Hazards forum

The Hazards Forum Newsletter

Issue No. 83
Summer 2014

Web version

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Views expressed are those of the authors, not necessarily of the Hazards Forum

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Hazards Forum Executive Secretary: *Brian Neale*

June 2014

Hazards Forum AGM 2014

Brian Neale and Neil Carhart

The Hazards Forum Annual General Meeting was held on Tuesday 18th of March at the Institution of Civil Engineers, One Great George Street, Westminster, London, SW1P 3AA. The meeting began at 16:30 and was chaired by the Hazards Forum Chairman, Rear Admiral (retd.) Paul Thomas CB FREng.

The Chairman welcomed all those in attendance, recognising the high turn-out at the AGM, and reported the apologies for absence received from those members who could not attend.

R/Adm Thomas highlighted the availability of the Annual Report of the Trustees 2013, along with the Notes of the previous year's AGM. Having established the approval and acceptance of the previous year's notes, the Chairman turned to the Annual Report of the Trustees 2013.

The Chairman reported on the changes to the Executive Committee for the coming year. He expressed the Hazards Forum's thanks to Andrew Petrie, in his absence, for his contributions as a trustee. Andrew stepped down from the Executive Committee during the year due to a work commitment in Australia. As there were three candidates for three vacant trustee positions, John Armstrong was endorsed as a new trustee of the Hazards Forum, with David Fargie and Brian Wimpenny being endorsed for their second three-year term as trustees. Dr Owen Keys-Evans was also welcomed as a new co-opted member of the Hazards Forum Executive Committee.

The Chairman highlighted the Hazards Forum's new website that had been commissioned during the year (launched in January 2014), its importance as a tool for communication and therefore its role in helping to fulfil the Forum's charitable aims. The Chairman thanked all those who have contributed to the development of the Hazards Forum's communication channels, including the Twitter feed which was introduced during the year in March. He paid particular tributes to the efforts of Brian Neale and John Armstrong in these matters.

The Chairman then turned to discuss the success of the year's evening events. He highlighted the high quality of the speakers and thanked those who had contributed to them and to their organisation, including those groups and organisations that had provided sponsorship including: the Institution of Civil Engineers, the Institution of Mechanical Engineers, E.ON UK, the Institution of Engineering and Technology, EDF Energy, RSSB, RISAS and RISQS. The first event, which had proved very popular, explored *Education, Social Media and the Internet: Inspiring Risk Understanding in the Y Generation*. This was followed by further successful events on *Risk Proportionality*, *The Crossrail Major Infrastructure Project* and the *Supply Chain Risk Challenge*.

R/Adm Thomas then discussed the Hazards Forum financial accounts. The Forum continues its policy of maintaining a reserve roughly equivalent to one year's turnover as insurance against a sudden loss of income. This is just about being achieved with a small deficit reported in the year due largely to a small decrease in membership. The Forum is continuing activities to attract new members, with a small number joining during the year.

The Chairman thanked the Executive Committee for their tireless efforts, the members of the Hazards Forum, the Institutions who established the Forum and the companies for their support without which the Forum could not continue.

On behalf of the forum he personally thanked Executive Secretary, Brian Neale, Tim Fuller the Secretariat Office Administrator and Janet Homer the Accounting Technician for their hard work and commitment over the previous year.

Following some contributions from the floor during the meeting, and as no other business had been raised, the Chairman once again thanked those in attendance, and highlighted that the next Annual General Meeting has been proposed for 24th March 2015 at the same location.

Executive Committee membership - updates

New Trustee

The Hazards Forum is pleased to welcome John Armstrong as a new Trustee to the Forum's Executive Committee from the AGM in March.

Mr John Armstrong, MEng CEng FIMechE MBA

John Armstrong has been a member of the Hazards Forum executive committee since March 2013 when he joined as a co-opted member. He is a Chartered Engineer and a Fellow of the IMechE. He is a member of the Energy Institute Power Utility Committee, IMechE Process Board and Oil, Gas & Chemicals committee. More recently John has graduated with an MBA at Warwick Business School.

He has worked as an engineer across the energy sector initially working in plant design for onshore oil and gas facilities and then moving into broader engineering roles in the utility sector including Head of Safety for E.ON in the UK a role which included leading the implementation of a process safety framework across the E.ON group as well as investigating incidents globally. John is currently head of operations for E.ON's Community Energy district heating and chill business with sites nationally. Community Energy is one of the fastest growing company in the E.ON group.

John is passionate about engineering safety and making the link between excellent safety and commercial performance.

When not working John enjoys the great outdoors and spending time with his young and energetic family.

New Co-opted member

The Hazards Forum is pleased to welcome Dr Owen Keyes-Evans to the Forum's Executive Committee as a new Co-opted member as from November 2013.

Dr Owen Keyes-Evans MA MFPHM MFOM FRSA

Dr Keyes-Evans has 27 years' experience in the field of health, both in the public and private sectors. This is not only as a practicing doctor but also in policy and research, and he has become a registered specialist in public health medicine as well as occupational medicine.

He is currently consultant for a London-based company which provides a range of occupational health-related services.

In recent years he has been contributing to the Health & Safety policy advisory group at the IET, and he now joins us as a co-opted member of the Executive Committee.

Institution of Engineering and Technology - Health and Safety Risk Management

Graham Barber, Health and Safety Policy Panel Secretary
Institution of Engineering and Technology

The Institution of Engineering and Technology (the IET) is a membership organisation licensed by the Engineering Council to grant Engineering Technician, Incorporated Engineer, and Chartered Engineer status to suitably qualified persons who meet the requirements of the UK-Spec: http://www.engc.org.uk/ukspec.aspx . This includes meeting the risk assessment and competency requirements in clauses E2 and E3. Further, the IET accredits engineering courses at UK Higher Education establishments which accord with the risk teaching and examination requirements specified in the Engineering Council's "Accreditation of Higher Education Programmes": http://www.engc.org.uk/education--skills/accreditation/accreditation-and-approval

For 20 years the IET gave leadership to the Inter-Institutional Group on Health and Safety (IIG), a cross-disciplinary body with representation from professional engineering institutions and professional health and safety institutions. The IIG work majors on risk assessment and competency, for example, its 2013 papers on 'Risk Communication', 'The Business Case for Health and Safety', and 'Life-long Learning' : http://www.theiet.org/policy/collaboration/iig/index.cfm

The IET produces over sixty guides for its members, which are publicly available for free download, on 'risk' related health and safety topics through publishing its Health and Safety Briefings: http://www.theiet.org/factfiles/health/index.cfm . Similarly it produces guidance for companies on managing safety competences: http://www.theiet.org/factfiles/msc/index.cfm . This work is often augmented through IET Local Network/Community events and seminars, for example, the Safety Critical Systems Course, a demand-dependent summer school run most years: http://mycommunity.theiet.org/communities/events/item/47/79/93 .

The IET guidance on safe electrical wiring to accord with BS 7671 is nationally, and in many cases internationally, adopted. The "Requirements for Electrical Installations" is now in its 17th edition, with associated application guides, and recommended electrician training courses: http://electrical.theiet.org/wiring-regulations/ . This expertise and leadership has been extended with the publication of a code of practice for Electrical Safety Management: http://www.theiet.org/resources/standards/esm-cop.cfm . Other similar standards to mitigate risk have been developed, or are planned: http://www.theiet.org/resources/standards/ .

The IET has, for example, taken a pioneering leadership role in developing guidance for the design of products and systems which have to be functionally safe to be immune to electromagnetic interference, throughout their operational life: http://www.theiet.org/factfiles/emc/index.cfm .

The IET developed, with the HSE, a competency management framework for safety related systems: http://www.theiet.org/factfiles/msc/index.cfm, along with detailed guidance on the competency criteria for engineers working in this area: http://www.theiet.org/resources/books/policy/comp-crit.cfm .

The IET through its professional volunteer committees, such as the Health and Safety Policy Panel, and the Safety Community, contribute knowledge and good practice to professional risk related initiatives. The IET Local Networks arrange seminars which sustain member continuous professional development some of which raises awareness that helps the member manage risk in their work.

Returning to Normal Service – Challenges of Resuming Normal Operations Following Disaster

Neil Carhart

On **Tuesday 18th March 2014** the Hazards Forum hosted an **evening event** at the Institution of Civil Engineers, 1 Great George Street, Westminster, London.

Part of the Hazards Forum's mission is to promote the public understanding of risk and to provide a forum for high level debate. This event involved the discussion of case studies from the rail, aviation and energy industries to highlight challenges from both an industry and regulatory perspective in returning to service post incident.

The event began with a few brief words from **Hazards Forum Chairman** Rear Admiral (retd) **Paul Thomas CB**. He welcomed the audience and thanked the Institution of Civil Engineers (ICE) for hosting the event, together with co-sponsors, the Safety and Reliability Society, before introducing the Chair for the event, **Jane Willis**.

Jane, who has worked in HSE for much of her career gaining experience in policy, corporate and strategic roles, has most recently been involved leading the response to Professor Ragnar Löfstedt's Review of Health and Safety Legislation and HSE's work on the Red Tape Challenge. She is HSE's Better Regulation Champion, a member of the Cross-Government Health Work and Wellbeing Executive, and part of HSE's corporate leadership Senior Management Team.

The first speaker of the evening, **Ian Prosser**, HM Chief Inspector of Railways, has worked in safety critical industries for more than 30 years: originally in the chemical pharmaceutical and automotive industries, primarily with ICI plc, but also with Laporte. Seven of those years were spent in North America. The roles performed spanned a wide spectrum from works/production management to project and technology management. Ian has spent the last eight years in the Rail Industry, initially with Amey Rail followed by Metronet Rail and now as HM Chief Inspector of Railways. His talk described how the response from both the regulator and regulated can have a material effect on public perception, highlighting lessons learned from events in the rail industry.

The second speaker was **Dr.Guy Gratton**, head of FAAM, Europe's largest and most capable facility for airborne scientific measurements, which since 2004 has centred on the BAe-146-301 Atmospheric Research Aircraft. Dr Gratton described how FAAM has successfully responded to three major national emergencies: Buncefield, Eyjafjallajökull, and finally the Elgin gas leak. He also described FAAM's learning process through these, all of which were successfully met, but which went from handling the completely unexpected with Buncefield, to a very smooth "business as usual" management with Elgin.

The evening's final speaker was **Martin Carter**, E.ON UK's Director of HSE. Martin has over 20 years' experience of risk and integrity management in high hazard industries. Prior to joining E.ON he held a range of operational, project and consultancy roles with some of the world's biggest companies including BHP Billiton, BP, Centrica, Shell, Total and Talisman Energy. He is also a Visiting Fellow of Cranfield University where he lectures on risk management. In his talk he presented an industry perspective on returning to service post-disasters, looking at what companies and industries can learn from each other.

Ian Prosser, HM Chief Inspector of Railways, set the scene for the first talk of the evening by explaining how it would be based on his personal experiences and observations from his time in the railway industry. He drew on the things he felt when he first joined, and the journey he has observed the industry go through subsequently. Using two real examples, Ladbroke Grove and Hatfield rail crashes, he looked at the immediate and medium-term recovery, and asked whether the long-term lessons were really learnt and addressed by the industry. In addition to this he also set out to look at the current approach to level crossings which raises some very interesting issues regarding the societal perception of risk. He concluded by demonstrating how the regulatory regime works effectively today.

He began by discussing his observations on the railway industry when he first joined in 2000. This was after the Ladbroke Grove rail crash in October 1999, and during the public inquiry led by Lord Cullen. The industry at the time was facing a situation with an increasing number of degraded rails and signals which had experienced multiple "Signal Passed at Danger" (SPAD) events. Ian expressed a personal view that at this time the regulator was not doing all it could to address the increasing risk. The result was an industry in a bad place as evidenced by the three public inquiries conducted around this time. The reaction from the regulator and the regulated groups following the Hatfield incident could be interpreted as an industry in meltdown. There appeared to be a lack of understanding of risk management. People were increasingly travelling by road as a result.

Within the regulator the focus on Safety Culture was very much standards based and dealing with the status quo. The fragmentation of the railway had also impacted "system" safety management through the interfaces leading to ineffective regulation at the whole-industry level. The result from the public inquiries was quite dramatic. The industry had been discussing Train Protection systems for years, but nothing ever really happened. The discussions focused on why not to do it rather than the reasons to do it. However, regulations to ensure Train Protection on a risk basis turned out to be reasonably practicable. Many of the decisions were forced through by the public and politicians deciding that an unacceptable level of risk of human failure existed. Improvements were then forced through by regulation. The Rail Accident Investigation Branch (RAIB) was created a few years after this following a recommendation by Lord Cullen. The Rail Safety and Standards Board (RSSB) was also created as a very positive step, supporting system safety issues and working towards coordination in the otherwise fragmented system. This also led to the development of some very sophisticated system risk models. The inquiries also identified several important cultural issues. However, there were issues again in Network Rail in 2010 with regard to the non-reporting of incidents. So had the lessons really been learnt? All the immediate reactions seemed to lead to a focus on fixing the direct causes, such as broken rails.

When the incident at Hatfield happened, Ian had only been in the role for 6 months. He observed the immediate reactions by the industry to this event. The immediate reactions increased risk to road users, rail-workers and operations on the network (i.e. the system risk). The focus on the rolling contact fatigue issues with the rails led to blanket speed restrictions which caused a change in the risk profile. The blanket speed restrictions did not seem to be supported by a risk based decision making process. The rigid prescription of new standards actually increased the risk. There was no appropriate response to this from the regulator who found themselves undertaking a lot of the work testing rails. This led to the public feeling that the industry was broken, perhaps even more so than following the Ladbroke Grove incident.

One lesson from this is the potential danger of not understanding the total risk, the underlying risks, and not dealing with the individual, collective and societal risks. There was no proactive enforcement on

broken rails, although it was being discussed by the regulators. It could be described as an ad hoc managed business; this allowed the failures to develop over a number of years. The regulator's reputation was damaged. A very important lesson was the need to stand back and be evidence and system risk based in proportion to the overall societal risk. The regulator needs to show leadership in this area.

Following these events broken rail risk decreased quickly and dramatically as new rules and technologies were introduced. But this did not prevent the incidents at Potters Bar in 2002 and Grayrigg in 2007. Was the industry really learning all the lessons it could? Was it managing all the risks appropriately? The learning had not been translated to deal with risks around other parts of the system. There was lots of action, lots of 'doing' to fix obvious errors, but little reflection on the maturity and culture of the organisation being in the right place to prevent the incidents.

There have been many incidents around level crossings leading to several prosecutions over the last few years. In 2008 Ian found many issues outstanding with regards to level crossings. There were poor risk assessments and a lack of quality data with which to make judgements. There was still a focus on compliance with standards. There was a fragmented sense of responsibility and the status quo was often accepted over the need for continuous improvement. The public distrusted how the industry was managing the risks associated with level crossings.

The regulator had to change its approach to level crossings. This led to proactive inspection and enforcement, designed to shift the culture in the duty holder from standards based to risk based. There has been a shift towards better risk assessments and ownership within Network Rail to achieve risk reduction through innovation. In many cases this can involve working with local communities to understand the real risks of level crossings so that all decisions are proportionate. Many communities feel the risks are tolerable and it is their choice to use it. It can greatly affect their mobility and even local economies if those crossings are closed. It is very important from a regulator's point of view to engage in these discussions. The actions taken have resulted in a more than 25% reduction in risk at level crossings over the last 5 years.

The challenge ahead is to take the collective estate of level crossings to a position better than reasonably practicable. The amount being spent will eliminate 2 or 3 fatalities a year, and that is very important. What is the best solution to risk reduction though in terms of individual, collective and societal risk? If there is a fatality at a level crossing a system has to be in place to make sure that the reaction does not increase the overall risk in the area. The Transport Select Committee advocated an aim for zero accidental fatalities. This has to be balanced with local communities who want to keep level crossings operational, believe a level of risk is tolerable, and are wary of what could be perceived as a 'nanny state'.

Ian concluded that at a fundamental level it is necessary to ensure that the management maturity is improving so that all areas of risk can be appropriately tackled. This includes asset management and information management, and all other fundamental aspects of running a good business. This means addressing the underlying causes and not just leaping from one crisis to another, fixing the surface level failures.

The second talk of the evening, titled "Responding to Disasters: FAAM at Buncefield, Eyjafjallajökull and Elgin", was given by **Guy Gratton**, head of the Facility for Airborne Atmospheric Measurement (FAAM) based at Cranfield University Campus. He began by describing FAAM and its role. FAAM is a joint facility of the Natural Environment Research Council (NERC), the UK's main funder of natural sciences research, and the Met Office. FAAM is managed through the National centre for Atmospheric Sciences (NCAS). He explained how his role involves the BAe-146-301 Atmospheric Research Aircraft (ARA). This is a very large research

aircraft which typically takes off weighing about 42.5 tonnes, of which about 4 tonnes is instrumentation. It flies with a crew of up to 22, of which 15 or 16 are potentially scientists. It is very busy, flying about 420 hours a year. For comparison, the busiest research aircraft NASA has flies about 250 hours per year. By virtue of being the big national research aircraft for the UK, with many groups feeding in and supporting it, it is the most capable research aircraft in Europe, and is certainly of world class. He stressed that this is a research facility, it is not set up to serve emergencies and doing so is not the job of the aircraft. However, emergencies happen in the atmosphere, and three times in the nine years the facility has existed, it has been asked to support the national response to an emergency. Guy explained how over the course of his talk he would describe the process of learning FAAM went through from the first instance of emergency response when they weren't thinking in terms of supporting emergencies, to the last event where it had almost become business as usual.

Figure 1, BAe-146-301 Atmospheric Research Aircraft

The three incidents were the Buncefield oil storage terminal explosion in December 2005, the largest peace time explosion and fire in European history. The explosions affected 20 large storage tanks and were measured by the British Geological Survey to result in an event measuring 2.4 on the Richter scale. There was a complex mix of burning products and wind conditions taking the smoke plume over parts of London. The obvious question was how bad this was for public health. To find out required identifying the nature of the plume. The second event was the Eyjafjallajökull volcanic ash contamination of European airspace in March – June 2010. This particular eruption was unusual for three reasons: (1) it was a continuous eruption over a relatively large period of time; (2) it was erupting through a glacier causing it to mix through water and create a complex chemical mix, and; (3) there was a large blocking high-pressure zone over the Iberian peninsula that was trapping the emitted aerosol over northern Europe. The third event was the Elgin oil platform leak in March 2012. This emitted what was initially thought to be around 200,000m^3/day of methane, closing two platforms and costing a large amount in oil and tax revenues. Again there was a need to assess the danger of the situation and establish what needed to be done to reopen the facilities.

At the time of the Buncefield explosion FAAM was a new facility, having been located at Cranfield for about a year. When the event occurred the government sent FAAM a request to sample the plume and measure what was present within it. FAAM first had to assess whether it was possible to do the job with the equipment they had (plane, crew, instrumentation etc.). Having decided it was technically possible they acknowledged that there was no procedure in existence for performing such a task. They had never envisaged themselves as an emergency facility, had no activation process, and no airspace access. The airspace over London is very complex. There are large airports all around with airliners going in and out of them all the time and over the top of London. Suddenly cutting into that airspace and flying the FAAM aircraft on its own flight-plan that didn't involve any of the London airports is not easy. It is not a situation that had been encountered before.

Ministerial intervention assisted in unpacking the complexity at a political level within the Cabinet Office. Airspace co-ordination and emergency activation procedures were put in place allowing the aircraft to get access to the plume and samples to be taken. The samples were split into two, half going to the university and half going to the Defence Science and Technology Laboratory where it was possibly to quickly analyse the content of the plume and asses the risk to public health. Thankfully this risk was low, but it was only by undertaking this exercise that this conclusion could be reached.

Figure 2, Buncefield from the FAAM Aircraft

Guy then went on to summarise and share the lessons learnt following the Buncefield event. Airspace co-ordination needed to be in place to cope with such events, so permanent procedures were introduced with the Civil Aviation Authority/Directorate of Airspace Policy. Activation procedures also needed to be in place in case the FAAM aircraft needed to be used in a similar way in the future. These were established via the Met Office which at the time was an MoD agency. The Met Office is involved in a whole range of potential national disasters, so they already had a lot of the infrastructure in place to do this. The other big lesson involved media communications. Buncefield was a significant event, and as such received a great deal of media coverage. It was necessary to explain to the nation what was happening with regards to the smoke plume, and what was being done about it. New procedures were put in place to address this. FAAM employed active use of both the Met Office and NERC PR departments. The public has every right to know what is going on, and for this they need to hear about it from somebody who knows what they are talking about. That is not the PR department or the organisation's directors, but the specialists dealing with the problem. Those experts have to have adequate media training to be able to engage and serve both their organisation and the public.

The Eyjafjallajökull eruption created a different situation from which further learning can be extracted. FAAM's ability to assist in dealing with this event was initially affected as the incident happened to occur at the same time as the FAAM aircraft had been stripped of its instrumentation for refurbishment. The United Kingdom was two weeks away from a General Election, meaning political leadership was also somewhat affected.

When the volcano erupted and the ash cloud was emitted, public airspace across much of Europe was closed. Despite the lack of direction from a shut-down government, the senior management teams within the relevant agencies (FAAM, NCAS, Met Office, university scientists etc.) were all in constant discussions with each other. It was assumed that when it was considered by government they would request action. The group proceeded under this assumption using emergency procedures that were now in place. Initially the Airborne Research and Surveying Facility (ARSF) Do-228 research aircraft, based at Gloucestershire airport was used. A composite solution was devised between FAAM and the ARSF. The objective was to measure the ash cloud. Britain was 4 days faster than any other country in Europe to get an observational platform airborne.

Figure 3, ARSF's Do-228 "Science 1"

Then things started to go wrong. Various partners in the arrangement disagreed over the type of support they should be providing. Because there was no central government request, central government felt it should not be paying for the observations. The actions caused significant disruption to the planned science programmes at FAAM. Yet again, there were lessons to be learnt.

Firstly, when offering a solution to government it is important to make sure it is clear how this response is going to be funded. This includes the cost of all disruptions to planned work, not just the direct activities. This makes it essential to

obtain appropriate authorisation. As a result of this lesson the authorisation procedures were changed. In this particular case the money was eventually recovered.

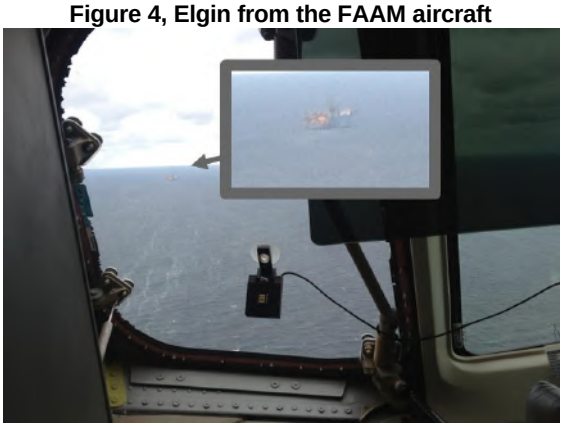
Secondly, the operation should be adaptable where necessary. Procedures are useful, but the nature of an emergency is such that it probably will not be quite as envisaged and changes may be required. In this instance the procedures related to the initially unavailable BAe-146 aircraft were adapted to the Do-228. There are a lot of communication procedures concerned with communications post-accident, these were used as the basis for communications about the activities relating to the volcano. Relationships were also adapted. The Civil Aviation Authority (CAA) is a regulator which oversees FAAM's work, but suddenly this event meant the CAA became a customer. Volcanologists who had been discussing the possibility of using FAAM's facilities suddenly became FAAM's suppliers. In both cases the existing relationships were useful and could be adapted.

Possibly the most contentious lesson was to not be secret, even if it is tempting to do so. There are potentially 100s of people who can help you solve the problem, but they can only do that if they know how you are planning and how you are dealing with issues. If you make a habit of keeping your plans and data closed then they cannot help you.

The final incident concerned the Elgin oil platform, approximately 240km east of Aberdeen. On the 25th of March 2012 the platform experienced a gas leak resulting in the release of large amounts of methane. The platform was evacuated along with another platform nearby. This shut down a lot of the nation's revenue generating oil supply. FAAM became aware of the incident through the news media and recognised that there was potential for them to be of service to the recovery. The aircraft and its crew were available, as was the instrumentation as coincidentally they had just returned from a mission in the arctic measuring methane emissions. Taking the lessons from the volcano they put a plan together and worked out how much this would cost, including the disruption to FAAM's programme of work. This was taken to two bodies: the Cabinet Office, who co-ordinated multi-ministry issues in government, and Total who own the platform.

While these organisations were considering their responses, FAAM went to measure the emissions anyway having realised the scientific benefits of doing so. They used their science flying budget to take an initial look and shared these results. The Cabinet Office decided it was an industry problem, whilst Total became very enthusiastic for the potential benefits. They began to ask what could be done, what data could be obtained and over what time scales. Having agreed a price, further flights were commissioned and the data packages delivered to Total. Total paid for the whole mission, including the initial exploratory flights. This information helped them to be able to recover and reopen the platforms more rapidly than they would have otherwise been able to.

Figure 4, Elgin from the FAAM aircraft



Guy concluded his talk by highlighting that having learnt the lessons of the previous two emergency response missions, FAAM was able to successfully assist in the recovery of the Elgin platform to the significant benefit of all stakeholders.

The final talk of the evening was given by **Martin Carter**, Director of Safety, Health and Environment at E.ON UK and Visiting Fellow at Cranfield University. He began by reading two quotes. A Chinese proverb states that 'wise men learn from other men's mistakes, fools by their own' while Aldous Huxley said: "That men do not learn

very much from the lessons of history is the most important of all the lessons of history". History has given us plenty of opportunities to learn, including the Flixborough disaster, Challenger, Piper Alpha, Texas City oil refinery, Ladbroke Grove rail accident, Columbia, Buncefield and Deep Water Horizon. This raises the key question: what can we learn from these and, regrettably, where and when will the next one occur, because there is nothing to suggest it won't.

Martin explained his starting premises that every major disaster has been a foreseeable failure of risk management. He described how all risks could be placed into one of four categories based on the type of outcome and the shape of the probability curve associated with that outcome. Outcomes can be simple or complex; probabilities can be normal distributions (uncertainty driven) or indeterminate or 'fat tail' distributions (event driven risk).

		Outcome	
		Simple	Complex
Probability	Normal Distribution	**Q1**	**Q3**
	Indeterminate or 'fat tail' distribution	**Q2**	**Q4**

An event with a simple outcome and a normally distributed probability, such as tossing a coin, are predictable and can be expected to outturn in a fairly predictable manner. These can be described as a Q1 risk. The second type, Q2, again involve simple outcomes, but the probability distribution is skewed one way or the other (a 'fat-tail' distribution). This makes it very difficult to predict when the simple outcome will occur Martin suggested coconuts falling from trees as an example of this type. If one were to fall on someone's head it could kill them, but it is very hard to predict when they might fall.

Unlike Q1 and Q2 risks which have simple outcomes, Q3 type risks have multiple complex outcomes. These are typically found in complex systems with a high degree of interdependency between components. But whilst the overall system is complex, the behaviour of the components and their interactions are well known and governed by physical laws and normal probability distributions. Thus monitoring the variables can be used to make judgements about the condition of the whole system.

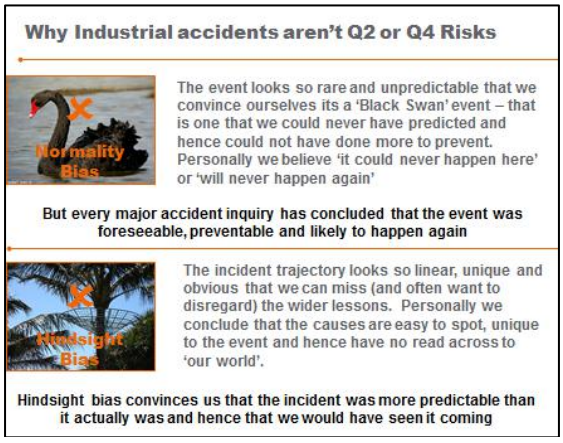
Q4 type risks are a step on from Q3 risks, occurring in complex systems with huge and complex interconnectedness with infrequent but potentially catastrophic events that are almost impossible to predict or pre-empt. Recently these have come to be known as Black Swans, taken from the title of Nassim Nicholas Taleb's book. The term originates from the time when people in England believed all swans were white, because they had only ever seen white swans. . It was only when explorers travelled to Australia and they discovered black swans that this was proven to be incorrect. In retrospect, the belief that Black swans could not exist was nonsensical, since there was nothing in nature to prevent them. The term is use, therefore to point towards our blindness and disregard of things simply because they lie outside our personal experience.

Martin asked the audience which quadrant they felt most major industrial accidents could be characterised as, before arguing that he believed them to be Q3-type risks. We manage very complex systems, but these are underpinned by a good understanding of the engineering processes. It can be argued that this is even the case in terms of behavioural safety.

However, when it comes to incident and accident investigation, Normality bias can leads us to perceive some events as Q4-type risks. This is particularly prevalent within the organisation which experienced the event where there is often a tendency to argue that nobody could have foreseen that the event could have happened. This is, however, invariably Black Swan thinking; no-one conceived it could happen simply because it had never happened in the past. In reality there were plenty of signs within a 'Q3' type risk monitoring system to point towards a potential problem

emerging. These signs are often missed or ignored however because we are stuck in Black Swan thinking – i.e. we've never seen it happen before so it's inconceivable that it can happen in the future.

Yet no inquiry into an industrial accident has ever identified it as a 'Black Swan' event. Every inquiry has concluded that the accident was foreseeable and hence preventable. The problem is that because the event has not happened in the past, our risk management models based on historic data do not predict it happening in the future.



Another common trap is to categorise accidents as Q2-type risks. This is invariably due to hindsight bias. Post event analysis by its nature tends to highlight the specific and unique chain of events that caused the undesirable event and focuses the investigation around that. In this way, practically every event is reduced to a single chain of connected prior events often using the 'Swiss Cheese' model. .

The Swiss Cheese model is great at isolating and illustrating the events trajectory. However, in doing so it ignores all other factors that worked, were a distraction or may have distorted the message in real time. Hence the clarity of the Swiss Cheese model convinces us that the incident was a Q2 'event waiting to happen'. We therefore conclude that the causes were obvious, easy to spot and unique to that event. We in turn conclude that if it happened in 'our' business or on 'our' watch we would have seen the signs and taken action to prevent the event and hence the findings have no read across into our own industries or organisations.

Martin went on to argue that, whilst investigation reports generally highlight failure in policy, capability, management, execution and judgement, most major accidents are actually caused by failures in memory (people forgetting how things were supposed to work) and imagination (people forgetting to be afraid), driven by normality and hindsight bias as described above It is for these reasons that it is hard to learn from disasters.

Martin went on to further explain his premise that disasters are driven by failures of memory and imagination. We know that risk is the product of likelihood and consequence. For any operational risk we generally have three options: eliminate it, treat it or tolerate it. If we consider the risk to be intolerable and we can't eliminate it we have to treat (i.e. reduce it). We reduce the consequences by enhancing or adding in more mitigation and reduce the likelihood by enhancing or putting in more preventative barriers. We continue to add more barriers and mitigations until the residual risk is considered tolerable i.e. as low as reasonably practicable (ALARP). Martin stressed that this is Risk Assessment not Risk Management. Yet all too often we see this as the end point of risk management. In reality it is the start of the process. Risk Management is not about demonstrating that the risk **<u>can</u>** be reduced to ALARP, but the discipline of ensuring that the actions being taken in real time ensure that it ***is currently*** ALARP. Risk Management is a verb; it is a continuous process and not a one off activity. We need to focus on the current condition of all the barriers and mitigations we identified as being critical in ensuring that the risk remains tolerable. A lack of appreciation of the condition of the barriers and mitigations, and/or a general acceptance of their downgraded condition is at the heart of every major industrial accident. Active and effective risk management involves asking 'how is it supposed to work?' (memory) and 'what is the worst that could happen?' (imagination). The failure to ask

these questions is the major lesson we can learn from every major industrial accident.

Martin illustrated this using four case studies. The first was an incident on Mumbai High North Platform in the Indian Ocean. The event occurred on the 27th July 2005 after a cook on board a support vessel cut off the tips of two of his fingers. It was decided to transfer the cook to the main platform complex for medical attention. Monsoon conditions in the area meant helicopters were unable to fly and so it was decided to transport the cook by basket transfer. Ordinarily the vessel would approach the platform on the leeward side, with the platform providing some shelter from the winds and ensuring that any failure in the vessel propulsion system or extreme wave or wind event would mean the vessel would be carried away not towards the platform.

However, the leeward side crane wasn't working so it was decided to approach on windward side. As the vessel's dynamic positioning system was not working, the ship's captain decided to take the vessel in under manual control. As they approached the platform a strong swell caused the helideck on the back of the support vessel to strike a gas riser on the platform. This riser had previously been identified as being at risk from ship impact but the protection works were not designed for impact from a vessel that size. The gas ball ignited other risers which did not have fire-protection on them, resulting in the complete loss of the rig, and 22 lives. Martin argued that whilst it might be impossible to predict this specific chain of events in advance, a broader perspective by someone in authority of the chain of events as they unfolded could have imagined the possible outcome and intervened appropriately. Furthermore, there was, for instance, a failure of imagination by the designers of the riser upgrade works and those who allowed the leeward crane to fall into disrepair as well as a failure of memory by those in command on the platform and vessel to recall why certain protocols were in place.

The second case study involved Congonhas Airport in San Paulo Brazil. The airport is located in a highly congested area and has a notoriously short runway that was particularly slippery when wet. About two months prior to the event in question the airport had actually been closed to large jets as they were having difficulty stopping, particularly when it was raining. The authorities appealed on economic grounds (Congonhas airport is the second biggest in Brazil) and it was reopened on the condition that the runway would be resurfaced. By July 2007 the main runway had been resurfaced but the rainwater drainage grooves had not been completed. On the 16th of July 2007 two small planes ran off the runway. On the 17th of July a TAM Airlines airbus left another airport in Brazil with one of its reverse thrusters non-operational. This was allowable under aviation rules. Operational reverse thrusters were not mandatory. Procedures were in place for safely landing with one operational reverse thruster. Two minutes before the aircraft was due to land at Congonhas the pilot asked the co-pilot to check ahead for the landing conditions. They were informed that the conditions were wet and slippery. The pilot therefore decided to take manual control of the landing to allow him to land as close to the leading edge of the runway as possible so as to maximise the stopping distance. He also decided to use an old landing procedure for when one of the reverse thrusters isn't working. The old procedure advises to take both engines to idle and reverse the thruster in the one that is working, leaving the other engine in idle. The procedure was changed following a number of cases of pilots inadvertently leaving some power in the engine where the reverse thruster wasn't working, hence increasing the stopping distance since the plane continues to receive forward motive power. The new procedure instructs pilots to take both engines to idle, and then to reverse both as they would if both reverse thrusters were operating. The on-board system works out that one thruster isn't working and reacts accordingly. However, the new procedure, whilst reducing the risk of error, increased the overall stopping distance by about 55 meters. For this reason, thinking that he needed all the distance he could get, the pilot went

against aviation rules and used the old procedures. In doing this he implemented the same mistake that many others had done before, and left some power on the engine with no reverse thruster. This meant that the aircraft continued to skid forwards, exacerbated by the slippery conditions and off the runway. It crashed into a warehouse killing all 181 passengers and crew plus 12 people on the ground.

The case shows how application of imagination ('it is raining at Congonhas, the runway is slippery, I therefore need to maximise my stopping distance for the safety of everyone on board') can lead to decisions being taken which, due to a failure of memory (remembering that the new procedure increased the stopping distance, therefore deciding to use the old one but forgetting why it was changed and making the very mistake it was designed to avoid) led, rather than prevent disaster.

The third case study was the Piper Alpha explosion in 1988. There are many learnings associated with this tragic event, but Martin explained he just wanted to focus on one finding which at first glance may appear insignificant. One of the key pre-cursors to the incident was the fact that work permits were being signed off 'blind' i.e. without proper discussion, review or work place inspection. One item on the permit check asked whether the worksite was left clean and tidy. This was routinely ticked off on permits, and yet the cleanliness and housekeeping standards on the platform were reported to be very poor. Anyone – but most likely someone in a position of authority charged with taking a broader perspective - with a mind-set of memory (i.e. remembering that tidiness was considered to be so important that it was included in the permit) would question this disparity behind the permits and the tidiness. The usual course of action would be to ask 'why so' and instigate a programme to ensure work places are kept tidy. An 'imagination' mind-set, however, would ask the more powerful 'so what' question i.e. so what else is being ignored? Imagination is required to look beyond the immediate problem.

The final case study involves the USS Carl Vinson. A crew member working on deck lost a spanner and reported it to his superior who in turn reported it up the chain of command. Rather than assume that the spanner would cause no harm or damage, the senior leaders decided instead to close the flight deck until the spanner was found. This required all airborne planes to be redirected to land elsewhere and left the fleet without air cover. The next day the crew member was given a commendation in front of the rest of the crew. This demonstrates positive activation of memory and imagination; the crew member remembered that there should be no loose objects on the flight deck and imagined the consequences should his spanner be left there. The leadership imagined the consequences both of ignoring the danger of the lost spanner but, more importantly, imagined the impact that punishing rather than commending the crewman would have on the willingness of the rest of the crew to report future lost objects and the potential catastrophic impact that this could have.

Martin summed up his talk by stating that most operational disasters are caused not by technological failures, but by human nature. But this does not make events 'Black Swans', since the failures are generally imaginable and predictable. This does not however mean they are easy to predict. Mindfulness towards the condition of barriers designed to prevent failure, coupled with active and on-going application of memory and imagination are essential and need to be hardwired into policy, procedures and management systems. However, the drive for efficiency and demand for greater returns means that there is an ever greater tendency to push the envelope, creating evermore complex and highly interconnected systems overseen by fewer competent people. Unless properly controlled – by the use of memory and imagination – there is a danger of breeding Black Swans simply because systems become so complex, interconnected and automated that objectivity and hence the ability to make effective interventions is lost. If not properly and objectively managed the drive

for efficiency and/or profitability can override sound technical judgement and clear warning signs are missed when faith in our own abilities overrides memory and imagination. Sound risk management is key, focused on building and maintaining resilient systems: those with sufficient redundancy, resources, reliability, robustness and responsiveness, underpinned by a culture of chronic unease.

When recovering from disasters within your own organisation Martin suggested that, regardless of how it looks, it probably wasn't a Black Swan, but it probably wasn't obvious either. Do not fixate on the specific trajectory of the failure but do fixate on the habits underlying them. The key questions to ask are what has changed and why is it safe now? When reacting to a disaster occurring elsewhere the key thing to remember is it probably wasn't a Black Swan but it wasn't a Q2 risk either, despite what the Swiss Cheese Model may suggest. Don't hide behind culture and assume the same underlying reasons couldn't happen within your own organisation. Remember, everyone there was probably doing a good job too. Assume it could happen within your organisation, and if you don't think it could, be very clear about why not, and make sure that doesn't change over time.

Jane Willis thanked the speakers and opened the floor to the audience for debate. The first question asked whether repeated risk assessment in high hazard industries had left us somewhat comfortably numb, and whether too much effort was spent on upfront assessment at the expense of emergency response capability. Martin Carter responded by describing how many organisations have questioned how they bring their safety case and other documents alive to prevent them from becoming static documents just sitting on a shelf. While we don't necessarily need to do less up front, we need to recognise that risk management is a continuous process which involves many activities. Guy Gratton added that anybody who is in the job of responding to emergencies has to have a degree of flexibility. Following the event at Buncefield, FAAM modified their procedures, but the next event was not the same as Buncefield and they had to be able to adapt them to the specific conditions of the new event. Pilots spend a significant proportion of their time practising emergency scenarios, but they have to be able to adapt to deal with scenarios they may not have prepared for. Whatever the next event is, it probably won't be the same as the things you have trained for. This is because the training will be based on the same thinking and historic data as the risk assessments which will have taken other actions to reduce the risk of those events occurring. One way to partially address this is to ensure that the training standards do not just train people to deal with historic risks, but also promote safe flexibility within people. This can be very hard to do in practice. Teamwork is very important, as is the ability to question each other even in the face of perceived experience and seniority. This is something that is relevant in all safety critical industries. Ian Prosser added that there needs to be a form of tension in an organisation that causes it to continually challenge its actions and safety, and not just accept the status quo.

Further discussions from the audience drew on the case studies highlighted by Martin Carter, particularly in reference to the ways in which an emergency response can make the situation considerably worse. How can we make sure this does not happen? The speculative nature of 24hour media coverage was also raised as a particular challenge during the process of recovering from an event. There is perhaps a missed opportunity in the use of social media. Previous campaigns highlighting reckless behaviour at level crossings for example have been received well by the public who recognise foolish behaviour and are sympathetic to the safety implications they are reminded of. It was felt that these two points were related. Ian reiterated the importance of being open, clear and concise in making relevant information available to the public as quickly as possible. It is important to make sure the picture is clear before the situation becomes confused by speculation. Facilities such as Twitter can be used in a

positive way, and not just in emergency response, but in reporting of incidents and keeping the public informed. Guy added that the recovery process can be damaged as a result of inappropriate conjecture in the media. The intelligence of the public should not be underestimated. The best solution is to have knowledgeable people explaining the situation in an unpatronising manner, through whatever media outlets are available to them. Martin suggested that there is a tendency to want to take visible actions as soon as possible following an event, and sometimes this is not the best thing to do. Response, even to a very specific event like a cook's cut fingers, requires someone to maintain a view of the bigger picture. This is in order to ensure that the response does not increase the risk elsewhere or to the whole system. The modern media changes the pace at which a response is expected, organisations need to be ahead of this and make sure there is not an information vacuum.

The evening's chair drew the proceedings to a close by thanking the speakers on behalf of the Hazards Forum and audience for their informative talks, before inviting all those present to continue discussions over refreshments.

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 to Hf events is by invitation.

Date	Event	Venue	Contact/further information
June			
17th	Hf Event: Reducing risk through sharing experience – why wouldn't you?	Institution of Civil Engineers, One Great George Street, London SW1P 3AA	admin@hazardsforum.org.uk
23rd	IChemE Event, Hf Supported: Process Safety in the Water Industry	IChemE, One Portland Place, London, W1B 1PN	conferences@icheme.org
July			
1st	ICE Event: ICE Rail 2014 – Engineering an Integrated Network	Institution of Civil Engineers, One Great George Street, London SW1P 3AA	http://www.ice-conferences.com/ice-rail-2014/about/
September			
10th	IChemE Event: Human Factors in Health and Safety, Module 4	Edinburgh, UK	courses@icheme.org
16th	IChemE Event: Layer of Protection Analysis (LOPA)	Staff House Conference Centre, The University of Manchester, Sackville Street Campus, Manchester, M1 3AL	courses@icheme.org
23rd	Hf Event: An inspirational approach to learning & sharing – young risk managers' ideas (Provisional)	Institution of Mechanical Engineers, One Birdcage Walk, Westminster, London, SW1H 9JJ	admin@hazardsforum.org.uk
October			
2nd	SaRS Event, Hf Supported: SaRS2014 Annual Conference: Don't Panic! No cause for alarm…	The Marcliffe Hotel & Spa, North Deeside Road, Pitfodels, Aberdeen, AB15 9YA	info@sars.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 events 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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