Issue 32 / Autumn 2017

RISKworld

The Newsletter of Risktec Solutions

In this issue

Welcome to Issue 32 of RISKworld. Feel free to pass it on to other people in your organisation. We would also be pleased to hear any feedback you may have on this issue or suggestions for future editions.

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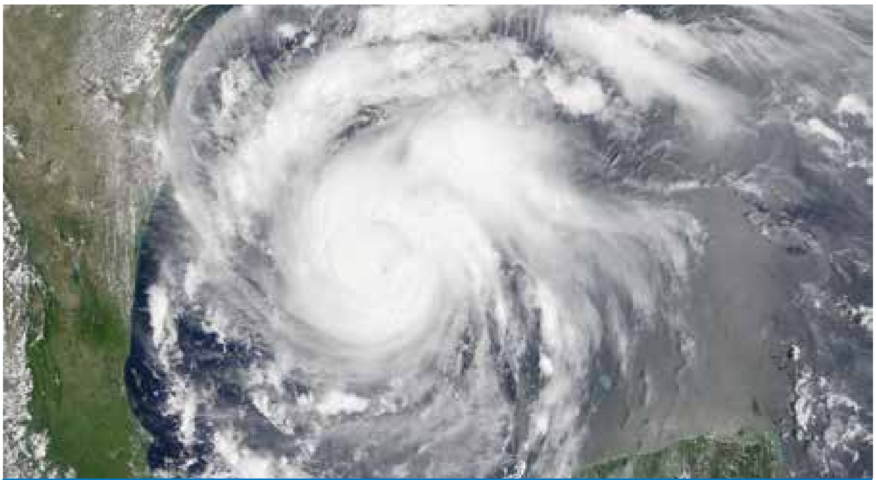
Preparation – the key to success



"The best preparation for tomorrow is doing your best today."
H. Jackson Brown Jr., author of Life's Little Instruction Book

At Risktec we are committed to continuous improvement. That is why our bi-annual client survey is so important. We strongly believe that this open approach helps us to develop long-term relationships with our clients.

The results from our latest survey show that we continue to achieve very high levels of satisfaction. 97% of clients are satisfied with our service and 99% would recommend us. Whilst this is a good result, we need to work hard to maintain the very high standards we have set ourselves.

Hurricane Harvey (above), which struck Texas in late August, reminds us that extreme events, although unlikely, do happen. We look at the impact on high hazard facilities (page 2).

We are very pleased to be collaborating with Liverpool John Moores University to offer a Degree Apprenticeship in Risk and Safety Management. The apprenticeship (page 4) has been designed for practitioners in risk and safety management roles within high hazard industries, and aims to develop rounded professionals.

Digitalisation is all around us, but are there specific considerations for high hazard industries? The article on page 6 stems from our recent collaboration with Manchester Business School.

On page 8 we discuss how we can use data to make better risk informed decisions, in this case reducing the risk of ship collisions with offshore structures.

Finally, if you're feeling a little tired, turn to page 10 which explains how bowtie analysis can be used to support fatigue risk management.

As always, we welcome your feedback and look forward to your continued support.

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Launched: Sept 2001 **Projects:** 5,519 **Clients:** 1,244
Employees: 250 **Offices:** 14

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Crisis management: The impact of Hurricane Harvey on petrochemical facilities

Hurricane Harvey, a Category 4 storm, hit Texas in August 2017. It caused an estimated $180 billion in damage, more than any other natural disaster in US history. But hurricanes are nothing new to the Houston area, home to one of the world's largest manufacturing centres for petrochemicals. So how well prepared were these facilities?

Hurricane Harvey made landfall on the Texas Gulf Coast on 25th August, with winds topping 130 mph. In a four-day period, many areas of Houston received more than 50 inches of rain as Harvey meandered over eastern Texas, causing catastrophic flooding. With peak accumulations of over 5 feet of water, Harvey is the wettest tropical cyclone on record in the US.

The floods inundated hundreds of thousands of homes, displaced more than 30,000 people and prompted more than 17,000 rescues. There were at least 82 deaths.

With weather forecasters issuing dire warnings, the majority of petrochemical facilities initiated crisis management plans. The indications are that these plans generally worked very well, though clearly lessons need to be learned from some events - for example, the Arkema chemical plant explosion and fire, where site flooding and loss of all power to the refrigeration unit was arguably a foreseeable scenario.

CRISIS PLANNING

Crises are unpredictable. However, that doesn't mean a response cannot be planned. Crisis management requires a forward-looking, systematic approach that creates organisational structure and processes, as well as trained people and supporting equipment. It is evaluated and developed in a continuous, purposeful and rigorous way.

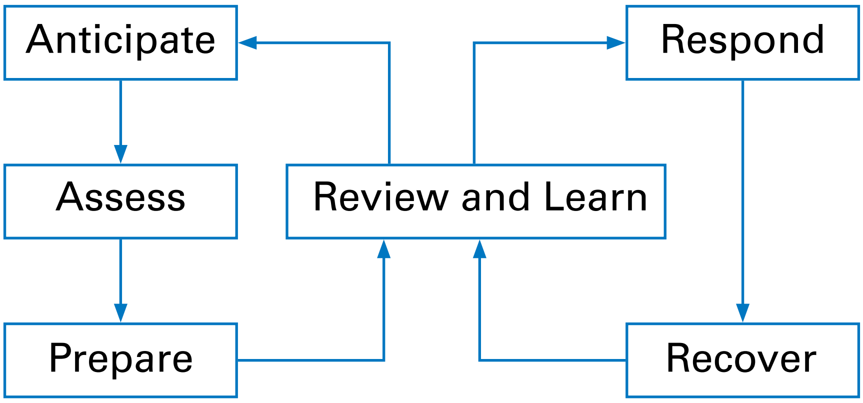

Figure 1 - Crisis management framework

A typical framework for crisis management is shown in Figure 1 (adapted from Ref. 1). The elements are:

- **Anticipate** – Identify potential crises and other disruptions.
- **Assess** – Analyse evidence and make judgements about potential impact and actions required.
- **Prepare** – Ensure the readiness of the organisation to face specific risks and handle crises that are not foreseen.
- **Respond** – Act quickly in an informed manner and with the desired effect.
- **Recover** – Sustain crisis response into a longer term, strategically-directed effort to recover reputation and value.

HARVEY'S AFTERMATH

Houston has more than 400 chemical manufacturing establishments employing over 35,000 people. Houston also has two of the four largest US refineries, including ExxonMobil's complex in Baytown.

The New York Times reported that more than 40 sites, including petrochemical plants, refineries and toxic waste sites, released hazardous pollutants because of Harvey. The Houston Chronicle reported that

Harvey toppled storage tanks and spilled nearly 2,000 barrels of oil and waste water over several locations. Most of the releases of hazardous pollutants occurred during the process of shutting down facilities prior to the storm hitting and then restarting them once the worst was over. For instance, during shutdown there is inevitably a great deal of flaring.

ExxonMobil acknowledged that two of its refineries were damaged, causing the release of hazardous pollutants. High emissions of volatile organic compounds were caused when a floating roof covering a tank at the Baytown oil refinery sank in the heavy rains. At the company's Beaumont petrochemical refinery, a sulphur thermal oxidizer was damaged. As a result, the plant released over 1,300 lbs of sulphur dioxide, well in excess of permissible levels. Other toxic chemicals such as benzene were also released in excess of permits.

In another example, Chevron Phillips said that it expected its Cedar Bayou chemical plant to have exceeded allowable limits during shutdown procedures for several hazardous pollutants, such as 1,3-butadiene, benzene and ethylene.

RIGHT RESPONSE

Getting the essentials right to protect people and plant is not a trivial undertaking. Most facilities initiated their crises management plan many days in advance by:

- Stopping all non-essential work.
- Rotating staff so that those in the local area had time to prepare their homes and families for the hurricane.
- Staging critical equipment needed for recovery.
- Working with partner mutual aid organisations from industry to pre-plan.
- Shutting down or reducing throughput.
- Releasing all non-essential personnel.
- Providing safe shelter, food and water for those that remained on site during the hurricane.

Many companies have critical emergency response teams which are populated by employees from outside the affected area. They were brought in ahead of time to help stage recovery equipment, or brought in afterwards to help clean up debris, check fitness for service of equipment and assist with key start-up phases.

RECOVERY POSITION

For the vast majority of owners, the health and wellbeing of their employees is the highest priority once the event is over.

The riskiest time of any high hazard facility is during shutdown and start-up, especially following such an extreme event where latent damage is a possibility. It requires the full attention of all employees, which may be challenging if they are preoccupied with the status of their family or home. So it is in everyone's interest to ensure that employees and their families are safe and secure before beginning the recovery process.

The bulk of the Gulf Coast's vast energy network made a comeback within three weeks of Hurricane Harvey. By late September, fifteen of the twenty refineries that went down or slowed production had almost fully recovered, though about 1 million barrels a day of refining capacity was still offline. So whilst Harvey's epic impact has been largely temporary, it is sobering to note that had it made a direct strike at full hurricane force, the impact would have been more lasting and disruptive.

CONCLUSION

The severity of Hurricane Harvey has been characterised as a 1 in 500 year flood. This simply means there is a 0.2% chance of having a flood of that magnitude in any one year. The crisis management plans of hazardous facilities in the Houston area appear to have been effective in limiting damage from such an event, with perhaps some exceptions. In time, the lessons learned will unfold and suggest improvements to current plans.

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References: 1. UK PAS200 Crisis management – Guidance and good practice

Brett Coomer/© Houston Chronicle

Degree apprenticeship in risk and safety management

Apprenticeships have long been recognised as an important way to develop the skills needed by employers, and the UK government is transforming the quality and quantity of apprenticeships in England. Nobody understands the skills that employers need better than the employers themselves. As a result, the government is placing employers in the driving seat for designing apprenticeships to focus on the knowledge, skills and behaviours (KSBs) needed from their future workforce. A financial levy puts employers at the heart of paying for and choosing apprenticeship training.

THE NEW APPRENTICE

The traditional view of apprenticeships is that they are undertaken by 16 year old high school leavers taking up trades such as mechanic, electrician or plumber.

But apprenticeships today span the full spectrum of vocations and qualifications right up to master's level.

Degree apprenticeships entitle apprentices to achieve a full bachelor's (level 6) or master's degree (level 7). They are co-designed by employers, universities and professional bodies and combine university education and work experience.

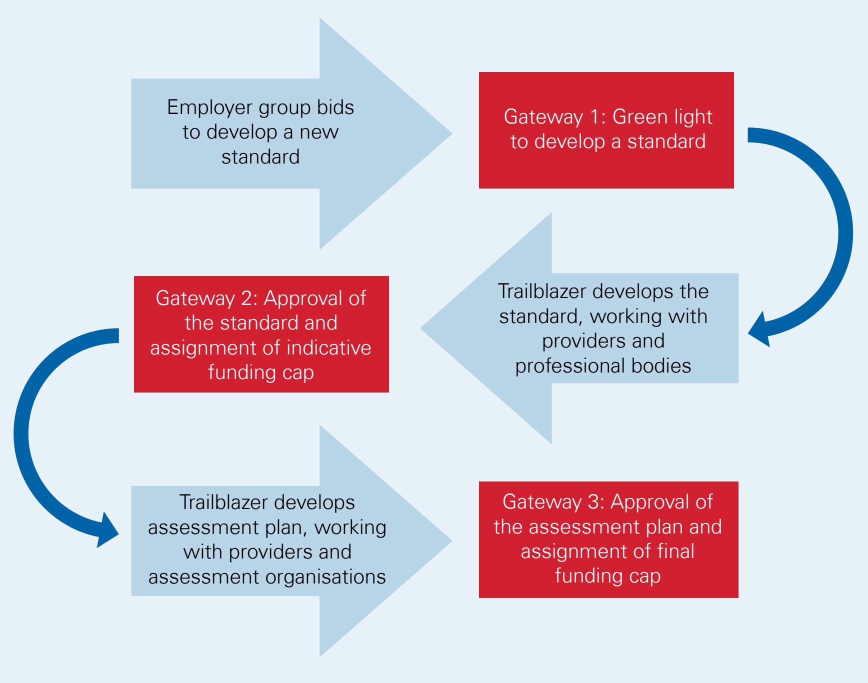

Figure 1 – Trailblazer process

For the apprentice they are a great alternative to the traditional university-only route in that the individual receives a salary, incurs no tuition fees (no student debt), gains vocational training as well as an academic education and has the chance to gain professional accreditation and membership. According to a recent survey, even if money was no object, 62% of parents would still prefer their child took a degree apprenticeship.

The employer gains an employee with a directly relevant academic qualification and practical experience, who meets the competence requirements of their role. The employer also makes efficient use of the funds that they have paid by their levy.

TRAILBLAZING

Apprenticeships in England have been undergoing a transformation, with employers trailblazing the definition of new standards. The 'trailblazer process' for each new apprenticeship standard is operated by an employer group, which goes through the activities and gateways shown in Figure 1.

When fully developed, the standard itself describes the occupational profile linked to the KSBs that bring full competence. The assessment plan is another key document, showing in detail how the KSBs will be assessed.

Once finalised, the apprenticeship is approved by the Institute for Apprenticeships (IfA) for use by employers.

RISK AND SAFETY MANAGEMENT APPRENTICESHIP

There are a number of clear reasons for developing a degree apprenticeship in risk and safety management:

- More punitive legislation, use of novel technology and high profile major accidents mean that risk and safety management is a growing profession.
- There is a shortage of skilled risk and safety professionals, and the ageing workforce will only exacerbate this as 'baby boomers' retire in the next five to ten years.
- There is increasing effort by professional institutions to recognise risk and safety management as a standalone discipline, e.g. IChemE's professional registration in process safety.
- As well as recruiting graduates into the profession, upskilling experienced discipline engineers via a master's qualification helps fill the skills shortage.

Knowledge	Skills	Behaviours
• Risk management principles and practice • Risk assessment techniques • Industry domain • Employer specialisms	• Risk and safety management • Lifecycle view • Leadership • Effective communication • Problem-finding and creative problem-solving	• High reliability mindset • Change, adapting and visualising • Improving • Professional participation

Figure 2 – KSBs of the Risk and Safety Management Professional (Degree) Apprenticeship

The degree apprenticeship aims to create rounded professionals capable of working competently in their chosen industry, but with KSBs that are transferable across high hazard industries, as shown in Figure 2. Such professionals typically work in the fields of technical safety, safety and reliability, nuclear safety, chemical and process safety, rail safety, product safety and air safety.

The Risk and Safety Management Professional (Degree) Apprenticeship has been recently approved by the IfA. The associated academic qualification requirements of the apprenticeship are met by Risktec's MSc in Risk and Safety Management, delivered in partnership with LJMU (Liverpool John Moores University).

CONCLUSION

Degree apprenticeships offer significant benefits for both apprentices and employers alike. The new degree apprenticeship in risk and safety management aims to help employers meet the skills shortage across the high hazard industries.

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Digitalisation: A framework for high hazard industries

Society struggles to encapsulate and articulate the biggest revolution of our time with clunky buzzword phrases such as 'The Second Machine Age', 'The New Digital Industrial Revolution' and 'Industry Revision 4.0'. Perhaps this is because 'digitalisation' is becoming so extensive, pervasive and ubiquitous, it has the potential to effect almost everything, everywhere. So what is it and what does it mean for the high hazard industries?

Whereas 'digitisation' is the process of converting information into a digital format, 'digitalisation' is the integration of digital technologies into everyday life by digitising everything that can be digitised. Digitalisation, if used appropriately, can make things easier, more efficient, faster, cheaper, more accessible, more visible, more user friendly, simpler, more reliable, safer, more secure, more realistic, more enjoyable and so on.

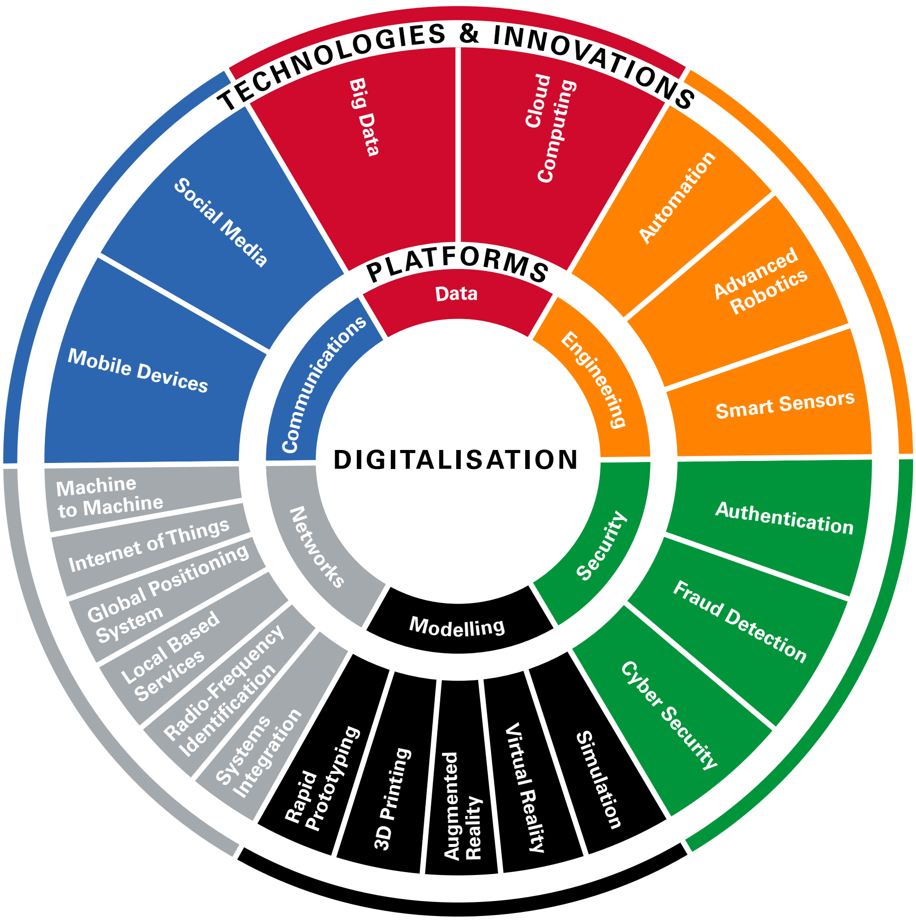

Figure 1 – Digitalisation framework for high hazard industries © Risktec Solutions

The opportunities are pretty much endless and only really limited by our imaginations. So, no wonder it is difficult to encapsulate and articulate.

OPPORTUNITIES...

Whilst businesses can choose to ignore digitalisation at their commercial peril, this is not an option for high hazard industries. Even if they wanted to overlook the opportunities to improve and optimise business performance, they must embrace the opportunities to directly reduce risk. They have a responsibility to ensure they maintain their risks as low as reasonably practicable (ALARP) by embracing all reasonably practicable opportunities that come along. Digitalisation presents a range of such opportunities, for example:

- **Advanced robotics** could completely remove operators, maintainers and inspectors from potential hazards thereby eliminating risk to people.
- **'Big data'** (allowing vast quantities of complex data to be processed and analysed extremely quickly) coupled with **artificial intelligence** could allow active condition monitoring systems to directly control operations, creating a self-policing system that is quicker, more responsive and hence safer than conventional human controlled systems.

- **Virtual and augmented reality** allows operators to practice safety critical roles and rehearse emergency response scenarios in a highly realistic and immersive way. This makes them more prepared, resilient and competent to perform these roles.

...AND THREATS

As with any change, despite good intentions, if inadequately conceived or executed, digitalisation could compromise overall safety. Such potential threats include:

- Unexpected or erroneous system responses caused by poor design of software or bugs, or virus attacks.
- Malicious operation of safety critical systems by hacking of cyber systems, such as big data and cloud computing.
- Inability of smart sensors to achieve the reliability targets required to meet their safety function, thus compromising overall safety integrity.
- Not addressing whether the outcomes of automated decisions will be decided by ethics or data. For example, in a critical situation, should automated machinery be programmed to damage a safety system if necessary to avoid harming a worker?

MEASURE TWICE, CUT ONCE

You can only manage the risks you know about; so, before introducing digitalisation, high hazard industries must appreciate fully the potential threats associated with each change. This can only be achieved through a fundamental understanding of the specific innovation and what it does for operations and safety. This means:

1. Understand what digitalisation actually is. **Figure 1** presents a helpful framework to work through.
2. Translate this language into terms that designers, operators and managers of facilities can understand and relate to. This challenge should not be underestimated. Those at the forefront of digitalisation generally have very different backgrounds and outlooks from those involved in the more conservative industrial sectors.
3. Apply this understanding to identify what opportunities digitalisation presents and what the associated threats may be.

MANAGING CHANGE

From this point onwards embracing digitalisation is about change management and standard risk management processes apply. This involves identifying the hazards introduced during implementation and subsequent operation, as well as those measures that can be put in place to ensure that the associated risks are reduced ALARP. As noted above, one key break from the status quo will be the need for relevant digitalisation expertise to bridge the language barrier. Digitalisation skills will surely become central to high hazard industry competence frameworks in the not too distant future.

It would be a mistake to view digitalisation as a one-off activity. By its very nature it is a fast moving landscape with new developments, breakthroughs and applications happening all the time. High hazard industries should embrace these when the time and opportunity is right. This implies both regular and adhoc reviews to keep up to date with general developments and to react to major, ground-breaking innovations.

CONCLUSION

Digitalisation is intended to make life easier and is becoming integrated into everything we do in a seemingly relentless series of technological advances. In doing so, it presents a new challenge for high hazard industries. But, armed with a detailed understanding of what digitalisation means and a robust risk management process, this is a challenge that can be readily overcome, reaping the benefits.

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Ship collision risk assessment – turning data into realism

Ship collisions can result in substantial damage to offshore assets and be a major contributor to the risks of personnel onboard. With the growing availability of historical ship location data, comes the ability to provide bespoke predictions of ship collision risk and target specific risk reduction measures.

INTRODUCTION

Collision risk is often assessed using available information such as published accident statistics and shipping densities. Accident frequencies typically relate to broad operating regions, e.g. UK continental shelf, and whilst shipping densities may be more location specific, they can still cover relatively large patches of sea and provide little information regarding the nature of vessels. Given the coarse geographical resolution of such information, the question for operators is whether such data are representative of their specific circumstances and, by extension, whether it can be used to provide meaningful conclusions.

LOCATION, LOCATION

The details of historical shipping traffic around a location of interest can significantly improve any analysis of collision risk. Such information is widely available from vessel tracking service providers, based on collated transmissions from the Automatic Identification System (AIS) used by most vessels.

AIS is a system designed to automatically provide information about a ship to other ships and to coastal stations. It is required to be fitted on all ships on international voyages of 300 gross tonnage (gt) or more, cargo ships of 500 gt or more and all passenger ships irrespective of size. The system is also routinely used by smaller vessels to help reduce collision risks. Each AIS transmission provides the position, speed, course and heading of the vessel, and static information such as identification (e.g. call sign, name, IMO number), length, beam and vessel type. An AIS data set can therefore provide a wealth of information regarding the historical vessel traffic around an installation.

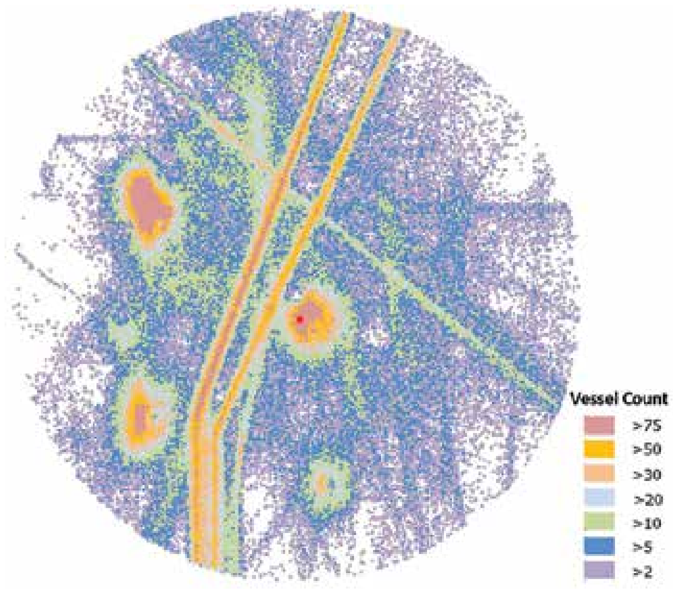

Figure 1 – Example AIS vessel density plot around an offshore installation (red dot at the centre)

DATA MINING

The number of signals in the data set depends on the vessel activity in the region, and also on the spatial extent, time period and sampling time in the data (i.e. time between AIS signals from the same vessel), but it is not unusual for there to be several million records to analyse. For relatively large data sets like this, the use of a database package and associated query language (e.g. SQL) is essential for storage, rapid interrogation and processing of data.

Most risk assessment models for vessel collision consider contributions from passing vessels in nearby shipping lanes that could potentially steer or drift off course onto a collision course, as well as the hazards from fishing boats in the local area and planned visits by vessels attending the installation. The AIS data can be used in a number of diverse ways to highlight and define the risks presented by each of these contributions.

A simple analysis of the positional data associated with each signal allows vessel densities to be visualised (Figure 1). This can immediately identify key routes or lanes close to the installation, e.g. the orange straight lines running top to bottom in Figure 1. Further interrogation of shipping lane data can quickly determine the number of vessels and the distribution of vessel types, speeds, energies, sizes, transit times and closest points of approach for vessels in a particular lane. Such analysis can be directly applied to collision models of passing traffic, noting that it reflects actual operations in the area.

Fishing vessels do not follow such predictable courses, but understanding the local fishing vessel density and potential impact energies can allow generic accident frequencies to be calibrated appropriately. The types of gear and engine sizes of fishing vessels can also be determined by cross-referencing identified vessels against local fishing fleet registry information. This can be particularly relevant to subsea infrastructure, with the potential for damage by snagging of nets and trawling board impacts.

BIG BROTHER…

It is common for operators to implement strict vessel management procedures for vessels visiting an installation (e.g. supply vessels, offloading tankers), with only authorised vessels allowed to approach closer than 500m and with significant speed restrictions. Using historical AIS data, it is straightforward to identify all incursions into the restricted zone as well as the particular vessels and speeds. Such information not only provides actual incursion and speed statistics for use in the risk assessment, but also provides a check that in-field procedures are being followed appropriately. Where such restrictions are violated, procedures can be reviewed and improved.

CONCLUSION

Ship collision poses a severe hazard to offshore installations and the associated risks should be assessed carefully. Historical vessel movement data from AIS transmissions provide a means to analyse vessel movements in the immediate region around a facility and can provide a rich insight into the nature of the traffic. This allows for an improved assessment of collision risks for an installation compared with the traditional use of generic data, and allows more specific risk reduction measures to be identified.

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Fatigue risk management with bowties

Fatigue is a major issue for organisations with shift working patterns, especially those with long or irregular hours. Where facilities operate 24/7, extended wakefulness, inadequate sleep and night work can be common and it is impossible to totally eliminate fatigue from the workplace.

Traditionally, organisations have adopted a prescriptive approach to managing fatigue that focuses primarily on controlling the hours an individual can work per shift, minimum break times, maximum number of sequential shifts or the cumulative number of hours worked in a given period.

Whilst compliance with limits on working hours has a valid role to play, in recent times fatigue management has moved towards a more flexible and multi-layered approach (see Refs. 1 and 2), where prescribed working hours are only the first layer in several lines of defence (Figure 1).

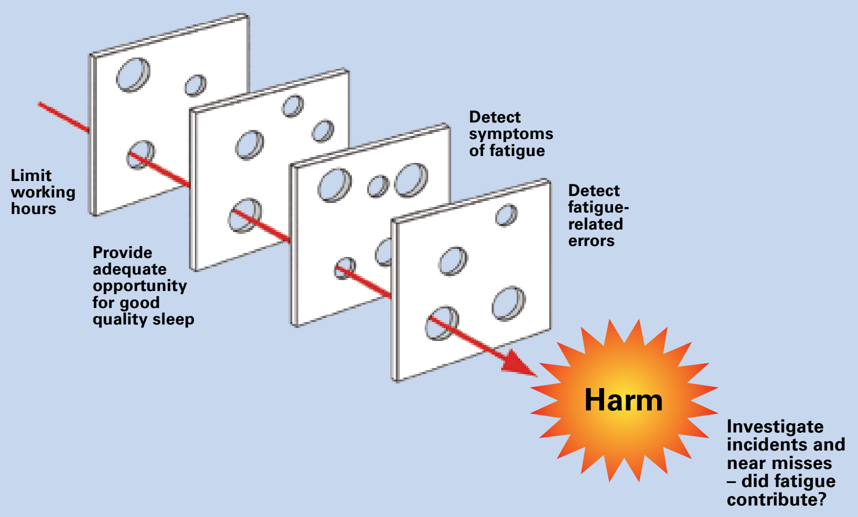
Of course, fatigue can be managed in the same way as any other workplace hazard. Risk assessment techniques can be adapted to identify the causes and consequences of fatigue and ensure that a variety of prevention and mitigation measures are implemented to provide the multiple layers of defence described in Figure 1. The identified measures can then be implemented through a structured fatigue management framework, which becomes an integral part of the organisation's overall health and safety management system.

BOWTIE ANALYSIS

One proven approach to developing a risk-based fatigue management framework is to apply bowtie analysis. This ensures that the framework targets the location- and activity-specific causes and consequences of fatigue for specific operators. Given the bowtie diagram structure, with its origin in the Reason 'Swiss cheese' model, bowtie analysis is an ideal way of identifying, evaluating and demonstrating multiple layers of defence for managing fatigue.

A bowtie diagram is straightforward to develop from relevant good practice (e.g. Refs 1 to 5) and a multi-disciplinary workshop involving managers, supervisors, operators and safety representatives. The team identifies ways in which the organisation could adopt specific tools to address gaps between current arrangements and fatigue management good practice. The workshop also considers further risk reduction measures, in order to reduce fatigue risk to ALARP levels. All resulting bowtie prevention and mitigation measures (i.e. those currently in place at the time of the assessment, plus additional measures agreed for implementation) can be captured in the framework.

Figure 1 – Fatigue management layers of defence



SHARED RESPONSIBILITY

Extracts from an example bowtie diagram are shown in Figures 2 and 3. The diagrams illustrate that responsibility for managing fatigue in the workplace is shared between an organisation and its employees. Certain prevention and mitigation measures are within the control of the company, others are controlled by the individual. Similarly, although company-wide measures are sufficient to manage the majority of the risk, case-specific additional controls may be required to ensure sufficient layers of defence. For instance, these may include:

- Review of sleep quality and quantity and the identification of improvement measures.
- The dynamic assessment of fatigue symptoms by the individual, his peers or supervisor.
- Flexible strategies for reacting to fatigue, such as exercise, short breaks or task rotation.

The bowtie provides an easy-to-use template for an organisation to assess its fatigue management arrangements for each operating asset against the requirements of its fatigue management framework and good practice, e.g. by auditing against the barriers shown on the diagram. Should fatigue be indicated as a contributing factor to an incident, the bowtie also provides a starting point for determining failure mechanisms and underlying root causes.

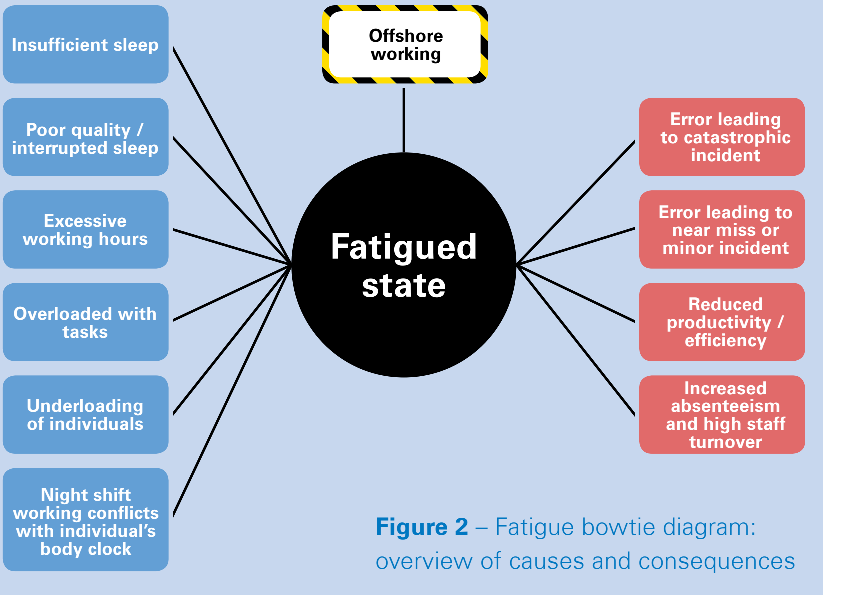


Figure 2 – Fatigue bowtie diagram: overview of causes and consequences

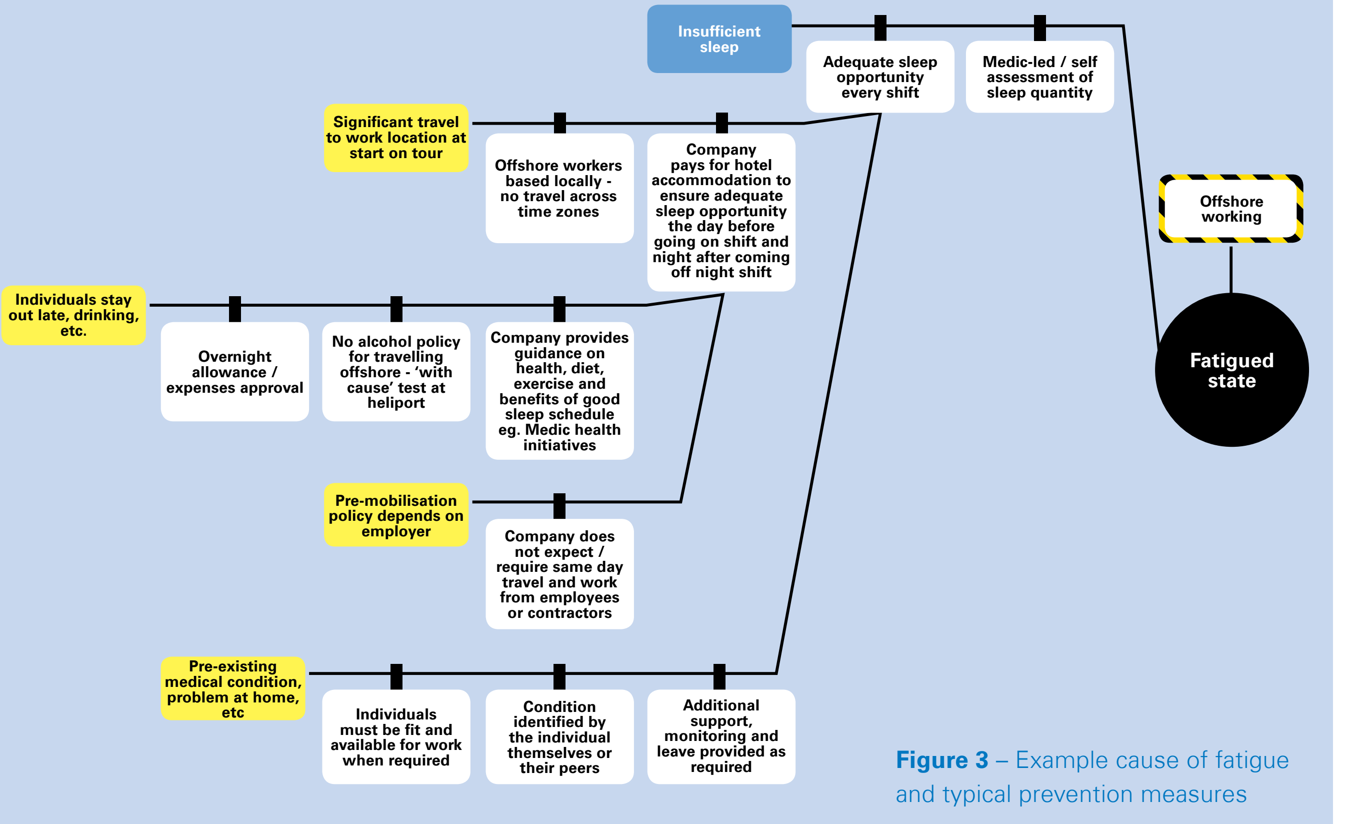


Figure 3 – Example cause of fatigue and typical prevention measures

CONCLUSION

Clear communication of hazards and their controls is a recognised benefit of bowtie analysis. In this case, the bowtie diagram illustrates, in a readily-understandable form, what an organisation is doing to safeguard its workers against fatigue and what the workers can do for themselves.

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