RISKworld

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In This Issue

Welcome to Issue 23 of RISKworld. If you would like additional copies please contact us, and feel free to pass on RISKworld 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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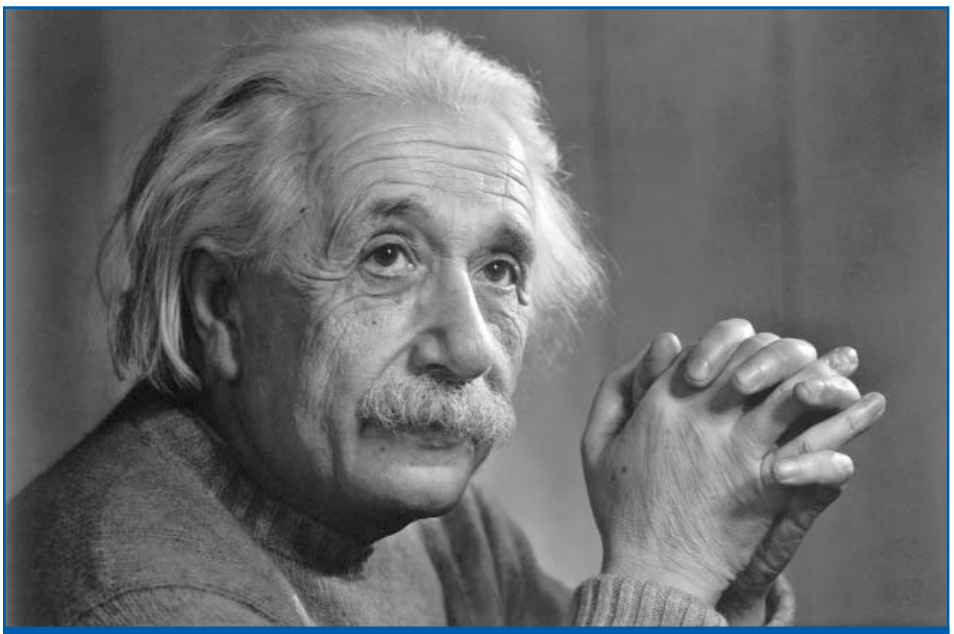
Risktec

Safety by People for People



"The world is a dangerous place to live … because of the people who don't do anything about it." Albert Einstein

Risktec continues to grow and develop the services we offer to our clients. With over 200 personnel, supplemented by up to 500 associates, operating from 14 offices in the UK, Middle East and North America, we are organised to deliver an effective service to our diverse client base. Our most recent office in Derby in the UK is responding to recent demand from the rail sector, but in the longer term we aim to provide local support to our other clients in the area.

Our strong growth has not diluted our core objective – to deliver high quality, fit-for-purpose services to our clients. Our people share a strong desire to ensure their work makes a difference that results in the implementation of genuine risk reduction measures.

The results of our most recent client survey confirm that we are striving hard and achieving very high levels of client satisfaction. We are extremely appreciative of, and receptive to, the feedback we have received.

We are conscious of the pressures our clients face and the challenges associated with safe operation in a competitive world, where the perspectives of numerous stakeholders need to be managed. The need for impartial and clear pragmatic advice, backed by appropriate risk assessment has never been greater, and we aim to rise to this challenge.

In this edition, we focus particularly on the importance of people to safety, whether through leadership skills, organisational culture, specific job-related critical activities or effective training. We hope that you find the associated articles to be interesting and thought provoking. As Einstein observed, doing nothing doesn't make the world a safer place.

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Major hazard safety leadership

Investigations into recent major accidents, such as the Texas City refinery explosion, the Gulf of Mexico oil well blowout and the Fukushima nuclear accident, all highlight the importance of effective leadership in preventing disasters in the major hazard industries. But why emphasise leadership and not management? What does a leader need to do differently to assure major hazard safety as opposed to personal safety?

A leader is different to a manager

Leadership and management, while necessarily linked, are not the same thing and it is worthwhile thinking about the differences. The manager's job is to plan, organise and coordinate. The leader's job is to inspire and motivate. The American quality guru Peter Drucker arguably best described the difference, "Management is doing things right; leadership is doing the right things." So if major hazard safety leadership is about doing the right things to control major hazards, what are those things?

Box 1 - Doing the right things

- Does our Board have any competence in major hazard safety?
- What are the possible major accident events at our facility?
- What action is being taken for events at the upper end of the risk profile?
- Are the reporting lines of engineering authorities and major hazard safety specialists high enough in the organisational structure to have influence over decisions?
- Do senior management incentive systems incorporate measures of major hazard safety?
- How are the layers of protection (risk control systems) performing? Are there any warning signs such as more leaks, increasing maintenance backlog, etc?
- Are we identifying the root causes of our 'near miss' incidents where, under slightly different circumstances, a major accident could have resulted?
- Have we incorporated lessons learnt from major accidents in our industry?
- Do we ask open questions about major hazard safety during our management walk rounds?
- Do people in the organisation raise concerns and issues?
- Do we welcome bad news?
- Do we regularly 'step back' and take a fresh look at our organisation?

Major hazard safety is different to personal safety

Whilst important for personal safety, holding the handrail and putting lids on cups of hot coffee will not prevent major accidents. Disasters don't happen because someone slips down the stairs or scalds their hand. They result from flawed ways of doing business that accept poor risk control.

Leaders must understand this difference. If they don't, they cannot focus on the right things. If they don't focus on the right things, why should anyone else? The best leaders focus intensely on what they know is right and what needs to happen. Others see this and know what the leader cares about. This creates employee engagement and loyalty, and in this environment, employees choose to do the right thing as well.

Focusing on the right things

All major hazard facilities operating in highly regulated environments will have a management system of some sort in place to control major hazards. For example, there will be operating and maintenance procedures, and standards covering risk assessment, management of change, incident investigation, emergency preparedness and audit.

This is the world of management and, while having these systems is important, what really matters is the shared beliefs and perceptions about major hazard safety – that is, the safety culture of the organisation. This is the world of leadership. The Institute of Nuclear Power Operations (INPO) puts it very clearly, "Production behaviours will take precedence over prevention behaviours unless there is a strong safety culture – the central focus of leadership".

Whereas a manager is more likely to accept the status quo, a core characteristic of a leader is to challenge and improve the systems and the culture. Indeed, the Australian professor Andrew Hopkins, author of several excellent books on major accidents, refers to "mindful leaders" as those who don't just assume that because systems have been put in place everything will be fine. Their mindset is one of "chronic unease" – they are preoccupied with the potential for failure and the possibility of a major accident, not solely on commercial matters, lost time injuries or climate change, for instance. Mindful leaders continually ask searching questions of themselves and their organisation to get a feel for whether the right things are happening (see Box 1).

Conclusion

To prevent major accidents leaders need to focus on things that make a difference. In this respect, a leader's role is to challenge the organisation on whether the right things are being done. And it is better to do this today rather than in the aftermath of a major disaster.

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Leadership guidance

- Leadership Fundamentals to Achieve and Sustain Excellent Station Performance, INPO, 2007.
- Corporate Governance for Process Safety, Guidance for Senior Leaders in High Hazard Industries, OECD, 2012.
- Understanding Your Culture, Hearts & Minds, Energy Institute.

Culturally-enabled HSE management systems

If you had to name a single attribute of an organisation responsible for its success or failure, it would probably be its culture. While difficult to define precisely, we know good culture when we encounter it and we acknowledge its importance.

The term **safety culture** was first coined after the 1986 Chernobyl nuclear accident to help explain how the collective lack of understanding of risk and safety by the employees and organisation contributed to the disaster. Today, safety culture is often defined as "the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management" [Ref. 1].

The concept of a **Health, Safety and Environmental Management System (HSEMS)** evolved in the nineties and is commonplace today. Simply put, a HSEMS is a framework of processes and procedures that ensure an organisation can fulfil its HSE objectives.

Three steps to improvement?

Progressive HSE improvement and risk reduction are commonly represented as three stages corresponding to changes in engineering, management systems and leadership and culture (see Figure 1).

This model helpfully distinguishes the different key elements of HSE improvement but implies that improving culture is separate from, and follows, engineering and management system improvements. However, it must be emphasised that this is not the case – they are mutually dependent.

Mutual dependence

A **culturally-enabled HSEMS** is one where the HSE management framework and HSE culture are fully aligned and mutually supportive. Effective management systems can facilitate the development of good safety culture, helping it grow to become an integral and ultimately, fully embedded, part of the organisation. The principle of mutual dependence is key – good organisational culture should drive the development and implementation of the HSEMS, and the HSEMS should be designed to promote and support a positive HSE culture.

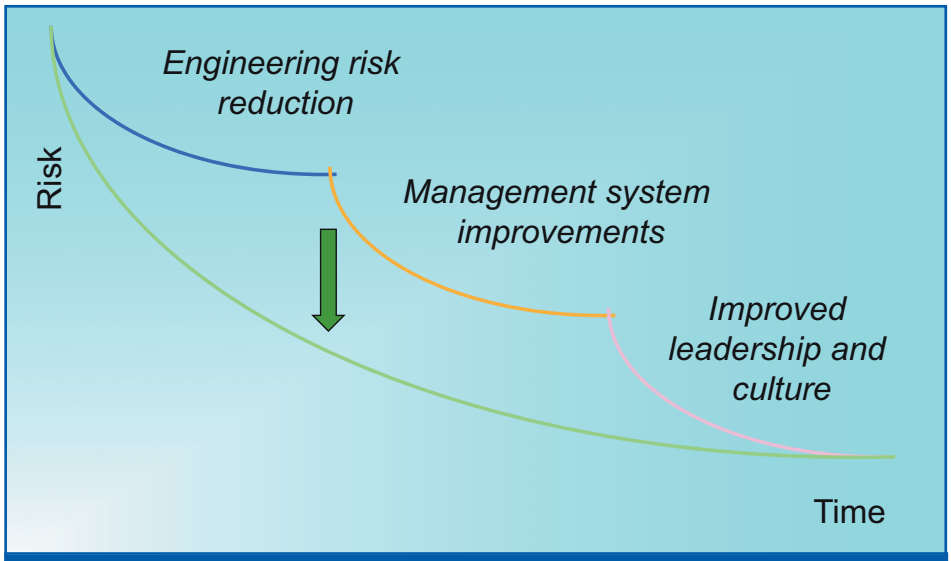

Figure 1 – A culturally-enabled HSEMS allows for faster risk reduction

The HSEMS provides a framework within which everyone in the organisation should be committed and motivated to work within. Although this framework will be documented and managed through procedures, manuals, databases, etc. and compliance with these may be mandated, this is not, and cannot be, sufficient. Inevitably, documented procedures will never be 100% correct and unambiguous, and demanding compliance will always be an inadequate means by itself of assuring all HSE issues are addressed effectively.

The importance of participation, ownership and personal commitment to HSE as a value throughout the organisation – a positive HSE culture – cannot be overstated. By achieving this, the highest standards of HSE management become common sense and commonplace. Correspondingly, the evaluation of the HSEMS design and implementation (through audit, performance measurement and management review) must focus on the overall effectiveness of HSE management, not solely on compliance with procedures.

A key benefit of a culturally-enabled HSEMS is also illustrated in Figure 1 – it allows for faster and, possibly greater, risk reduction. As a minimum, it ensures that engineered safeguards and procedural barriers will function as intended. At its best, it can promote proactive, often innovative, risk reduction, leading to further improvement.

The five Cs

The essential requirements of a culturally-enabled HSEMS are the "five Cs" [Ref. 1]:

- **Control**, achieved by securing the commitment of employees to clear HSE objectives.
- **Co-operation** between individuals, HSE representatives and groups.
- **Communication** throughout the organisation.
- **Competence** of individuals.
- **Consistency** in all activities.

There is extensive literature describing the characteristics, nature and importance of a good safety culture [see Ref. 2 for example].

Even an excellent HSEMS which is thorough, clear, well-structured and well-documented, can flounder with a 'pathological' culture that does not care as long as it is not caught. Conversely, a 'generative' or high reliability culture will enable even an incomplete HSEMS to function reasonably effectively, and as importantly, this culture will tend to drive the necessary improvements.

Conclusion

While there are many factors that can contribute to HSE risk reduction, a culturally-enabled HSE management system offers the most assured, resilient and expedient way to achieving and surpassing HSE objectives.

References

1. HSG 65, Successful Health and Safety Management, UK HSE, 1997.
2. Safety Culture - Assessing and Changing the Behaviour of Organisations, J.B. Taylor, 2010.

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Bowtie: Closing the loop between risk assessment and the management system

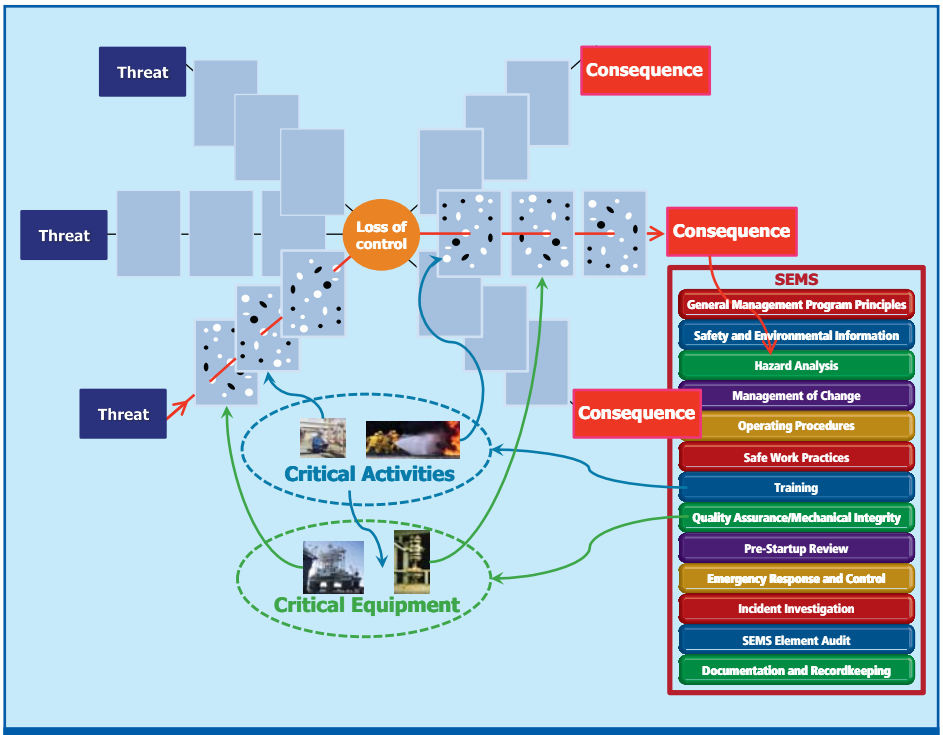

Figure 1 – Joined Up Thinking: follow the links from SEMS to critical activities & equipment to barriers

Companies in major hazard industries have long been accustomed to carrying out hazard identification and risk assessment. They are also expected to have in place a structured safety management system. In recent years, moves have been made to link the two visibly – to demonstrate that the management system is indeed able to control the actual hazards present, rather than being a separate system produced in isolation.

The latest such development has occurred in the US, where offshore operators are required to develop and implement a Safety and Environmental Management System (SEMS) for oil and gas operations in the Outer Continental Shelf. A key requirement is for SEMS to demonstrate that safety critical equipment is being maintained and that safety critical jobs are undertaken by competent people – in other words a joined up SEMS.

Linking barriers to the SEMS

Bowtie analysis is an established risk assessment technique that allows detailed analysis of prevention and mitigation measures for specific hazards. This is achieved by constructing a bowtie diagram which illustrates potential causes of the hazardous event and ultimate consequences. However, one aspect of the technique that is not always exploited to its full potential is to verify the link between the barriers in the bowtie and the SEMS (see Figure 1).

Each prevention barrier on the left side and each mitigation barrier on the right side can be linked to critical tasks which keep the barrier working and are in turn linked to job descriptions, training and competence assessments, i.e. the **competence assurance** part of the company's SEMS.

Barriers that make a claim on a piece of equipment can also be linked to computerised maintenance management systems which specify the equipment's criticality and inspection/test regime, as well as to performance standards, performance assurance activities and verification schemes, i.e. the **asset integrity** part of the company's SEMS.

Managing what matters

Exploring these direct links between risk assessment and the SEMS highlights any weaknesses in arrangements and establishes objectively whether effective systems are in place to sustain those measures essential for controlling hazards.

Not only does this provide assurance that hazards are effectively managed, it also ensures that the SEMS is designed to focus on the real-life threats to the organisation's safe operation – it manages what matters.

Having conducted the risk assessment and confirmed the links between hazards and the SEMS, a further 'layer' of bowtie analysis allows for the audit of the arrangements on the ground. The bowtie diagrams and supporting critical activities and equipment reports can act as checklists to verify that the hazards continue to be controlled as intended.

Living safety cases

Safety cases can use bowties to map the link between major hazard barriers and the SEMS. Operators or regulators inspecting the facilities can easily check for evidence of the supporting competence assurance and asset integrity activities, providing proof that the safety case is based on reality and that hazard management is truly owned by the workforce.

Conclusion

Making full use of the bowtie methodology helps organisations develop a joined up SEMS, which is targeted at major hazards. The approach ensures that the SEMS is indeed managing what matters. Thereafter, using bowties to audit competence and asset integrity closes the loop between the SEMS and risk assessment.

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To say and do: how do different learning methods measure up?

Consider the last training event you attended. Which aspects of that training do you remember most clearly? The most memorable elements were probably the activities you participated in, or the anecdotes recounted by the teacher. Can you remember the slides as they flew past?

Figure 1 illustrates that the amount of learning we retain is directly proportional to the amount of participation. So how do various learning methods stack up against the ideal of 'say and do'?

Figure 1 – Level of Retention versus Involvement (adapted from Ref. 1)

Face-to-face classroom training offers the most obvious opportunity to set activities where the participants can 'say and do'. Students actively working together to brainstorm a solution, design a prototype, or explain new principles to each other are engaged, enjoying themselves and learning effectively.

A novel, engaging mechanism for training is game-based learning which is a refreshing alternative to conventional teaching, and can easily be incorporated into classroom-based activities. It increases the impact of training by linking a fun exercise to a serious concept. For example, the fundamental concept of layers of protection is easy to demonstrate using the well known Jenga 'tower block' game. Since the participants' levels of 'do' are very high, the retention rates for their learning are greatly enhanced.

Assessment is a proven way of getting students to engage more with the material and can range from a simple multiple-choice to a full university-validated postgraduate essay question requiring research and critical thinking. Apart from the obvious benefit in encouraging the students to pay attention because there is a test at the end, the time spent going over the course materials and researching their essays embeds the learning effectively.

Books are relatively cheap, easily accessible and a good source of reference material, but usually lack the elements that encourage the reader to 'say' or 'do'. The best instructional books engage the reader through simple activities and anecdotes.

E-learning does not always offer the most obvious opportunities for participants to 'say' and 'do', and for this reason can sometimes receive bad press. However, a study at Touro University International in New York City concluded, "we can deduce that DE [Distance Education] not only is comparable to traditional instruction, but also... can outperform traditional instruction".

To ensure the effectiveness of e-learning, it needs to have the following characteristics:

- Engaging: contains different types of media to keep the students' minds engaged and entertained.
- Practice and feedback: should allow students to receive feedback and guidance on their work. There needs to be features that provide corrections, engender critical thinking and promote decision-making.
- Motivational: the curriculum needs to be relevant to the real world and constructed to enable students to learn at their own pace and in their own style.

E-learning has some clear advantages: Students can learn almost anywhere and at times that best suit them. It allows measuring of progress using objective, reliable and standardised tests, which can be difficult to achieve by an instructor alone.

However, not everything can be taught using e-learning. There are many skills which require interaction with and feedback from a subject matter expert in order to achieve and maintain good performance on the job, such as presentation skills and report writing.

Conclusion

Whatever the delivery method, human interaction and hands-on exercises are key. There should also be ample opportunity to ask questions, which requires a trainer with practical experience. Some would have you believe that technology alone can improve the quality of the teaching; but technology does not teach students, effective teachers do.

References

1. E. Dale, Audiovisual Methods in Teaching, 1969, NY: Dryden Press.

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Applying QRA more widely

In recent years, there has been increasing interest in extending the scope of quantitative risk assessment (QRA) beyond the risk to people to look at areas such as environmental damage, economic impact and the effect on reputation. High profile accidents with widespread consequences, such as Deepwater Horizon, Buncefield and Fukushima, have left many organisations with a desire to understand better their exposure across the whole spectrum of potential risks. But how easy in practice is it to apply QRA more widely?

Traditional safety QRA

QRA in the oil and gas industry, for example, focuses on the risk to workers and the general public from major hazards such as fires, explosions and toxic gas release. This process involves identifying the hazards, evaluating the frequency of the various hazardous events and undertaking consequence analysis to estimate the magnitude and effects of the resultant fire, explosion or gas cloud. Geographical information is captured, including the location of the hazardous events and the number and distribution of people. This information and supporting analysis of the hazard progression (taking into account detection, isolation and ignition, for instance) are combined with the vulnerability of people to each hazard to calculate the risk to people.

Wider effects

However, hazards may also have other negative effects beyond harming people. Liquid spills may cause harm to the environment, whereas fires and explosions can damage assets and infrastructure. These may lead to lost revenue, regulatory penalties, compensation to third parties, as well as damaging the reputation of the company involved. The information in QRA models can be extended to quantify some of these additional risks.

Harm to the environment is normally associated with releases of hydrocarbon or other chemicals either into the sea or onshore where it flows into water courses or permeates into the ground. The volume of release can often be estimated from the process data used in the conventional consequence modelling (release rate, duration and the volume of the isolated inventory). In practice, all potential sources of release would be screened first to determine whether they would reach the environment. While quantifying clean-up costs is feasible, measuring the harm to the environment is more subjective and is perhaps best achieved using a number of discretely defined, qualitative categories (for example see Figure 1).

Damage to assets and infrastructure depends on a combination of magnitude (overpressure or radiation) and in the case of fires, the duration, which may be limited by isolation and depressurisation. For onshore and offshore facilities it is usually straightforward to estimate the repair or rebuild cost. Lost production or processing revenues are sometimes a simple function of the outage period, though in many cases production is actually deferred rather than lost. However, oil and gas blowouts need to factor in the cost of bringing the well under control, which can be very high especially if a relief well needs to be drilled.

Bird's-eye view of the Gulf of Mexico oil spill

Regulatory penalties extending to loss of operating licence, compensation to neighbours and the public, and reputation issues are difficult to quantify, but it is usually possible to assign a qualitative indication of the harm, which can be presented as a risk matrix (similar to Figure 1).

Conclusion

The analysis of event frequency, event progression and consequences developed in traditional safety QRAs provides a sound platform from which to develop a wider picture of risk that can naturally include environmental, asset and economic factors.

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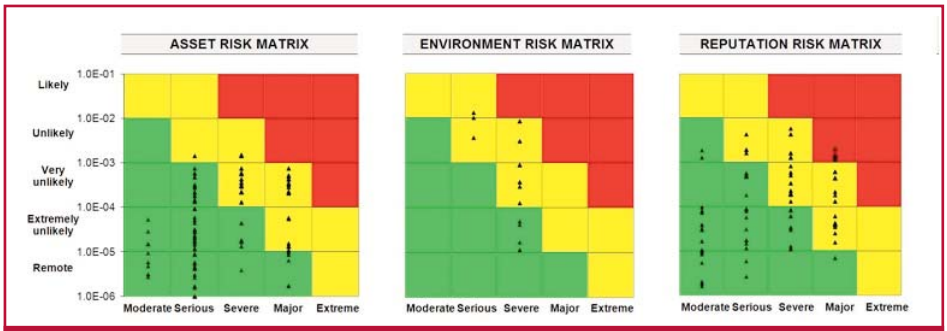

Figure 1 – Semi-probabilistic presentation of QRA results