

## No. 101 – Spring 2020

### Welcome

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#### *For all your news, views and events*

In HFN #101, we present notes from the March 2019, June 2019, September 2019 and December 2019 Hazards Forum events, together with a reflection on the first 30 years of the Hazards Forum as it marks this key anniversary. Another organisation sharing an anniversary is the Temporary Works Forum (TWf). Bill Hewlett and John Carpenter, the founding Chair and Secretary, reflect on the inspiration to found the TWf 10 years ago and why the evening and weekends dedicated by them and others were worthwhile.

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### In the news

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#### *Responding to COVID-19: an invitation from the Hazards Forum*

COVID-19 affects us all, many lives have been blighted some tragically and our thoughts and condolences go out to all affected. And of course, the news is full of COVID-19 and what its impact will be. Pandemic, it seems, is a risk we always had, but few did much to prepare for.

Likening the pandemic to the last world war is a popular analogy. But what we draw from this concerns the immediate post-war years. Old values were rejected, new idealism and values took hold. It was a hugely different 'new normal'.

So, what do we now embrace? What do we reject, for what do we strive? We can think about wasteful and polluting habits we have seen we can do without and we can place more emphasis on localism and human values, less on globalism and wealth. But in the context of Hazards Forum, let us take that up a notch or two. Now we have experienced just what the manifestation of a global risk is, what global risks should we eliminate or prepare to mitigate, freshly motivated as we are?

Mitigating and reducing hazards and disasters both man-made and natural (our Charitable Object) has not had the popular vote behind it like this for a generation or more.

We will be holding our next event on 15 July 2020, on-line to debate these important topics. Please join us for an event led by eminent speakers to examine how we as engineers can leverage our influence and find new direction in the post-COVID world as it develops.

## *Updated BP Texas City Animation on the 15<sup>th</sup> Anniversary of the Explosion*

The U.S. Chemical Safety Board has published an update BP Texas City animation on the 15<sup>th</sup> anniversary of the explosion. The original animation has been used extensively worldwide to understand the events leading up to the explosion and has featured in many academic lectures and workplace training courses as an opportunity to learn from the failings of others. This new video is updated with additional information and makes use of the latest in animation technology to provide a compelling resource for anyone concerned with the management of major hazards. The animation is available at <https://www.csb.gov>.

## **30 years of the Hazards Forum**

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### *Inception*

The 1970s and 1980s were marked by a number of natural and human-made disasters which raised questions about the preparedness of national governments to prevent or mitigate their effects. For example, the Chernobyl nuclear disaster of 1986 was a serious and wide-ranging catastrophe, rated 7 on the International Nuclear Event Scale, whose effects are still being felt. It raised important questions about the ways in which corporate management and government should respond to nuclear disaster. Similar concerns were raised by the 1980 Mount St Helens volcano explosion in Washington State which removed over 1000ft from its height and devastated a wide area. The Bhopal Gas Cloud disaster of 1984 killed several thousand people and left the affected population without compensation or support. Here again issues of corporate responsibility and national governance arose. These events together with those nearer home such as the Flixborough Chemical Plant disaster of 1974, The Kings Cross underground fire of 1987 and the Zeebrugge Ferry disaster of 1987 all raised issues of preparedness, assessment, mitigation and governance.

Against the same background the United Nations designated the period 1990 to 2000 as the International Decade for Natural Disaster Reduction and called on member nations to form national committees for natural hazard reduction. This process began after Dr Frank Press, President of the US Academy of Sciences, had called for such a decade in a speech to the American Earthquake Society in 1984. It was in this context that the Hazards Forum was established.

In his 1988 Presidential Address to the Institution of Civil Engineers, Dr Alastair Paterson CBE FREng gave examples of a number of disasters and discussed the role of the engineer in hazard mitigation. He commented: *“One element that each of these hazards has in common is the technology for the mitigation of their effects lies within the province of the civil engineer, who can hope to contribute directly to the reduction of the consequences of these hazards.”*

On the United Nations call for the formation of national committees for natural hazard reduction Dr Paterson said that the Institution of Civil Engineers had taken the initiative in the formation of such a committee for the UK and preliminary talks had already been held with interested parties. However, he had reservations about the prudence of this development having regard to the overlap between natural and human-made hazards. He said that at the first meeting of the new body it was intended to: *“consider whether a Hazards Forum might not be a better concept, giving consideration both to natural and man-made hazards”*.

And so, in 1989 the Hazards Forum was formed to encourage joined-up approaches to the mitigation of natural and human-made hazards. The founding partners were the Institution of Civil Engineers in association with the Mechanical, Electrical and Chemical Engineers.

On 8th June 1995 the Hazards Forum was registered with the Charity Commission as an unincorporated association, registered charity number 1047047, with the charitable objects: **for the public benefit to mitigate and reduce hazards and disasters both man-made and natural.**

## *Key activities and achievements*

Since its inception in 1989 the Hazards Forum has undertaken a range of activities in delivering its charitable objects. Its core activity has been, and continues to be, meetings with eminent speakers on a range of topics aligned to its charitable objects. In the 1990's the Hazards Forum hosted conferences and symposiums to adopt a more proactive stance in engaging with the wider public beyond the traditional confines. It was during the 90's that an annual lecture was held along with discussion dinners – these operated under the Chatham House Rule and aimed to bring together senior people from different backgrounds to discuss the topic of the day.

Since 1999 the Hazards Forum programme has been largely directed to evening meetings. These have broadly adopted a format of three speakers personally invited to give short presentations followed by adequate time for questions and discussions. The evening meetings are followed by a networking reception which often proves to be popular with meeting attendees. A wide range of subjects have been covered at these meetings and records are captured in newsletters, many of which are available on the Hazards Forum's website: <https://hazardsforum.org.uk>. The first of these newsletters was published and circulated to members in 1993 and over 100 editions have since been published. The evening meeting programme and the newsletters have thus become a permanent and successful feature of Forum work as a means of bringing the issues before key decision makers, who may or may not be engineers.

Two books have been produced under the aegis of the Hazards Forum: Safety by Design - an Engineer's Responsibility for Safety (1996) and Safety Related Systems - Guidance for Engineers (1995 revised 2002). The first was written by a team of experts selected by Professor Sue Cox, who was Professor of Health and Safety Management at the University of Loughborough, and the second by Professor Philip Bennett. Copies of these publications were sold until 2008 when they were judged to be insufficiently up to date.

Over its 31-year history the Hazards Forum has maintained strong links with other bodies, most notably its founding engineering bodies, the Royal Society, the Royal Academy of Engineering, the Health and Safety Executive, and the Parliamentary and Scientific Committee.

## *Looking to the future*

Since 2006 the World Economic Forum has produced a Global Risks Report focussing on global trends and risks. This macro perspective indicates a different world to 30 years ago and one in which environmental and geo-political risks are at the fore. These reports further reveal the interconnections between trends and risks. For example, and albeit simplistically, climatic change may trigger a water crisis which in turn may lead to negative impact on crop yields, as this impacts livelihoods so the potential for discontentment and unrest may rise.

The 2019 report highlights the following key concerns:

- **Geo-political and geo economic tensions:** growing nationalism has impacted collective progress on global challenges;
- **Environmental risks:** features highly in top 5 risks by likelihood and by impact;
- **Technological vulnerabilities:** data breaches, hardware weaknesses and AI potential to engineer more potent cyber-attack, presenting impact for critical infrastructure;
- **Biological threats:** changes in how we live have increased the risk of a devastating outbreak occurring naturally; new biotechnology promises great advances but brings with it significant and even daunting requirements for oversight and control;

- **Rising sea levels:** urbanisation concentrates people in areas of potential damage and exacerbates risks by destroying natural resources of resilience;
- **Mental health:** anxiety and unhappiness are evident; some 700 million people worldwide are affected; declining psychological and emotional wellbeing also impacts social cohesion.

Top five global risks by likelihood:

- Extreme weather events;
- Failure of climate-change mitigation and adaption;
- Natural disasters;
- Data fraud or theft;
- Cyber-attack.

Top five global risks by impact:

- Weapons of mass destruction;
- Failure of climate-change mitigation and adaption;
- Extreme weather events;
- Water crises;
- Natural disasters.

And yet as we move into 2020 facing a pandemic not seen for over 100 years with its global lockdown, unprecedented economic impact, and devastating and tragic loss of life, it is, perhaps with a degree of hindsight, notable that whilst the spread of infectious disease was highlighted as a key concern in the 2019 report, it did not feature in the top five global risks by likelihood or impact.

Looking forward to our next decade we have been thinking hard about the place of the Hazards Forum in a world where the smart phone is part of the human form and every unknown is a 'google' away. We cannot and should not lose the opportunity for interdisciplinary debate on these global challenges and issues, building partnerships and alliances, and breaking down thought-silos in risk mitigation and reduction. We have been reflecting on our impact and value and we recognise there is more we can do to turn outputs into outcomes by extracting value from our significant body of knowledge. We have worked hard to develop a new strategy to 2025 which will be launched in the coming months.

The Hazards Forum membership comprises of engineering bodies, public sector bodies, corporates, and individual affiliates which it relies upon for its source of income to enable it to continue to deliver upon its charitable objects. The Board of Trustees are grateful for their contribution and on-going commitment.

## Safety in space

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### *A New Frontier, a report on an event at the Institution of Civil Engineers on 19 March 2019*

Our March 2019 event saw us partner with the Safety and Reliability Society (SaRS) to present 'Safety in Space - a new frontier' – a topic area not previously considered by the Forum however, it is perhaps one that we will revisit in the coming years. Over the past decade, the number and variety of organisations launching into space has significantly increased. The major driver for these activities has been a growing commercial sector, a change from the institutional dominated missions seen in the early years of the space industry. UK companies in this growing space sector are involved in everything from constellations, to on-orbit servicing, to launch. All these missions require a clear understanding of safety and the risk presented in orbit and on the ground. One of the areas receiving particular attention in the UK is launch. Commercial actors in the UK are now developing a range of launch options and locations for space ports to allow small satellites to be launched from the UK rather than using international launch sites. As space infrastructure continues

to develop, it will continue to be at the frontier of an evolving legislative regime. This will create new challenges in terms of risk assessment and appropriate health and safety regulation.

Our speakers were drawn from the UK Space Agency and the Health and Safety Executive. The event was co-chaired by Dr Emma Taylor, Chair of SaRS and Dr Luise Vassie, Chair of the Hazard Forum. Andrew Ratcliffe, Head of Launch Systems at the UK Space Agency, provided us with an overview of the space environment, the high-level risks and the regulatory regime:

The UK Space Agency is an executive agency, of the Department for Business, Energy & Industrial Strategy. To put into context the importance of space to the UK, here are some key facts:

- It contributes £13.7 billion to the UK economy each year
- It employs 38,500+
- 6.5% share of global space economy
- It is a critical national infrastructure
- It underpins all other key industrial sectors

Space is a busy place. In 2017 there were 86 launches putting 400 spacecraft into orbit, an increasing trend. Spacecraft come in all shapes and sizes, and many are as small as 10cm. The total mass of objects 10cm and above in earth orbits in 2017 was 7600 metric tons, of which half is debris. This debris poses the following risks:

- **Commercial risk:** loss of mission e.g. collision of debris with operating object; loss of performance e.g. increased shielding and more propellant needed for collision avoidance;
- **Infrastructure risk:** critical national infrastructure e.g. global navigation satellite systems, disaster relief, meteorology, communications;
- **Human risk:** risk in orbit of a collision with human tended spacecraft e.g. crew capsules, space stations; risk on the ground e.g. propellant tank crashing to earth.

Limiting the growth of debris in space is key to controlling these risks and regulations and information sharing are the means to do this such as the Outer Space Act (OSA) 1986: the legal basis for regulation of activities in outer space carried out by UK persons. OSA establishes that the licensing and other powers are with the Secretary of State acting through the UK Space Agency and the terms of the license. License approval is dependent on applicants demonstrating ability to comply with licence conditions. Requirements are informed by accepted international best practice, standards and guidelines, and embody three key principles: (1) preventing on-orbit break-ups; (2) removing spacecraft and orbital stages that have reached their end of mission operations; (3) limiting the objects released during nominal operations. Information sharing takes place through tracking and monitoring of objects in near-earth orbit.

Space debris is a growing concern for Governments and commercial partners due to impacts on national infrastructure and future business cases. New actors in space mean that active approaches to managing risk will need to be considered to reduce risk and increase safety in orbit.

Robert Garner, a mission safety analyst at the UK Space Agency then considered the safety aspects of launch:

The number of countries with satellites is increasing and size and cost of satellites is reducing too. Launch UK is engaging with industry to stimulate sustainable interest in the UK launch market and in the operation and use of UK spaceport services.

So how can activities in space be controlled and managed to mitigate risks? The Space Industry Act (SIA) provides the UK government with the powers to regulate launch. Its key principles are to protect the uninvolved general public and comply with international treaties. Currently secondary legislation and guidance to support the SIA is being drafted. There are a number of players in the

regulatory landscape, for example the Health and Safety Executive (HSE) and the Civil Aviation Authority (CAA). The HSE regulates everything on the ground, UKSA regulates all vertical spaceports, launch vehicles and in orbit operations and tracking into orbit, and the CAA regulates all airspace, spaceplanes and horizontal spaceports.

The interaction between the various licensees can present safety challenges as does geography: large down range distances, international risks and international legal and liability treaties. Three different licenses will be required for a spaceport, launch vehicle and range.

Ron Macbeth, the Risk Assessment Technical Lead from the Health and Safety Executive was our third speaker and tackled the question of “*Is space a risky business?*”:

Looking at principles of ALARP and reflecting on learning from several international space incidents, Ron concluded that a high hazard industry, such as space does not have to be risky. Key to this is the adoption of good engineering practices, learning lessons from other industries and importantly, 70 years of space exploration and a focus protecting public and workers through siting and range control and operator competency.

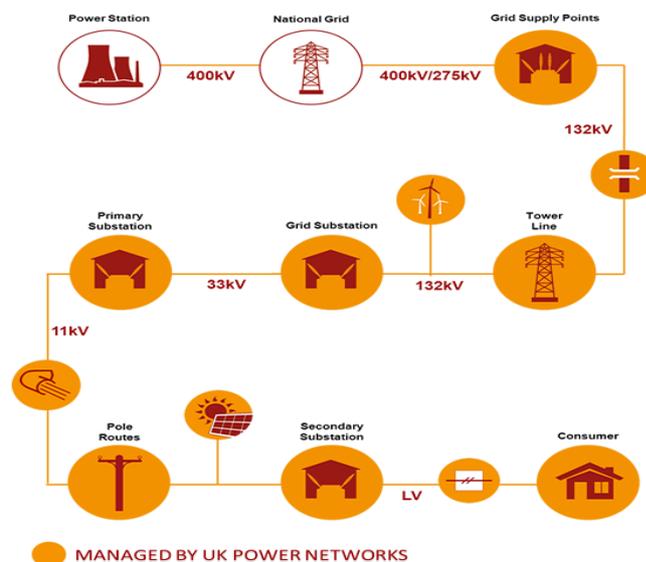
The panel discussion that followed saw wide ranging discussion on the challenges and complexities. Key takeaway points included (1) the need to establish and maintain a clear and common understanding by all parties of the applicable legislative regimes; (2) we don’t know all we need to know to assess risk – we are still learning and what we’re doing now in orbit will not be what we’re doing five years from now. Watch this space...

## 30th anniversary event: artificial intelligence and automation

### *Risks and Opportunities from the increased use of Artificial Intelligence in Industry and Society, a report on an event at the Institution of Civil Engineers on 18 June 2019*

The event marked the 30<sup>th</sup> anniversary of the Hazard Forum and was opened by a keynote address from the Chair of the Board of Trustees, Luise Vassie. The meeting then proceeded onto its main item: risks and opportunities from the increased use of artificial intelligence in industry and society.

John Duller, Control Systems & Automation Manager with UK Power Networks, spoke on how Distribution Network Operators need to continuously improve and innovate to meet customer, regulatory and shareholder expectations. The control and automation systems are key to a distribution network operators’ success and this role will continue to increase over the next few years. John gave an overview of UK Power Networks and how automation in the distribution network has evolved into the Adaptive Power Restoration System (APRS) developed with GE Digital Energy.

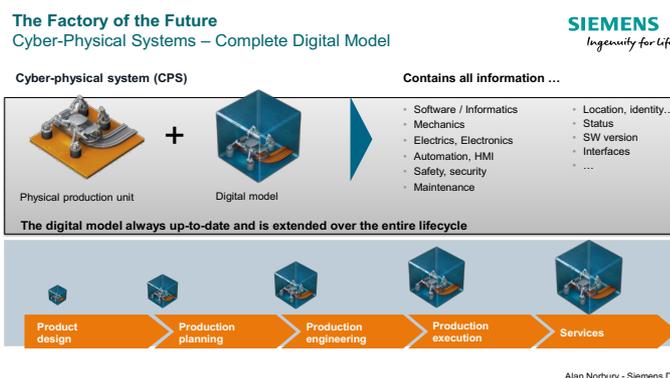


He described the importance of the Supervisory Control & Data Acquisition System (SCADA) and its importance in managing distribution to the consumer from numerous power generation systems like power stations (nuclear and fossil), wind and other alternative energies. He outlined the main drivers for automation and the safety barriers put in place.

Steven Naylor, Data Scientist with HSE, described the demand in use of artificial intelligence-based technologies in industrial workplaces in transforming process operations and how operational decisions are arrived at in workplaces. Such technologies are transforming the interaction between humans, equipment and industrial processes in workplaces and the general consensus of opinion is that this is only likely to gather pace. Such a trend is opening up a host of new opportunities for using technology to better control health and safety risks. However, the trend also has the potential to introduce new health and safety risks into workplaces requiring attention. Steve gave a number of examples where industry and society can benefit from Artificial Intelligence but also highlighted a few examples where things have gone wrong. He also discussed the role of the Regulator in the future and the extensive programme HSE has put in place with Manchester University and Lloyds Register to deliver health and safety benefits through a data driven global community.

Alan Norbury, Siemens Central Technology Officer, spoke on 'Industry version 4' and the impact on Health and Safety. Digitalisation is changing all areas of life: the way we stay informed, the way we travel, the way we buy things, and the way we manufacture products. It also changes business models. The pace of innovation and the ability to disrupt are becoming key success factors in global competition. This new 'Digital Revolution' commonly referred to as 'The 4th Industrial Revolution' is driven by 'embedded' or 'cyber physical' systems interacting intelligently. The most important characteristics of the 4th revolution are: Virtual/Augmented Reality, Digital Twin, Cyber-Physical Systems, Big Data/Smart Algorithms, Advanced Robotics, Cloud Technology, 3D Printing/Additive Manufacturing and Cyber-Security.

Alan described how the future of manufacturing will rely on the integration of both the physical and the digital aspects of not only manufacturing facilities and the entire supply chain but of the products they are producing. Utilising data from product design through life service to improve the customer experience and future product design in a virtuous circle.



He presented arguments on how technologies will change the way we do business, what this means for UK productivity and growth, and how will this impact on Health & Safety.

## **New hazards in road transport**

### *Automation, Infrastructure and Acceptability, a report on an event at the Institution of Civil Engineers on 17 September 2019*

Advances in technology mean that we can look forward to the benefits of faster, more efficient and environmentally sound transport. However, some significant barriers and hazards remain to be overcome. Some of the key questions relate to:

- How can we construct the whole transport infrastructure environment to integrate the development of human and automated interactions?
- Can we build transport systems which we can implicitly and confidently rely on once we give up being "in the driving seat"?
- How can we build sensors which we can trust in all circumstances?

Professor Neville A. Stanton, Director of the Human Factors Engineering Team, Transportation Research Group, at University of Southampton spoke about driver's reactions to automated vehicles, and explored the question: why do partially automated vehicles crash?

Over the past two decades, Professor Stanton and his research team have been testing the effects of automated driving on drivers: in simulators, on test-tracks, as well as on open roads. These studies have revealed that drivers of automated vehicles are less able to respond in an emergency than when driving manually. Professor Stanton asserts that the role of monitoring automation continuously with the task of intervening only very occasionally is almost impossible for drivers to undertake effectively, particularly for an extended duration. In fact, if drivers attempt to monitor, as they are expected to do, it actually places greater mental demand on them than driving manually. In any case, they cannot sustain this level of attention for long. What happens, in reality, is that drivers adopt a more passive 'passenger' mentality and start engaging with other tasks and devices in their vehicles. Watching vehicle automation for any extended period is very boring. These studies have led Professor Stanton and his team to the conclusion that partially automated driving (where the driver is expected to monitor and intervene) is a really bad idea. In this provocative presentation, he presented some of his research team's studies in simulators and on UK roads to explain why partially automated vehicles crash.

Kate Carpenter, Divisional Director (Operational Road Safety) for Jacobs, spoke about the infrastructure implications of a mixed vehicle fleet. Kate discussed some of the impacts of current and upcoming AV technology on road infrastructure. For example, we have engineered our urban and rural roads to improve safety and traffic flow in ways that take advantage of the ways that human drivers behave, but which can have unintended consequences with driver assistance technology, let alone autonomous control. Each element of vehicle technology and each highway design feature can raise challenges that vehicles will need to address, and which individual manufacturers may answer differently. Kate discussed some of these coming challenges for highway authorities and the pedestrians, cyclists, motorcyclists, motor vehicle and all other users of the roads.

Kate's presentation highlighted that autonomous vehicles rely on road signage for some inputs, with some very modern road environments now having significantly less signage and road markings in place, this reduces the amount of information relayed to the autonomous vehicle. This would tend to reduce the reliability or functionality of the autonomous vehicle. In these reduced information environments, operational experience indicates that human drivers actually have less accidents since they are able to concentrate on the actual environment rather than compliance with multiple signs. This highlighted how autonomous vehicles may need a different and more structured road environment to operate most effectively, leading to additional considerations in the design and maintenance of the road.

George Filip, Knowledge Transfer Manager, Connected and Autonomous Vehicles, for Innovate UK spoke about connected and automated vehicles and the hazardous journey ahead. Although ever constant in the news coverage around the world, Connected and Automated Vehicles (CAVs) face a series of difficulties towards their emergence on the market. The presentation covered the current state of the art for CAVs in the UK, their promise as well as the obstacles they are facing. In particular this knowledge transfer network is concentrating on specific interfaces and bringing together technical specialist for different disciplines and areas to derive new technological solutions. This is a very fertile environment for development and could have significant spin off benefits in developing quite targeted solutions by identifying organisational synergies. In this way the innovative and prototyping abilities of smaller organisation could be matched by the development and scale up abilities of other organisations, allowing both the functionality and reliability of such systems to be developed at the earliest stages.

## Forensic Engineering

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### *Failure, Investigation and Learning – the Anatomy of a Loss, a report on an event at the Institution of Mechanical Engineers on 3 December 2019*

Our December 2019 event, and unknowingly at the time, our last physical meeting before Covid-19 necessitated the March 2020 shutdown in the United Kingdom, was a well-attended event, held at the London offices of the IMechE and sponsored by the IChemE, and chaired by their President, Stephen Richardson. The event topic aimed to introduce the membership to some of the parties that may be involved in the all-important forensic analysis after a loss, or near miss event.

In the aftermath of a loss, focus turns to getting to the root cause and causal factors associated with the loss. Many parties have interest in this activity, and with often different agendas, ranging from the Operator's desire to learn and take actions to ensure the event or similar events are not repeated within the company; the regulators'/standards providers' need to ensure that learnings are made available to a wider audience and as necessary change regulation or practice; the insurers' need to establish if the loss is covered and the associated quantum; and the lawyers' need to gather evidence to support criminal or civil actions arising from such a loss.

With such different needs, an industry has developed to support for the needs of all the above parties, to allow detailed forensic analysis to be conducted and to ensure the truth is reasonably established.

The event looked at three different aspects of this process, including:

- Material Failure Investigation & Analysis
- Incident Investigation
- Forensic Accounting

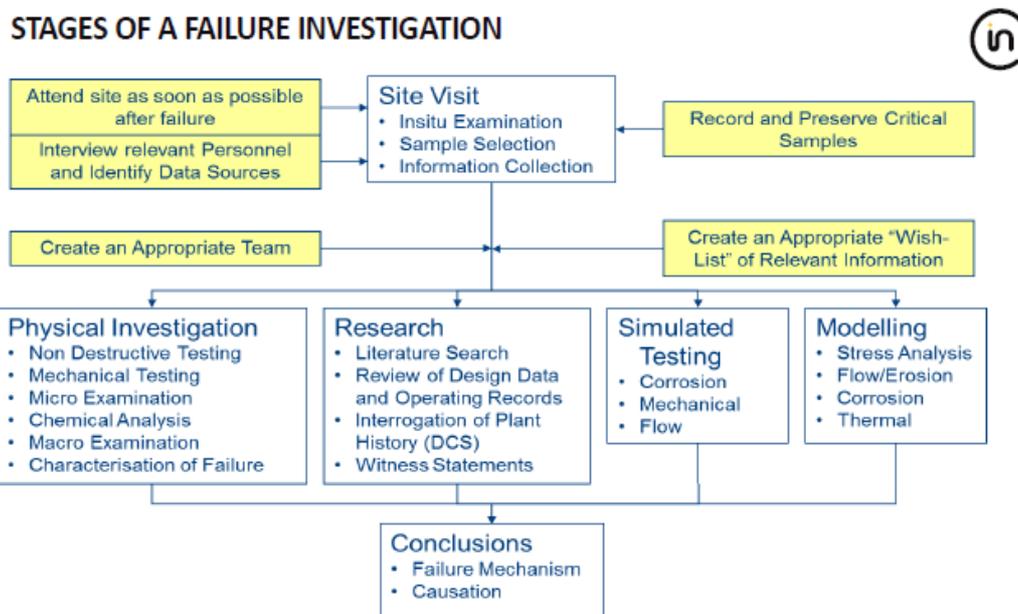
### **Material Failure Investigation & Analysis**

Andrew Piercy, a Principal Engineer within the Failure Investigation and Consultancy Team of Intertek Production & Integrity Assurance spoke on the role of material forensic analysis within the context of failure analysis and incident investigation. Andrew has more than 30 years' experience of corrosion and metallurgical investigations and testing. His main areas of expertise are corrosion and corrosion-related failure analysis, metallurgy and mechanical failure analysis.

Andrew first put the concept of material failure into perspective, and it does not necessarily mean a complete collapse or loss of containment (although this may well be the case), but can also apply to a loss of operability, functionality or reliability such that continued use is not possible, or is unsafe. It was emphasised that failure analysis is not aimed at concluding a root cause (this comes later in the investigation), but is there to answer two main questions:

1. What is the mechanism of the failure (How)?
2. What was the cause (immediate) of the failure (Why or What)?

Emphasis was placed on the need for a structured investigation, that broadly follows the process depicted in the following diagram; this diagram also provided the structure for the body of the presentation.



The importance of visual inspection, and ideally site inspection to contextualise was stated, in addition to taking as many photographs as you can. Just as it is at a crime scene, you only get one chance to capture the ‘as is’ evidence.

The presentation then provided an overview of the laboratory techniques that could be used to support the failure analysis investigation.

Once a range of test results are available, these are then reviewed in conjunction with other evidence gathered, to put the results into context with environmental and physical conditions, mode of use, design specifications of the material and whether results tally with owner/user provided information.

It was acknowledged that during the reporting you may conclude that there is no ‘smoking gun’, and that a “Sherlock Holmes” approach may need to be taken: “ it is an old maxim of mine that when you have excluded the impossible, whatever remains, however improbable, must be the truth”.

Often a material failure investigation may conclude the need for further analysis.

It was also stated that failure investigation work can become part of legal proceedings, and will need to be able to stand up to the processes and techniques used in such proceedings.

### ***Incident Investigation***

Roger Stokes of BakerRisk Europe Ltd, presented a high-level review of the key stages of the incident investigation process, and illustrated how the work in the failure investigation stage is used to drive towards a root cause and, most importantly, the lessons that can be learned from the incident.

Roger has close to 40 years of post-graduate experience in the processing industries, from chemical manufacturing, loss adjusting in the insurance context and more recently as part of the Process Safety Group, where his work is currently focused on incident investigations, insurance risk engineering and process safety management. In 2018, he co-authored a number of sections in the latest (3rd) edition of the CCPS book: Guidelines for Investigating Process Safety Incidents.

Roger started with some useful cause definitions, as illustrated in the diagram opposite. He then stressed the need for a cooperative and collaborative approach to investigation that was sensitive to the needs of the various parties involved. It was stressed that Incident Investigation was an essential part of a risk-based process safety driven management system.

Cause definitions	
Immediate cause(s)	<ul style="list-style-type: none"> <li>The agent of injury or ill health (HSG245)</li> <li>The final act in a series of provocations that leads to a particular result or event. This would directly produce the result without intervention of any further provocation.</li> <li>Last event in a series of events which causes another event, particularly an injury, to occur.</li> </ul>
Underlying cause(s) Causal Factor(s)	<ul style="list-style-type: none"> <li>Unsafe acts and unsafe conditions. (HSG245)</li> <li>System or organisational (e.g. trip test not carried out, inspection less than adequate)</li> </ul>
Root Cause(s)	<ul style="list-style-type: none"> <li>The most basic cause that can be reasonably identified and that management has control to fix.</li> <li>A fundamental, underlying, system-related reason why an incident occurred that identifies a correctable failure(s) in management systems.</li> <li>A causal factor with no predecessor that is relevant for the purpose of the analysis.</li> <li>The failure from which all other failings grow, often remote in time and space from the adverse event.</li> </ul>

The need for systematic evidence collection and cause determination was again given emphasis, and a distinction made between time sensitive and not so time sensitive evidence, which can help to give structure to an early part of an investigation. Scientific Method as given in NFPA 921 was also illustrated, and a range of root cause determination techniques offered depending on the depth of analysis warranted.

The presentation concluded with a case study of a pipe rupture, which helped to illustrate a hypothesis matrix approach as illustrated opposite. From this the investigation was able to systematically and rapidly eliminate scenarios and home in on the most likely scenario to take forward to more in depth root cause analysis and ultimately lessons learned.

Hypothesis Matrix for pipe rupture			
Scenario	Verification	Finding	Hypothesis
Rupture due to excess pressure	Review DCS records to identify pressure reached		TRUE/ FALSE
	Metallurgical inspection of pipe		TRUE/ FALSE
Internal loss of wall thickness	Metallurgical inspection of pipe (internal)		TRUE/ FALSE
External corrosion	Metallurgical inspection of pipe (external)		TRUE/ FALSE
Incorrect materials for pipe	Metallurgical inspection of pipe		TRUE/ FALSE
Impact by passing vehicle	Physical/ metallurgical inspection of pipe		TRUE/ FALSE
	Review location and proximity of vehicles		TRUE/ FALSE
Fallen object	Inspect pipe and security video		TRUE/ FALSE
Accidental cutting into line	Review work permits and maintenance system		TRUE/ FALSE

### Forensic Accounting

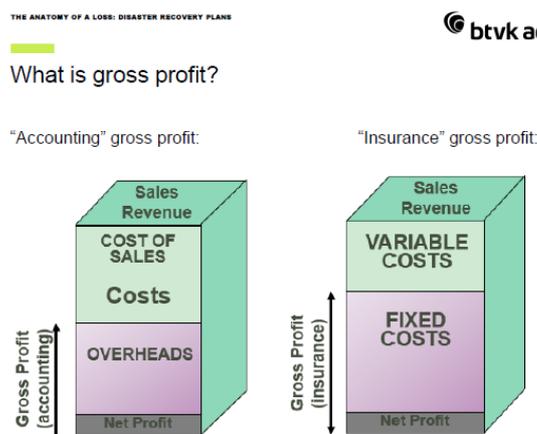
Justin Crick, a Partner at BTVK Advisory concluded the evening, by drawing on his experiences of forensic analysis and quantification of Business Interruption losses across a wide range of industries and geographies over the last 20 years to discuss the lessons learnt when the disaster recovery plan is put to the test.

Justin is a skilled and experienced forensic accountant. Working with many of the leading insurance companies and law firms around the world, Justin specialises in the quantification of major and complex losses in industries ranging from energy and power generation to mining to construction and manufacturing.

Justin started with a link to the case study in the previous presentation, and considered what were the wider commercial impacts of a failure in a mode of transportation such as a pipeline, including both business disruption for first and second parties, between which there may be contractual obligations, and the resulting mitigation measures to maintain a product supply.

He then discussed the role of the forensic accountant within an incident investigation, often appointed as an expert third party to quantify the monetary consequential loss, and how this might be recovered under a given insurance policy.

Justin then provided a useful business interruption insurance cover '101', emphasising the difference between an accounting gross profit and insurance gross profit (which provides the basis of recovery for many business interruption insurance policies). The importance of contractual commitments, and the impact they may have on business interruption was stressed, and how all behaviour is governed by contract, and that the insurer has to work within the restrictions of such a contract, and that some costs thought to be variable, may actually be fixed (take or pay contracts).



Justin then drew on the many hundreds of claims he has helped adjust, and considered the key lessons learned concerning getting a business back on its feet, particularly how this should be captured as part of disaster recovery plans. He contextualised this with three case studies, which strove to emphasise the importance of recovery plans being in-place and subject to detailed analysis and testing. Further, pre-loss reviews should be undertaken involving internal parties (with an intimate knowledge of operations) and external experts. Loss events should be 'desk-top' tested, drawing on actual experience either in the company or within the wider industry. This should highlight both gaps in the plans as presented and any potential gaps in insurance recovery before an actual event arises.

## 10 years of the Temporary Works Forum

*History does not repeat itself, but it often rhymes: an inspiration for the Temporary Works Forum 10 years on by Bill Hewlett, Consultant at Bill Hewlett Associates Ltd, TWf Chair 2009-2017, & John Carpenter, Consultant, TWf Secretary 2009-2014*

In 2019 the Temporary Works Forum (TWf), [www.twforum.org.uk](http://www.twforum.org.uk), celebrated its 10th anniversary with a prestige seminar and reception for its 182 member companies and their guests at the Institution of Civil Engineers (ICE) in London.

At its beginnings, TWf had just 15 founder members and met in borrowed offices. At the 10-year point, it was filling arguably the most prestigious engineering venue in the UK, with a 12-fold growth in membership. This presence and broad engagement positions TWf well to serve as a huge force to enable construction safety.

In the context of TWf, 'temporary works' has quite a specific meaning: they are the temporary structural supports and other provisions needed during the building, modification and demolition of assets in the building, civil engineering and construction sectors; BS5975 refers (BSI, 2019). Things such as falseworks to support bridges during construction, formwork into which concrete is poured, and sheet piling for temporary excavation support are all 'temporary works'. The subject hit the headlines in the 1970s due to a spate of collapses during motorway construction works, leading to the Bragg Report (HSE, 1976) and the first edition of BS5975 (BSI, 1982).

*"The need for a body of some kind to give a lead and focal point for all those involved in temporary works was spotted independently by the two of us", John recalls. At the time, he was Secretary of SCOSS, the Standing Committee on Structural Safety ([www.structural-safety.org](http://www.structural-safety.org)). The Committee had seen a rise in the number of temporary works incidents and was keen to see the industry react positively. Bill's motivation was a growing frustration that our engineering institutions seemed not to give much attention to temporary works, even though the structural engineering is every bit as*

significant as for permanent works; for instance as a temporary works engineer you could not qualify for IStructE, there were no dedicated industry prizes, there was little if any research and no formal university teaching.

More significantly, both saw that engineers and managers coming into the industry did not seem to think that structural failure was a real possibility, so they gave temporary works less attention than those with longer memories. Bill recalls specifically: *“I had started my career in the early 1980s and the collapses of the 1970s were in the active memory of my older colleagues. Although I had not witnessed any failures personally, their experiences were clearly harrowing, and their accounts were vivid. One of my foremen was at Birling Road on the day it collapsed”.*



**Figure 1:** One man died and many were injured at the Birling Road collapse in March 1971 (HSE, 1976)

The learning from these experiences led to the Bragg Report in 1975 and the innovative British Standard BS 5975. The BS set out design rules and importantly a management regime for temporary works. The change to the industry at the time was dramatic and has proved lastingly beneficial. But over the 30 years to 2009, with very few failures occurring, the recognition of the level of hazard that temporary works represents was being lost; while management regimes were kept up, the awareness of why, and the consequent attention and care, was waning. What we were seeing was a case study of generational forgetfulness. Sibley and Walker (1977) had alluded to this effect; Petroski (2012) and Brady (2013) have since taken up the theme.

What became evident as they explored the subject was just how institutionalised the forgetfulness had become. Not only were those with personal memories retiring, but factors of safety in codes were reducing, the level of technical training was reducing and those that had sought to implement Bragg’s recommendations (where not enshrined into BS5975) had fallen silent.

1	Statutory reporting	✓	10	Proprietary equipment	?	19	Training	?
2	Regulations	?	11	Materials testing	?	20	University courses	✗
3	3% rule	✓	12	2 <sup>nd</sup> hand equipment	✓	21	Professional reviews	✗
4	FOS ≥ 2	✓	13	Fully qualified engineers	✓	22	Short courses	✗
5	Design for erection tolera	✓	14	Novel designs	✓	23	Practical courses	✗
6	All falsework to be design	✓	15	Permanent works design	✓	24	HSE control of training	✗
7	Design of grillages	✓	16	Rigorous procedures	✓	25	Register of operatives	✗
8	Field studies	✗	17	TWC	✓	26	Training schemes	✗
9	Research	✗	18	Communications	✓	27	Handbook	?

**Figure 2:** Analysis of action on Bragg’s 27 Principal Recommendations (after Hewlett et al, 2014)

Their response was to found the TWf with, at first, little more ambition than getting a dozen or more like-minded senior engineers together to share their learning and provide at least some kind of collective voice. Once again lessons from the past came to our aid: the Institution of Civil Engineers, 200 years earlier, had been founded on just this basis.

The guiding principles were:

1. Be mindful of history especially what was written at the time when temporary works emerged as a profession;
2. Encourage narrative and storytelling; promote peer learning;
3. Maintain high professional standards and act in the public interest; avoid commercialism.

On this basis the TWf has been hugely successful. As an organisation it has grown (in October 2019) from 15 founding to 182 member firms; it meets for open and frank discussion every quarter with a packed house; it has branches across the UK and sister organisations have sprung up in Hong Kong and the Middle East; authoritative guidance (free to all at [www.twforum.org.uk](http://www.twforum.org.uk)) has been published on a dozen and more subject, and two guides have been developed by BSI as PAS documents; TWf

has been able to sponsor a dedicated Centre of Excellence for Temporary Works and Construction Method at City, University of London, where a dedicated MSc is now taught; research has been sponsored at both City and other universities; TWf enjoys the unstinting support of the HSE.

Out on the construction sites the industry is not without its temporary works incidents. A spate of reinforcement cage collapses in 2011-2016 has been significant, with 4 killed in a single incident in Great Yarmouth in 2011, and two men very seriously injured in a wall collapse near Manchester in 2015. However, TWf was able to coordinate industry action, quickly raising awareness and issuing guidance to get this back under control, acting in the public interest notwithstanding the cases being sub judice.

Bill reflects, "What can be said is that the scale of the collapses of temporary works in the 1970s has not returned. While the absence of something is no proof of the presence of something else, it does seem fair to say that TWf has been successful in pushing back against generational forgetfulness, that the pattern of history has not rhymed in this case." Long may it continue. As at Hazards Forum there is good evidence that open, fair and honest debate remains a vital ingredient of our safety culture.

## References

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## Coming up

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### *Responding to the Covid-19 pandemic*

With the unprecedented set of circumstances that we all find ourselves in, it is not surprising that the Hazards Forum has also been impacted by the Covid-19 pandemic and measures put in place by the Government to protect society. Both the March 2020 and June 2020 events have been postponed and the premises at which we hold our events are closed until further notice. The Board of Trustees and its Technical Advisory Committee are currently exploring how we may host events remotely by use of Webinar technology. We hope to be able to provide an updated web-based events programme in the coming months.

## ...and finally

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### *New Trustees*

The Board are delighted to announce the appointment of two new Trustees – Aysar Hanza and Nina Jirouskova, who bring with them a wealth of experience, energy and insight. The Board has also appointed one of its existing Trustees, Nick Shaw, as its new Chair.

## Hazards Forum News



The Board would like to extend its thanks to its outgoing Trustee Steve Osborne, and Chair, Luise Vassie, for their contributions to the Hazards Forum during their terms in office. As Chair, Luise navigated the Hazards Forum through a period of change, modernising the Charity's governance as well as increasing the diversity and inclusivity of the Board and Technical Advisory Committee.

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You will find a full list of Trustees and Committee members [here](#).