the speakers for their stimulating presentations and introduced

Prof. David Spiegelhalter OBE FRS, **Winton Professor for the Public Understanding of Risk**, **University of Cambridge** who opened the discussion period with a contribution from his extensive work in risk perceptions.

Prof. Spiegelhalter expressed his enjoyment of the presentations and reiterated the importance of the way culture, environment and people can shape perceptions of risk. He then outlined his particular interest in the way in which risks and numbers are communicated and manipulated (e.g. presented absolutely or relatively). He touched on the issues surrounding mobile phone use and the trade-offs of the perceived benefits against any outstanding uncertainties. He postulated the idea that risk assessments should be accompanied by a star rating relating to the confidence in that assessment. He concluded by posing the question: how can we encourage risk practitioners to be more open about uncertainties, particularly given fears over how this will affect trust and confidence?

This inspired **debate** which included a discussion of the tendency of media to interpret balance as providing equal representation, even when it doesn't reflect the distribution of expert judgement. Others suggested that scientists are keen to be more open about uncertainties but experts and politicians need to trust the public to accept them as a realistic (and useful to acknowledge) part of the decision making process. The discussion period also included questions about the perceived association of the people promulgating the risk (particularly experts associated with commercial operations), the potential effects of an increasingly litigious culture and the way in which low levels of risk are communicated in a comparative way. There was a question as to whether there might be benefit in scientists and engineers explicitly acknowledging when risks are negligible or trivial and it was queried whether there were occurrences of this happening. The final questioner asked about the comparison between individual concerns and societal concerns. This led on to a discussion about the potential misframing of societal risks and how they represent individual concerns.

Prof. Dick Taylor gave the **concluding remarks**, emphasising the increasing importance within the complex, highly-interdependent modern world of bringing together a diverse range of specialists to facilitate an interdisciplinary approach to risk and the effective communication thereof.

Paul Thomas then thanked the sponsors of the event once more, the delegates, all who had contributed and those who helped organise the event. He then invited all attendees to the networking session to continue their discussions over the light refreshments that followed.

[1]Löfstedt, R., 2011, 'Reclaiming health and safety for all: An independent review of health and safety regulation'. Available at http://www.dwp.gov.uk/docs/lofstedt-report.pdf

[2]Engineering Council, 2011, 'Guidance on Risk for the Engineering Profession'. Available at http://www.engc.org.uk/about-us/guidance-on-risk

[3] Available at http://my2050.decc.gov.uk/

Further Online Resources Provided by Contributors:

- The work of Cardiff University's Understanding Risk Group can be found here: http://www.understanding-risk.org/
- Information about the UK Energy Research Centre can be found at: http://www.ukerc.ac.uk
- Prof. Dick Eiser highlighted IRDR (Integrated Research on Disaster Risk): http://www.irdrinternational.org
- Prof. David Spiegelhalter's website on Understanding Uncertainty can be found here: http://understandinguncertainty.org/

Promoting Understanding of the Hazards, Risks and Benefits of Chemicals

Dr. S. R. Lipworth
Environmental Health and Safety Committee, Royal Society of Chemistry

The Environment, Health and Safety Committee (EHSC) is an expert working group of the Royal Society of Chemistry (RSC) that has been in existence for over 30 years. Broadly speaking, the work of EHSC is primarily concerned with promoting a balanced understanding of the benefits, hazards and risks associated with the use of chemicals. This Committee also seeks to create a supportive environment for innovation by informing and influencing UK and EU Chemicals Control Policy to ensure that legislation is risk-based, proportionate, and sustainable. In particular, the EHSC seeks to inform policy makers about the benefits, risks and costs associated with the use of chemicals and the potential consequences of different policy options. By monitoring environment, health and safety policy and related legislation, the EHSC is able to take a proactive role in shaping new developments.

Risk and Regulatory Policy

Ideally society would like industry to develop chemical substances that can deliver a desired property or effect without any negative side effects. We want flame retardant clothes but not flame retardant chemicals with bio-accumulative properties. However, while it is imperative to protect health and the environment it is not possible to design out all risks over the life cycle of chemical substances and products. Legislation therefore needs to strike a balance between reducing risk as far as is possible and maintaining the benefits to the society of chemicals.

For a chemical to cause harm requires exposure to its hazardous properties. The RSC has some concerns that hazard based approaches and the precautionary principle are being used in situations where risk based approaches are more appropriate. The appeal of hazard-based approaches is that they are easier to apply and administer, however such approaches may result in misdirection of effort to mitigate risk because they do not deal with the likelihood that particular hazards may be realised.

A 'hazard based' approach that provides a list of options ranked by ‘hazard’ is flawed because in reality most options possess a range of different hazards that will vary in magnitude from one option to another and often in opposite directions. For example, a highly flammable solvent may be less toxic than an alternative solvent of lower flammability. Thus although options can be readily ranked in terms of a specific hazard such as flammability, options cannot be ranked in terms of their overall hazard.

While the RSC supports the search for safer alternatives it must be remembered that chemical substances generally do not pose a single risk. Therefore in the search for less harmful substitutes with equivalent functionality and utility, care must be taken to ensure that a reduction in one risk is not replaced by an increase in another.

The almost non-toxic and non-flammable chlorofluorocarbons (CFCs) were introduced to replace refrigerants that were either very toxic to humans, such as ammonia, or were extremely flammable such as propane. When this substitution took place the impact of CFCs on the ozone layer was unknown. However

when this effect was discovered, the older refrigerants were reintroduced with a very significant increase in risk to the population.

Substitution is a practical outcome of comparative risk assessment, which aims to optimise the choice of substances for a particular use, taking into account potential risks to health, wildlife and the environment and the benefits to society as a whole. Substitution should seek to achieve an equivalent or greater functionality via technological or organisational measures.

Hazard based approaches that seek to eliminate a particular substance may also run counter to sustainability. This is because substitutes that may have a lower hazard profile may also have to be used in greater quantities or may consume more energy in order to provide the same level of efficacy. The decision to choose one option over another should therefore be on the basis of overall impact. Substitution by an alternative substance should not lead to any materially important reduction in sustainability.

Finally, legislation based solely on a chemical's hazardous properties and not on the actual risk it poses, can lead to a reduction in the number of available chemicals, which in turn can impact negatively on innovation.

The RSC believes that there are issues within European Government Agencies concerning the understanding of the conceptual basis of health and environmental risk analysis. This lack of understanding may render any policy advice derived from experience of limited value. It also makes serious discussion of individual points difficult. The RSC has always advocated that governmental advisory groups tasked with developing policy and legislation should where possible have sufficient expertise to evaluate the scientific and technical information put before them.

Unless good scientific (and technical) advice is taken into the policy making process, the process will yield policies that are not technically acceptable or, worse, not technically feasible. In such circumstances the consequences could include inappropriate Government positions, and unsatisfactory and/or unenforceable legislation. While appropriate chemicals control policies do contribute to increased safety and sustainability and can be a source of competitive advantage, policies which are not based on scientific knowledge can create additional costs for business that do not contribute to reducing risk.

The Role of the RSC's Environment, Health and Safety Committee

EHSC's strategic objectives are to:

1. Influence public policy and legislation on health, safety and the environment to ensure that they are based on sound science and in the public interest

2. Provide essential health, safety and environmental guidance for RSC members to help them fulfil their responsibilities as professional chemists.

3. Help to improve the public image of chemistry and chemists by improving public understanding of the risks associated with the benefits of chemicals.

4. Promote Sustainable Development through the above three objectives.

The Environment, Health and Safety Committee is made up of three groups. A Core Group, which, sets strategy and oversees the EHSC work plan; the Working Party on Notes which, produces guidance notes for members and the wider public about controlling the risks when using chemicals; and the Policy Group which seeks to inform UK and EU chemicals control policy.

The Working Party on Notes (WPN) develops professional guidance notes for RSC members and 'message' notes for decision-makers, media and the wider public. WPN publishes a series of informative notes covering all aspects of health, safety and environmental issues. Compiled by an EHSC working party, these

publications provide background information, on a whole range of topics from nanotechnology to the effects of chemicals on children.

The Policy Group responds to UK and EU Parliamentary & Government consultations, develops regulatory policy position statements on behalf of the RSC, prepares briefings for government ministers and senior civil servants and runs workshops on topical aspects of chemical risk. This Group proactively seeks opportunities to inform national and international policy makers about the benefits, risks and costs associated with the use of chemicals and the potential consequences of different policy options.

EHSC seeks to identify emerging issues of possible public concern relating to chemicals and proactively engages with interested parties. The Committee responds to public concerns about chemicals and proposed changes to UK and EU chemicals control and environment, health and safety policy. EHSC also represents the RSC on national bodies such as UK Chemicals Stakeholder Forum, the British Standards Institute and the UK Poisons Board as well as to *ad hoc* working groups established by the European Commission. In addition, EHSC also contributes significant input into the scientific and education policy projects and activities of the European Association of Chemical and Molecular Sciences (EuCheMS), and the European Platform for Sustainable Chemistry (SusChem) on matters relating to the introduction of new chemical technologies and building skills capacity and the teaching of practical chemistry.

Steven Lipworth is a policy adviser to the Royal Society of Chemistry's Environment Health and Safety Committee. This Committee is responsible for developing E, H&S policy on behalf of the RSC, as well as producing professional guidance for members. Steven has a MSc degree in marine ecotoxicology and a PhD in environmental economics and policy. Steven's professional interests lie in the areas of risk management, strategic planning, and professional development.

Prior to joining the RSC, Steven worked for the Department of Environment Affairs in South Africa, where his duties included coastal zone protection. In 1997 Steven was awarded a three year Wellcome Fellowship in Science Advice at the Royal Society. Thereafter he entered the consultancy sector and conducted policy projects for a wide range of technology-based organizations. Steven has also developed training material for the Technology Policy Masters Programme, run jointly by Cambridge University and the Massachusetts Institute of Technology.

For further information on EHSC please see:

http://www.rsc.org/ScienceAndTechnology/Policy/EHSC/index.asp
or contact: Dr Steven Lipworth
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The Role of the Precautionary Principle in Chemical Control Policy

Dr David Taylor and Dr Paul Illing
Environmental Health and Safety Committee, Royal Society for Chemistry

Evaluation of hazard data forms an essential part of risk assessment, but is there any role for the use of hazard data alone in taking decisions on chemical management?

Hazard- based Approach to Chemical Control

All substances, both naturally occurring and synthetic, have a range of different hazardous properties (hazard profile), and the known hazard profile may be incomplete. Substances can, for example, be toxic to humans or the environment, explosive, corrosive, volatile, flammable or radioactive. These hazardous properties rarely correlate with each other, thus a list of substances arranged in order of a specified human toxic impact such as carcinogenesis will be very different to one ordered in terms of flammability. Any attempt to classify substances into a single group of 'hazardous substances' has to be based on arbitrary rather than scientific criteria. This leads to unintended (and unexpected and often undesirable) outcomes.

Reliance on hazard assessment alone would dramatically, and unnecessarily, alter our lifestyle; both electricity and natural gas are inherently highly hazardous, drinking water is disinfected with either chlorine or ozone both of which are extremely hazardous materials, motor vehicles, both petrol and electric, derive their energy from hazardous materials carried in the vehicle in substantial quantities, and all solid state electronic devices, such as mobile phones, contain small quantities of highly toxic materials. However, for many people 'hazard-based decision making' appears to be a logical mechanism to apply the precautionary principle.

Risk-based Approach to Chemical Control

The Royal Society of Chemistry (RSC) is a very strong proponent of the use of risk assessment as being an essential step in the management of chemicals. It considers 'hazard assessment' as a critical and necessary part of the risk assessment process but insufficient on its own to be used for rational decision-making about regulatory chemical controls. In addition to considering hazard it is also important to take account of the quantitative nature of the hazard i.e. how much of the substance is needed to cause the undesirable outcome. In rational decisions about the management of chemicals all intrinsic hazards and their associated risks need to be balanced against each other and considered together with information on potential exposure. Both a risk assessment and a risk benefit evaluation need to be carried out.

The issue of 'unknown' risks

Risk assessment and evaluation is only useful where we are aware that a potential risk

exists. In 2002 Donald Rumsfeld famously observed that there were three types of risk; "There are known knowns. These are things we know that we know. There are known unknowns. That is to say, these are things that we know we don't know. But there are also unknown unknowns. These are things we do not know we don't know."

The first group can be readily managed because we have a very good understanding of the risks (e.g. the use of domestic electricity), the second group can be managed after conducting a risk assessment in which appropriate safety factors are included to deal with known uncertainties (e.g. the use of food preservatives). However, the final group is incapable of being managed since we are not even aware that such risks exist. As our knowledge increases, previously unknown risks become known and these can then be managed in the same manner as the second group (e.g. discovery of the ozone depletion potential of chlorofluorocarbons and other chlorine containing substances). However until the risk has become known, management is impossible.

As some risks are currently unknowable, this raises the question of the usefulness of the Precautionary Principle (essentially prevention/minimisation of exposure); can it be used to reduce the potential consequences of risks that may be discovered in the future? Essentially the same question arises when dealing with incidents: is the principle applicable when inadequate hazard information is available?

Defining the Precautionary Principle

One of the major problems associated with the concept of the 'Precautionary Principle' is that no universally agreed definition exists and hence its meaning and application are open to interpretation. For example, contrast these two expressions of the principle, both of which have been proposed by authoritative bodies.

"Where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (UN Conference on Sustainable Development, Rio 1992)

"The true application of the precautionary principle is in cases where there is reason to think that there may be an effect, but no evidence has yet been obtained for its existence or the evidence is inconclusive" (Royal Commission on Environmental Pollution, 21st Report par 4.47, 1998)

Such statements have sometimes led to calls for draconian precautionary action e.g. bans on substances being demanded in chemical management situations where there is any uncertainty in the available information. The implication is that the application of the Precautionary Principle always provides societal or environmental benefit.

This 'better safe than sorry' approach to the application of the 'Precautionary Principle' is problematic since there can also be negative consequences to its application. Firstly, where the science is uncertain, if the cause is wrongly diagnosed, subsequent 'precautionary' action may be either inappropriate or actually dangerous. This happens regularly with medically unexplained physical symptoms, which are often misdiagnosed as being due to a chemical exposure. The precautionary principle is invoked to justify management procedures before the correct hazard has been identified. Secondly, regulators tend to be risk averse; thus the criteria used and the assumptions made in risk evaluation will essentially be conservative, with a tendency to use multiple 'worst case' assumptions in the evaluation with resultant over precautionary conclusions. Finally, the elimination of all existing uses of a substance may result in currently

unrecognised but highly beneficial applications never being discovered.

Applying the Precautionary Principle

In 2000 the European Commission published an opinion on the 'appropriate' application of the Precautionary Principle in European Regulation. This document provides a pragmatic guide to when and how the principle should be used. Unfortunately this Communication [COM (2000)1] is hardly ever referred to. Application of the Precautionary Principle does not require that the use of substances should be 'banned'. The EU Document makes clear, that the management response needs to be proportionate i.e. the response should be chosen to achieve a given level of protection. Furthermore, it needs to be *'based on an examination of the potential benefits and costs of action or lack of action.'*

Risk is a combination of hazard and exposure. This is also true for unknown risks. Minimising exposure always leads to minimising risks. In the extreme, elimination of exposure by forbidding all use of the substance will eliminate all the risk. This also will deny any potential societal benefit arising from the use of that substance. For example, under normal circumstances it would not seem prudent to permit the use of a 'substance of very high concern' as a plasticiser in applications where hundreds of thousands of tonnes of the material were to be distributed worldwide, since both consumer and environmental exposure would probably be extensive. The same substance might justifiably be authorised for use as a starting material or intermediate in the synthesis of a novel antibiotic.

When faced with uncertainty, current knowledge indicates that:

- Substances that have long half lives in the environment and are mobile are more likely to pose future problems than those that degrade rapidly and/or are immobile
- Substances produced in large quantities and that are widely dispersed in their use are more likely to pose future problems than those that are produced in small quantities for contained uses.
- Substances that are intended to be biologically active are more likely to pose future problems than those that are biologically inert

All things being equal, we should be more careful how we use a substance with high biological activity and a long environmental half-life and more tolerant of a substance with low biological activity that degrades rapidly. The former circumstances warrant a higher degree of precaution.

These statements are generalisations, qualitative and incomplete. They can only be used to inform decision-making and should not be used in isolation as decision criteria. Unfortunately, such use of generalisations has led to the inappropriate use of a hazard assessment process based on the application of arbitrary thresholds.

Conclusion

The Royal Society of Chemistry fully supports the definition of the Precautionary Principle adopted at the UN Conference in Rio in 1992 and commends the European Commission Guidance Document of 2000 on the mechanism for its application.

The evaluation of hazard data forms an essential part of risk assessment. Furthermore we consider that hazard data can be used to inform a precautionary approach to 'substances of very high concern', the 'precautionary principle ' can only be applied to known risks ('known knowns and known unknowns'). Only careful risk monitoring can minimise significant future manifestations of currently unknown risks. The decision on appropriate management action must consider the likely degree of exposure and the ability to monitor the risk, together with the potential loss of societal benefit if use is restricted.

David Taylor is a professional chemist with a PhD in marine chemistry. A Chartered Chemist, he is a Fellow of the Institute of Water and Environmental Management and also of the Royal Society of Chemistry and is chairman of their Environmental, Health & Safety Policy Group.

He has 40 years experience of the evaluation, management and resolution of environmental issues in the heavy chemical, specialty chemical, agrochemical and pharmaceutical industries. Until June 2008 he was the Global Director of Environment & Sustainability for the pharmaceutical company AstraZeneca, where he was responsible, amongst other things, for the direction of the company research programme in environmental science.

He is now the Strategic Director of the independent consultancy firm wca Environment.

Paul Illing is a European Registered Toxicologist with wide experience in occupational health toxicology, regulatory toxicology and toxicological risk analysis, both as an independent consultant and in the Health and Safety Executive.

Currently he is a member of the RSC's Environment, Health and Safety Committee and the E, H & S Policy Group. Paul is the RSC's representative on the Home Office Poisons Board, a Titular Member of IUPAC Committee VII - Chemistry and Health and an Honorary Lecturer at University of Manchester Centre for Occupational and Environmental Health. He has written extensively on regulatory toxicology and toxic risk analysis.

For further information please contact:

Dr Steven Lipworth (lipworths@rsc.org)

From the Executive Secretary.....

The Executive Committee is pleased to announce that **Ian Wright** has accepted an invitation to become a **co-opted member** of the committee. Ian brings extensive experience to the committee through, for example, his activities as a chartered civil engineer, chartered structural engineer and as a practicing barrister. We plan to introduce him further in the next Newsletter.

We are pleased, also, to welcome **Dr Neil Carhart** as **editor** of this edition of the Newsletter and thank him for taking on this role. We plan to include more about Neil in the next edition by way of an introduction, also. In the meantime we record our thanks to **James Kearns**, who has been thanked personally, for his excellent past two and half years in the role. James has now moved on – and into the finance sector. We still hope to see him at events from time to time, however.

The first in the series of three **Evening Events** (reported in this Newsletter) on *Risk communication* proved to be very popular with a significant increase in the number of delegates attending. Those **wishing to attend** the remaining two events in the series are advised to respond early to the invitations and to register as soon as they are able to commit to attending. This is for room capacity reasons. (Please see p16 for the dates.)

Members may wish to note that the **next AGM** is planned for 19th March 2013.

Brian Neale

Parliamentary and Scientific Committee

The latest issues of "Science in Parliament", the journal of the Parliamentary and Scientific Committee of which the Hazards Forum is a member, has among its contents the following articles. Any member who would like any further information on any of the articles below should visit the PSC website www.ScienceInParliament.org.uk

LONDON 2012	Hugh Robertson MP
BUILDING SCIENCE INTO LONDON 2012	Sir John Armitt
HEALTH AND SAFETY ON LONDON 2012	Lawrence Waterman
SCIENCE AND SPORT	Dr Mark Downs
THE SKILLS DEVELOPED THROUGH SPORT WILL BE A LEGACY	Professor David Lavellee
MAKING A DIFFERENCE WITH MATERIALS	Dr Robert Quarshie
INNOVATIONS FOR THE OLYMPIC ATHELETES AND SPECTATORS?	Brian J. McCarthy
GEARING UP	
PVC IS ONE OF MANY MATERIALS PLAYING A PART	
CRITICAL COMMUNICATIONS AT THE OLIMPIC GAMES	Rupert Cazalet
RECENT DEVELOPMENTS IN SPORTS NUTRITION	Professor Ron Maughan
PROTECTING OLIMPIC RIDERS	Rachel Faulkner
WHY WOULD HS2 BE GOOD FOR BRITAIN	Addresses to the P&SC by Bridget Rosewell, Professor Andrew McNaughton and Sir Richard Leese
VOICE OF THE FUTURE	
STRENGTHENING THE TECHNICIAN WORKFORCE	Robert Neilson
FOOD AND GUT HEALTH	Addresses to the P&SC Professor Glenn Gibson, Dr Linda Thomas and Professor Simon Carding
HARNESSING THE POWER OF GENOMICS FOR ANIMAL HEALTH	Dr Jim Huggett and Dr Jason Sawyer
TURKEY: ONE OF THE LATEST COUNTRIES TO JOIN THE UK SIN NETWORK	Dr Başak Candemir
ROCKET SCIENCE: UK AND RUSSIA IN SPACE	Dr Julia Knights
GETTING MORE PEOPLE TO DO PHYSICS	Duncan Chamberlain

HSE eNews – Some Examples

++ **One in three basement projects fail safety check** ++
A day-long inspection initiative on 19 June saw a team of inspectors visit 59 construction sites across four London boroughs. Enforcement action was taken at 17 sites, with 20 Prohibition Notices served requiring dangerous practices to stop with immediate effect, and six Improvement Notices served requiring safety improvements to be made.
http://www.hse.gov.uk/press/2012/rnn-ldn-12212.htm

++ **Annual offshore injury figures continue improvement** ++
New statistics reveal that the number of offshore oil and gas leaks that could potentially lead to a major incident continues to fall. However, the HSE's head of offshore safety has warned industry not to be complacent as a result of the encouraging figures.

http://www.hse.gov.uk/press/2012/hse-offshorestats1112.htm
The offshore statistics bulletin is available at:
http://www.hse.gov.uk/offshore/statistics/stat1112.pdf

++ Consultation on changes to simplify RIDDOR launched ++
Changes proposed to Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995 will remove the duty to report in cases where the information is of little use or better collected through other means. The consultation is open from 2 August until 28 October 2012. The full document can be found at:
http://www.hse.gov.uk/consult/condocs/cd243.htm.

Calendar of Events

Please check the Events section of the Hazards Forum website for more information at **www.hazardsforum.org.uk** and to see any updates in the calendar. These may include additional events or perhaps amendments to the Events shown below.
Please note that attendance is by invitation.

Date	Event	Venue	Contact/further information
SEPTEMBER			
13	SaRS Event, Hf Supported: Reading the Tea Leaves – Performance Indicators and the Monitoring of Safety and Reliability	Friends House, Euston Road, London	info@sars.org.uk
25	>> Hazards Forum Evening Joint Event: Improving our understanding risk communication – Industrial perspectives (2nd of 3)	Institution of Mechanical Engineers, One Birdcage Walk, London, SW1H 9JJ	Tim at admin@hazardsforum.org.uk
25	Energy Institute Event, Hf Supported: Managing process safety hazards in the power utilities sector	Academy of Medical Sciences, 41 Portland Place, London, W1B 1QH	vnaidu@energyinst.org
OCTOBER			
2	IMechE event, Hf supported: Human factors in 3D – humans in engineering design	Institution of Mechanical Engineers, One Birdcage Walk, London, SW1H 9JJ	e_fox@imeche.org
3	IMechE event, Hf supported: Process Safety 2012 – Enhancing safety performance to prevent major accidents	Institution of Mechanical Engineers, One Birdcage Walk, London, SW1H 9JJ	t_khatun@imeche.org
NOVEMBER			
14	IMechE Event, Hf Supported: Reliability and asset management	Institution of Mechanical Engineers, One Birdcage Walk, London,	e_fox@imeche.org
28	>> Hazards Forum Evening Joint Event: Improving our understanding of risk communication (3rd of 3)	Institution of Chemical Engineers , One Portland Place, London , W1B 1PN	Tim at admin@hazardsforum.org.uk

The Hazards Forum's Mission is to contribute to government, industry, science, universities, NGOs and Individuals to find practical ways of approaching and resolving hazard and risk issues, in the interests of mutual understanding, public confidence and safety.

The forum was established in 1989 by four of the principal engineering institutions because of concern about the major disasters which had occurred about that time.

The Hazards Forum holds regular meetings on a wide range of subjects relating to hazards and safety, produces publications on such topics, and provides opportunities for interdisciplinary contacts and discussions.

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