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Contents

A change in focus from safety culture to human factors – proposed 'top 11' human factor topics for the Western Australian mining industry

A Chaplyn[1], R Lardner[2] and J G Pickering[3]

ABSTRACT

During the annual Mines Safety Roadshow presented by the Department of Mines and Petroleum (DMP) in 2015, a workshop was undertaken to identify areas where DMP could assist Western Australian mine sites to improve their safety performance. Improving safety culture ('the way we do things around here') was a common response.

Following an assessment of literature and activities being undertaken by other regulators, DMP recognised that human factors would provide a useful framework for managing the subject of safety culture. In particular, the UK Health and Safety Executive (UK HSE) top-10 human factor topics were seen as being highly relevant to the concept of developing a 'resilient safety culture' that was central to DMP's Reform and Development at Resources Safety (RADARS) initiative, which commenced in 2009.

The applicability of the UK HSE top-10 human factor topics to Western Australian mining was assessed. Available data sources were reviewed to identify human factor trends, with sources including industry research, incident data, mines safety literature and DMP records including safety alerts, site inspection records and reports. Internal focus groups were also consulted during the review.

The DMP review found that the UK HSE top-10 human factors framework is relevant to the Western Australian mining industry. More importantly, with minor modifications, it can provide a useful framework for operational and safety and health professionals wishing to adopt a strategic approach to managing human reliability and failure within the State.

INTRODUCTION

The term 'safety culture' first started to appear in the vocabulary of the Western Australian Mines Regulator around 1998, when the then-State Mining Engineer Mr Jim Torlach provided an editorial for the June edition of the Department of Minerals and Energy WA *Minesafe* magazine (Torlach, 1998). Within the editorial, Mr Torlach stated that 'an entrenched risk-taking culture' persisted within the State's underground mining industry, and this culture was a key factor in the industry recording a fatality rate approaching one per month. To change this culture, Mr Torlach believed that a 'total commitment and involvement on the part of all involved in the industry' was required. In an endeavour to drive the required change, the Mines Safety Inspectorate initiated a Safety Behaviour Working Party through the Mines Occupational Safety and Health Advisory Board (MOSHAB).

One of the working party's first activities was to undertake a safety survey of underground mining. The survey was completed in 1997 and found that risk-taking behaviour was evident, and its extent

1. MAusIMM, State Mining Engineer, Department of Mines and Petroleum, East Perth WA 6004. Email: andrew.chaplyn@dmp.wa.gov.au
2. Founder, Keil Centre, Perth WA 6000. Email: ronny@keilcentre.com.au
3. MAusIMM, Formerly: District Inspector of Mines, Department of Mines and Petroleum, East Perth WA 6004.

was governed by the quality and commitment of management at individual mine sites (MOSHAB, 1998). The working party subsequently made eight recommendations to address this problem. The recommendations covered training requirements for operators and supervisors, as well as various activities for mine site senior management to undertake to demonstrate a clear commitment to safety.

In 2002, the Safety Behaviour Working Party followed up with an expanded survey, which also covered surface mining. There was considerable improvement in perceptions regarding supervisor skills to influence safe behaviours, but there was a decline in perceptions regarding the availability of safe work procedures, training, compliance to procedures and the penalising of employees for performing tasks they considered unsafe. Following this second survey, the task of continuing to drive cultural changes in safety became the primary responsibility of individual mine sites, with the expectation that each site would address the recommendations identified within the report.

The next major safety change initiative undertaken by the State's mines safety regulator was in 2009, when the Reform and Development at Resource Safety (RADARS) initiative was implemented. The RADARS initiative evolved following a series of independent reviews and inquiries, increased expectations regarding safety in both the workplace and community, and increased workload on the regulator during unprecedented growth in the Western Australian mining industry (Department of Mines and Petroleum (DMP), 2015b). At the core of the RADARS initiative was the concept of driving the industry towards a 'resilient safety culture' (Table 1). The DMP Safety Culture Spectrum is based on the Safety Culture Maturity® Model published by the UK Health and Safety Executive (UK HSE) (Fleming, 2001), which outlines five levels of safety maturity, starting from 'emerging' and progressing to 'continually improving'.

TABLE 1

Safety culture spectrum – all operations should aspire to be resilient.

Safety culture type	Vulnerable	Rule followers	Robust	Enlightened	Resilient
Characteristics	In denial	Deal 'by the book'	Develop risk management capacity	Active leadership	Strive for resilience of systems
					Reform rather than repair
	Messengers 'shot'				Messengers rewarded
	Whistleblowers dismissed or discredited	Target = zero	Clarify/refine objectives	Accountabilities understood	Consistent mindset = 'wariness'
	Protection of the powerful	Reactive	Monitor/review progress	Regular reviews	Proactive as well as Reactive
	Information hoarded	Information neglected	Improve suite of performance measures	Safety management plan widely known	
	Responsibility shirked	Responsibility compartmentalised	Develop action plans	Advanced performance measures	Responsibility shared
	Failure punished or covered up	Repair not reform	Enhance systems		Failure prompt far-reaching inquiries
	New ideas crushed	New ideas = 'problems'			Actively seek new ideas
		Conform to rules		Competent people with experience	Flexibility of operation
Descriptions	In disarray Pathological	Organised Reactive	Credible Calculative	Trusting Proactive	Disciplined Generative
Strategy	Sanction	Direct	Encourage	Partner	Champion

As part of its RADARS initiative, DMP undertakes an annual Mines Safety Roadshow where it engages with mining health and safety representatives, frontline supervisors and other interested personnel on current safety issues. At the 2015 Roadshow, the theme was 'Why aren't we learning?' from incidents and accidents. DMP challenged attendees to identify areas where the industry needed to improve to achieve a resilient safety culture. Key issues raised included:

- a requirement to develop a positive safety culture through increased ownership and accountability
- the development of positive safety leadership through activities such as consultation between workers, management and health and safety representatives, and prioritising safety over production
- supporting more effective incident investigations
- the need for improved competence
- investing in safety by focusing on higher order controls in the 'hierarchy of controls', rather than relying on administrative controls.

Following the roadshow, DMP initiated a project to identify how else it might influence mining workplace culture to improve safety and health outcomes. It started by investigating the approaches adopted by other regulators.

For example, in 2007, Worksafe South Australia commenced a project with The University of South Australia to evaluate survey tools purported to measure or assess an organisation's safety culture. The project identified and evaluated 24 safety culture survey methods, with the final report released in November 2011 (Blewett and Flower, 2011). The authors concluded:

> *During the conduct of this research our concerns about the value of survey instruments as a means of evaluating 'safety culture' have grown. We now consider that proceeding with the development of another survey, as was the original intent of the research, will not lead to improvements in health and safety at work, but rather lead to further obfuscation.*

DMP continued to investigate the potential benefits from conducting some form of safety culture survey, but concluded this would be of little value because:

- the effective measurement of an organisation's safety culture requires a multidimensional approach that requires considerable effort (Fleming and Scott, 2011)
- industry safety culture surveys have been completed previously with an unknown impact
- those companies that see value in safety culture surveys are already using available tools and would therefore see little additional value from participating in a survey conducted by DMP.

DMP then reviewed the approach taken by the UK HSE. As the sole regulator overseeing a country with three times the population as Australia, the UK HSE has been able to invest many more resources into the subject of 'safety culture' than DMP, which it addresses through the lens of 'human factors'. In the UK HSE's view, safety culture is just one of many potential performance shaping factors that can contribute to an accident or incident in the workplace.

Shifting focus from safety culture to the concept of human factors offers distinct opportunities for DMP, including:

- consistency in the approach and messaging across the State's resources industry as the concept of human factors is widely used within the petroleum industry
- the concept integrates well with the DMP Safety Culture Spectrum, and already features in DMP's online information
- the concept of human factors provides a complete framework that integrates the impact of people, equipment, systems and organisational influences on safety outcomes, rather than just one element
- DMP can leverage off extensive literature and industry expertise in the field of human factors to help raise awareness and develop regulatory tools.

HISTORY OF HUMAN FACTORS AND RELEVANCE TO MINING

Research into the role of human error in accident causation started in earnest post-World War II (Human Factors and Ergonomics Society (HFES), 2016). The rapid growth of this research resulted in a new field of endeavour known as human factors. In 1957, the HFES was formed to 'promote

the discovery and exchange of knowledge concerning the characteristics of human beings that are applicable to the design of systems and devices of all kinds'. Growth in the field of human factors is illustrated by the number of human factor undergraduate and postgraduate courses offered within the United States, which is currently 75 (HFES, 2016).

According to Lees Loss Prevention (Mannan, 2012), research into the role of human factors, and how they relate to process and major hazard safety, commenced in the 1970s. The initial focus was on the analysis of operator error. In the 1980s, the scope expanded to include the analysis of human error within systems, and in particular how to prevent major accidents. Safety culture was introduced to the scope in the 1990s with the widespread introduction of safety management systems.

In the 1990s, the UK HSE started releasing reports and guidance material related to the topic of human factors. One of the more influential reports was titled 'Reducing error and influencing behaviour' (UK HSE, 1989). This publication covers the notion of human error and provides a framework for industry to use to improve safety performance.

The relevance of human factors to the Australian mining industry was clearly demonstrated in a study undertaken by Patterson and Shappell (2009) for Queensland Mines and Energy. Their study analysed 508 mining incidents in Queensland between 2004 and 2008. Patterson and Shappell (2009) found that at least one human factor was present in 95 per cent of the incidents studied, with the identification of 1554 unsafe acts related to human factors. Of these, 50 per cent resulted from a skill-based error, 41 per cent were a decision-based error, and only five per cent were a violation.

The field of human factors, as defined by the HFES and others, has an extremely broad scope. To provide clarity to its duty holders and inspectors, the UK HSE identified a 'top 10' list of topics (Table 2) that, when managed well, should increase human reliability and reduce the likelihood of human failure during operation and maintenance of hazardous facilities. The topics were classified into three distinct categories defined as:

1. core topics – fundamental to good human factor arrangements at all sites
2. common topics – relevant at most sites
3. specific topics – only relevant to some sites.

For DMP, the critical question was 'Do the UK HSE top-10 human factor topics align with Western Australian mining activities?'

Validation of UK Health and Safety Executive top-10 human factors for Western Australian mining

Definition of the UK HSE top-10 human factor topics was based on data from the UK offshore and onshore oil and gas and petrochemicals sectors, so it was important for DMP to assess whether they were also relevant to the State's mining sector or would require amendment, extension or adaptation.

A mapping and validation study was undertaken, using existing DMP data and subject matter experts, with the following objectives:

- establish whether the existing top-10 are equally relevant to the WA mining sector
- identify any differences, and any additional human factors topics relevant to mining safety
- select examples or case studies from the data which explain the relevance, using mining terminology
- prepare the output into a simple format which can be explained to DMP inspectors and industry stakeholders.

Table 3 lists the types of data available to DMP and used in the study.

TABLE 2

UK Health and Safety Executive top-10 human factor topics (UK HSE, 2005).

Core	Common	Specific
Competence assurance	Maintenance error	Alarm handling and control room design
Human factors in accident investigation	Safety critical communications	Managing fatigue risks
Identifying human failure	Safety culture	Organisational change and transition management
Reliability and usability of procedures	Emergency response	

TABLE 3
Department of Mines and Petroleum (DMP) data sources used for identifying human factor causal events.

Type of data	Data
Background reading – mining safety, human factors and regulation	A variety of published papers on mining safety, particularly those that concerned human and organisational factors affecting safety outcomes
DMP publications	Mines Safety Audits
	Mines Safety Bulletins
	Mines Safety Guidelines
	Mines Safety Information Sheets
	Mines Safety Matters pamphlets
DMP incident and inspection data, and related reports	Fatal accidents in the Western Australian mining industry 2000–2012
	Significant Incident Reports – fatalities
	Analysis of serious injury data in the Western Australian mining industry, July-December 2013
	Significant incident reports – serious injuries
	Inspectors' record book entries
	DMP Safety Regulation System database entry – injury
	DMP Safety Regulation System database entry – event

An analysis matrix was prepared comprising tables that recorded, for each topic and subtopic:

- the data source and associated study index
- a reference to a report number and/or page number
- the specific reference, which was often a direct copy or paste of the relevant text
- any additional relevant text, and/or a comment from the data analyst.

An additional human factors topic 'Emergency response' was added. While this is not a UK HSE top-10 topic, it does appear in the UK HSE's human factors inspector's guide as an eleventh topic. Also, a category of 'Not included elsewhere' was created to capture other important human factors topics that may be relevant to DMP and Western Australian mining.

Each of the data sources was carefully read by the second author (Lardner), who has 22 years' experience as an applied psychologist working on safety improvement in hazardous industries. The second author has worked extensively with the UK regulator and industry on the top-10 topics, so was able to readily identify any content that related to the top-10 human factors topics and subtopics.

Each instance of a topic or subtopic was entered into the relevant table. The 354 data points identified, which were distributed over the three topic categories, were entered into the 12 tables used for data analysis. Each data point could be analysed in two ways:

1. by counting its frequency
2. qualitative analysis of the related text.

Results of data analysis

The data analysis summary (Figure 1) shows that the majority of topics and subtopics were matched to at least one data source. Topics 1–4 and 6–11 inclusive were all matched by at least one instance of DMP incident and inspection data. Many topics were referenced in existing DMP publications. The data identified under the topic 'Not covered elsewhere' referred to management of physical and mental health, bullying, drugs and alcohol and managing the demands of the fly-in, fly-out mining lifestyle. These topics could arguably be termed 'Fitness for duty'.

Following completion of the data analysis and reporting, two focus groups were held with a cross-section of experienced DMP inspectors. The purpose was to:

- finalise a revised version of the 'top-10', which now had 11 topics
- validate the language and examples used.

Table 4 shows the final set of 11 human factors topics, validated as relevant and applicable to reducing the incidence of fatal and serious incidents in Western Australia's mining industry.

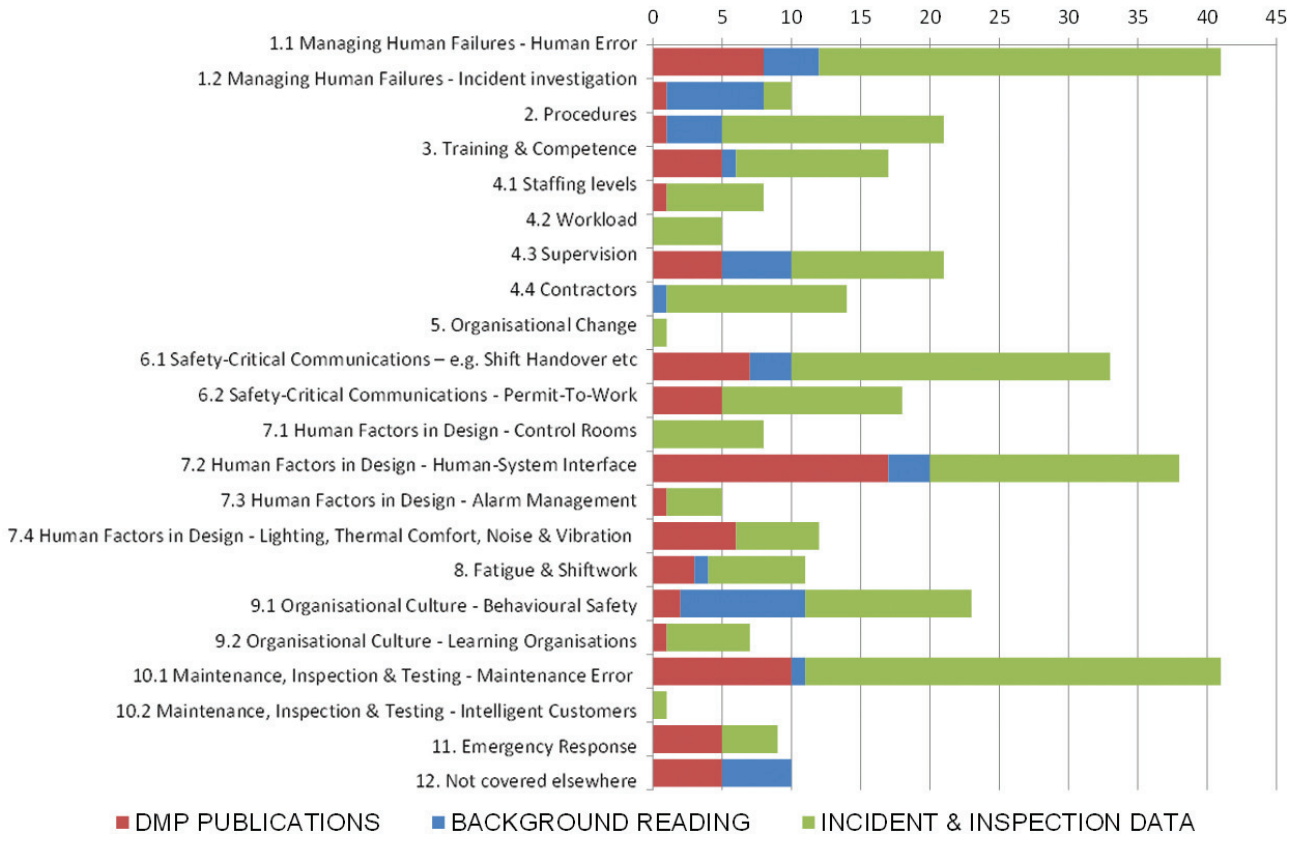


FIG 1 – Total number of reference by sources and topic.

Other data

A recent DMP initiative is the annual Registered Managers Forum, with the inaugural event held in 2015 (DMP, 2015a). This is an invitation-only event offered to those holding the position of Registered Manager, Quarry Manager or Underground Manager, which are key leadership positions as defined by the *Mines Safety and Inspection Act* (1994).

At the 2016 Registered Managers Forum, the subject of human factors was presented, including the proposed list of human factors topics that DMP believes are particularly relevant to Western Australian mining (Table 4). The attendees were asked to review, in groups of five to eight, a topic to verify its relevance. Feedback from this review process confirmed the relevance of presenting human factors as a safety framework, and indicated that no major changes were required to the proposed list.

A final verification process involved obtaining feedback from attendees at the 2016 Mines Safety Roadshow. After introducing the subject, attendees were asked to review one of the following human factor topics:

- safety critical communications
- designing for people
- human factors in incident investigations
- maintenance error.

These four topics were selected because they represent the highest number of data points within the data analysis. Attendees where then asked to rate the relevance of the topic to their individual mine site (Figure 2).

What next?

To use human factors as a framework for driving health and safety improvements, DMP should:

- educate the DMP inspectorate on the subject of human factors and provide appropriate support material
- educate and promote the importance of human factors to Western Australian mining

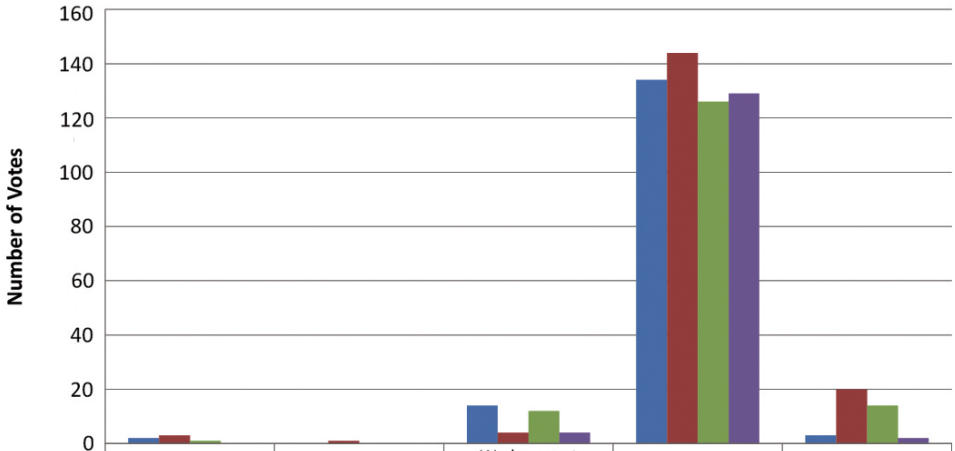
TABLE 4
Department of Mines and Petroleum final set of 11 human and organisational factor topics.

DMP topic area	DMP subtopic	Brief description
1.0 – Managing human reliability	1.1 – Preventing human failure	Structured inclusion of influences on human failure (violations and errors) during design, technical changes and risk assessment.
	1.2 – Human factors in incident investigation	As above but for incident investigation.
2.0 – Usable procedures		Provision of user-friendly procedures that support error-free performance.
3.0 – Training and competence		Combination of skills, experience and knowledge to undertake responsibilities and consistently perform activities to a recognised standard – includes contractors, and retention of organisational competence to manage and quality-assure contractor work.
4.0 – Staffing and workload	4.1 – Staffing levels	Appropriate level of skilled people available for adequate supervision, and safe task performance and lone working.
	4.2 – Workload	Manageable workload, especially during critical tasks, upsets and emergencies.
5.0 – Organisational change		Human aspects of organisational change risk-assessed and controlled.
6.0 – Safety-critical communications	6.1 – During operations	Structured process in place for activities such as shift and task handover, communication of vehicle movements via radio, and use of warning signs, communication protocols, log books.
	6.2 – During permits and isolations	Structured process for work permits, isolations and confined space work, which aids communication and reduces error.
7.0 – Designing for people	7.1 – Human-machine interface	Ergonomic design principles used for control rooms and vehicle cabs.
	7.2 – Alarm management	Ergonomic design principles used to prevent alarm 'floods'.
	7.3 – Equipment Ergonomics	Ergonomic design principles applied to enhance access to equipment, prevent musculoskeletal injury and promote engineering solutions to design or alter equipment.
	7.4 – Work Environment	Ergonomic design principles applied to manage lighting, thermal comfort, noise, vibration and atmospheric contaminants.
8.0 – Fitness for work	8.1 – Fatigue Risk Management	Organisational and individual responsibilities to prevent, manage and recover from impairment.
	8.2 – Drugs and alcohol	
	8.3 – Physical fitness	
	8.4 – Mental well-being	
9.0 – Health and safety culture	9.1 – Health and safety leadership (including learning lessons)	Includes supervision of contractors, experience and effectiveness of supervision, time available for supervisors to manage safety, and examples set by supervisors.
	9.2 – Effective supervision	
	9.3 – Individual duty of care	
	9.4 – Procedural compliance	
	9.5 – Contractor management	
10.0 – Maintenance, inspection and testing error		Structured process to minimise errors in place – coupled with widespread awareness of risk during maintenance tasks.
11.0 – Emergency response		Includes effective organisation, plans, training, procedures, clear roles, drills, staffing and radio communication.

- drive the above knowledge regarding human factors into key areas such as incident investigations and site inspections.

The second author approached a former UK HSE human factors champion and asked what approach DMP should take to promote human factors as a safety improvement tool. His response was that '… a boots on the ground approach is required. It cannot be undertaken from the office by reviewing paperwork…' (personal communication between R Lardner and J Wilkinson, August 2016).

DMP also needs to ensure its approach to the subject of human factors is consistent with other high hazard industries and regulators operating in Western Australia. DMP should actively promote or



	This topic is not relevant to our operation	We have not worked on this topic, and in our opinion it is not necessary	We have not done anything about this topic yet, and we believe it is something we should do	We have done some work on this topic, but more needs to be done	This topic is being addressed to our satisfaction, and no more needs to be done
Designing for People	2	0	14	134	3
Safety Critical Communication	3	1	4	144	20
HF in Incident Investigations	1	0	12	126	14
Maintenance Error	0	0	4	129	2

FIG 2 – Feedback on relevance of assigned human factor topic to respondents operational site (2016 Department of Mines and Petroleum Mine Safety Roadshow attendees).

seek the establishment of some form of professional network with personnel from the Department of Commerce (WorkSafe), National Offshore Petroleum Safety and Environmental Management Authority and Office of the National Rail Safety Regulator.

CONCLUSION

The safety performance of the Western Australian mining industry, as measured by the number of fatalities, appears to have plateaued following a period of continual improvement (Figure 3). To help mine sites improve their safety performance, DMP has been reviewing how it can influence safety culture as a means of driving industry improvements.

As noted within safety literature, safety culture is a term that can be difficult to both define and measure (Blewett and Flower, 2011). A corollary of this observation is that identifying activities within an industry, organisation or indeed an individual mine site, that will drive improvements in

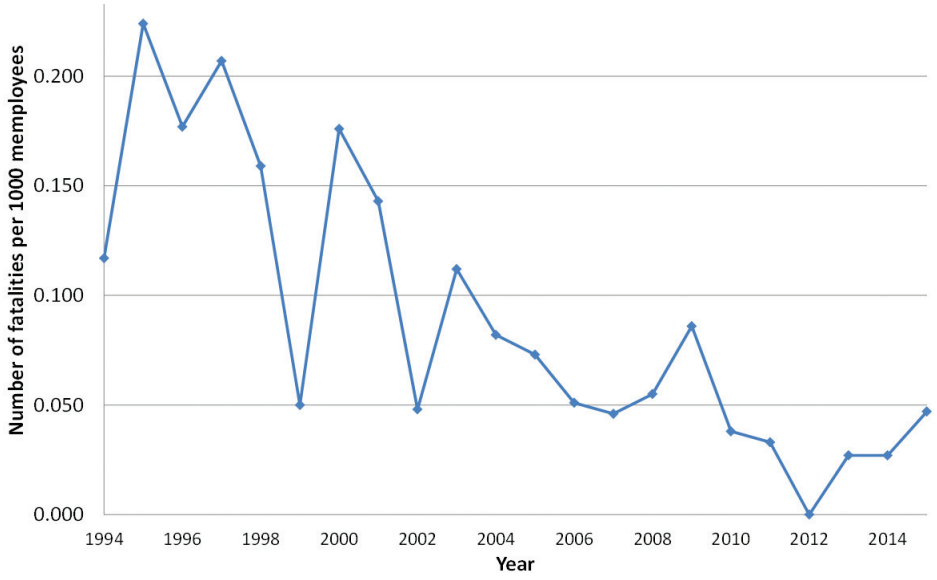


FIG 3 – WA mining industry – fatal injuries per 1000 employees.

safety performance via the lens of 'safety culture' will be problematic – it will be difficult to confirm a causal link between the activity and outcomes.

The UK HSE human factors top-10 topics provide a useful framework through which safety improvement initiatives can be identified by understanding the relationship between human error and performance shaping factors. This framework incorporates topics deemed to cover safety culture, such as leadership, supervision and behavioural safety. Importantly, however, addressing these issues in isolation will not drive a step-change in safety performance.

The subject of human factors is already widely known among mining leaders, as shown at the 2016 Registered Managers Forum. Many mining companies have adopted structured incident investigation techniques that utilise the concepts of human error as part of the causation analysis. Some companies have even identified the need adopt human factor principals, and have developed safety programs accordingly. Given this level of underlying knowledge, DMP duty holders should be receptive to DMP developing and implementing a human factors safety initiative.

DMP has established that the UK HSE top-10 human factors topics are relevant and applicable to Western Australian mining. Importantly, the UK HSE human factors framework is well supported in terms of educational literature and assessment tools. However, to effectively use these resources, the language and examples need to be updated for the Western Australian context. For example, the topic of safety critical communications would need to include communication between vehicles in open pits. A clear opportunity exists for DMP to utilise available human factor literature and resources to help develop integrated safety improvement initiatives that recognise the role human error plays at all levels, including those outside the organisation such as equipment manufacturers, suppliers and designers – not just the last person to touch the equipment.

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Defining a zero harm positive safety culture by applying mindfulness based high-performance thinking strategies

A G Schuback[1]

ABSTRACT

Safety management has evolved into a sophisticated function essential for good business outcomes. That said, simple, reoccurring injuries still occur despite extensive analysis of their cause and implementation of practice-based solutions. The analysis of the mental processes involved in these accidents has led to a new safety management approach based on human belief systems and the mind's function. This paper focuses on the utilisation of mindfulness and high-performance thinking strategies, as a way to embed a safety culture that aligns to zero-harm outcomes. A second focus was to determine if a worksite can track and benchmark their safety culture in real-time. The project involved both leadership and workforce roles in this process. The workforce component involved a fusion of risk management training and team-based workshops to assist workers to define the best version of their team, and condition their skills, values and beliefs to create a self-established positive safety culture. The mindful safety leadership component utilised workshops and one-on-one coaching to enable leaders to embed, support and inspire their workforce groups in the context of the desired safety culture. Evidence collected over the six-month project period found that the Mindsense Safety Program improved the safety culture, improved leadership/workforce alignment, improved safety leadership, and lessened the impact of the unstable workplace environment (undergoing restructuring) on the incident frequency rate. The program did not mitigate all injury-causing factors, but did introduce a level of safety resilience within the project group compared with the control group. The program also functioned to minimise cultural impact during a highly challenging business period. The research suggests further understanding of cultural influences external to the worksite, the impact of specific key cultural factors and extended intervention periods.

INTRODUCTION

Worker safety is a key component in any good business. The ability to preserve and maintain the health of a company's human resources is paramount. In 2009, worldwide, a worker died at work every 15 seconds. Over 500 000 safety incidents were recorded in Australia during 2009 (International Labour Organization, 2012). The cost of mismanaged safety in Australia is estimated at $60 billion annually (Safe Work Australia, 2012). The argument for safety is not only ethical but clearly economic (Takala *et al*, 2014). Fast forward to 2012 and the picture is not improving. The International Labour Organization estimates 2.3 million diseases and 474 million accidents are experienced annually by workplaces. They also estimate the social and economic costs of these accidents and diseases total approximately four per cent of global gross product (International Labour Organization, 2012). There have been large improvements in safety over recent decades. To look specifically at coal mining where the NSW Mine Safety Summary Performance Report 2014–2015 (Department of Industry, Skills and Regional Development, 2016) shows the rate of injury within the industry has reduced markedly, but data indicates a plateauing trend over recent years. All the key incident frequency rates

1. Principal, Aframes Safety, Kingsford NSW 2032. Email: alistair@aframessafety.com.au

(fatality, lost time injury, total recordable injury) have plateaued (Safe Work Australia, 2011–2012). Perhaps more concerning is the serious bodily injury frequency rate, which has almost doubled in the past year. This is despite increased rigour in regulatory framework and governance, along with a solid commitment by industry and government to reduce safety incidents (Department of Industry, Skills and Regional Development, 2016). In 2015, the most common injury factor was the interaction of workers with their environment. The most common injury type was hand injuries, primarily from a crushing mechanism. These are simple injury types with easily understood mechanisms. A large amount of effort and resources are applied to the prevention of this type of injury yet, the fact remains that they keep reoccurring. It appears that the previous safety approaches, however complex and sophisticated, have failed to address these simple injury events.

Historical approaches to safety management

Recent work looking at the history of safety management has allowed a theoretical framework to be created to clarify the evolution of safety in the workplace. Pillay (2015) has proposed that there are five progressive ages of safety management. The ages have evolved from a theoretical approach to safety management, to a human behaviour and human error approach, followed by socio-economic and cultural age culminating in an age of safety resilience. Pillay further simplified these ages into three distinct eras; the contemporary era, the advanced era and the sophisticated era. The increasing complexity of the world's worksites will require more sophisticated solutions, but when talking about how people interact with these environments, added complexity may in fact be counterproductive. Given the simple incident types discussed above, the definition of sophistication in safety may require rethinking. In the case of hands being crushed, the actions, the equipment and the method are all relatively simple. The most complex part in this equation is the impetus behind these actions, that is, the thought processes of the worker. With almost all safety systems where we rely on human behaviour, the assumption is made that a worker is knowingly conscious, clearly perceiving and rationally acting (Wilson, 2004). To question if this is a flawed assumption may offer a powerful insight that could shift the way we approach safety.

Resilience and the mind

When resilience is discussed, particularly with regard to humans, the discussion often centres on psychology, mental strength and, more recently, the area of mindfulness. Resilience training programs often involve emotional management techniques to ensure people remain mentally capable to manage their life. From a workplace perspective, resilient workplace programs engage in mental health initiatives in an effort to improve such factors as employee productivity, job satisfaction, motivation, cohesion, retention, conflict management and absenteeism. Recent work in the area of leadership is finding that mental management is having profound effects in the area of managing stress (both in teams and on the leaders), managing reactive emotions, increasing attention memory, empathy, and in increasing a leader's level of perception of reality (Hunter and Chaskalson, 2013). The mental management tools discussed, centre primarily on mindfulness and its ability to deliver leadership outcomes. Pillay's proposed resilience era in safety, given how resilience is managed in society, may be better expressed as an era in safety mindfulness.

An introduction to mindfulness

There are several definitions for mindfulness with a common thread involving being 'present' in the current situation. Dr Jon Kabat-Zinn (1982), who is largely credited for bringing mindfulness to western culture, defines mindfulness as 'paying attention in a particular way: on purpose, in the present moment, and non-judgmentally'. Although there is no universally accepted definition of mindfulness, there can be little doubt that it is a concept whose time has come, with an exponential increase in research occurring in the area over recent years. There appears to have been a divergence in eastern and western cultural definitions of mindfulness, primarily due to their application. Weick and Putnam (2006) reviewed the differences, sighting a similar definition to Kabat-Zinn as an eastern definition. The western definition comes from Langer who stated, 'mindfulness is a flexible state of mind in which we are actively engaged in the present, noticing new things and sensitive to context' (Langer and Moldoveanu, 2000). A common theme for both definitions is development of attention and internal focus as a way of achieving a result (Brown and Ryan, 2003). Mindfulness has been used in a range of pursuits such as medicine (Kabat-Zinn, 1982), clinical psychology

(Segal, Williams and Teasdale, 2000), psychological well-being (Manocha *et al*, 2011), law (Riskin and Negot, 2002), the military (Stanley, Schaldach and Kiyonaga, 2011), corporations (Chaskalson, 2011), management schools (Hunter, 2005; Duff and Newcombe, 2013), and professional sports (Lazenby, 2007). An important function of mindfulness is generating understanding of how the mind functions. Mindfulness acts to address the basic human condition of consciousness and the ability to mentally focus. Increasing psychological evidence is uncovering that up to 90 per cent of human actions are not conscious, but are subconscious patterns and processes that are automated, and go largely unnoticed (Drucker, 1999). These automatic-style operations are executed in different regions of the mind and are enacted in a rigid and mechanical manner. Automatic processes function well in a stable, predictable environment as they are efficient and require little effort to produce a known result. Placed in more unpredictable environments, automatic processes have limited ability to adapt and will act to hinder rather than assist in producing a result. Applying this insight into the mind and its propensity toward automation may offer some understanding in respect to simple safety incidents. Given a scenario where a less stable environment evolves in the worksite, if the mind is not aware of it, the mental processes applied may be inappropriate for the situation, and lead to a mismatch of the behaviour to the environment. The simple act of crushing a finger could be a case of not being 'conscious' or mindful at a particular time as opposed to knowingly making a mistake.

Mindfulness and safety

Mindfulness applications in safety is new territory, with only a few studies conducted in this space at this time. Studies have focused on mindfulness as a way to limit mental distractions and increase mental focus (Kerr *et al*, 2011) in the area of driving performance (Kass and VanWormer, 2011). Weick, Sutcliffe and Obstfeld (1999) developed the concept of high reliability organisations (HROs), which are a subset of hazardous organisations that enjoy a high level of safety over long periods of time. They coined the concept of 'organisational mindfulness' as a way to deliver this standard of safety performance. Their definition of mindfulness differs from a traditional version, theorising that if five organisational facets are achieved, the effect would generate an organisation that is mindful in the way it operates. Traditional safety models have focused on attentiveness and having higher degrees of situational awareness. Reason (2000) listed attention failure as one of the four human error causes. In the mindfulness paradigm, attention failure may not be so much a case of attention failure, but a failure to pay attention to the correct facet.

Zero-harm organisations

The term zero-harm has been part of the safety landscape for some time. It is increasingly viewed by society as the only acceptable result, making the idea of 'budgeting' for incidents difficult to justify. Zero-harm has largely been seen as a goal, and is ultimately measured by lagging indicators such as the number of incidents and injuries. Achieving zero-harm requires sustaining a very low rate of injuries (in fact, zero injuries) over an extended period of time. Safety data suggests this has proven difficult for many worksites to achieve.

Perhaps a more practical way to view zero harm is as a process rather than a goal. Weick, Sutcliffe and Obstfeld's (1999) definition of an HRO aligns closely to the ideals of zero-harm. A worksite that achieves a low rate of injuries over a long period of time could be said to have operated in a high-performance manner. An extension to this statement would be that workers at a low-incident worksite could be seen as operating as a high-performance team. High-performance teams outperform all other similar teams and they outperform expectations given their composition (Katzenbach and Smith, 2003). Creating high-performance teams would therefore facilitate a zero-harm process and in doing so, drive toward zero-harm outcomes.

High performance and mindfulness

The use of mindfulness for high-performance outcomes has been common over recent decades. Several studies have been conducted in the areas of elite swimming (Bernier *et al*, 2009), basketball (Lazenby, 2007), long distance running, arching and rowing (De Petrillo *et al*, 2009). Early work centred on the concept of mindfulness-acceptance-commitment (MAC) (Moore, 2009), to achieve optimal outcomes. It should be noted that all of these pursuits practice a high level of technical

competence with repetitive training the technical skills required for each respective disciplines. The safety equivalent for this would be excellent skills in risk management and hazard identification. High-performance thinking has been used for senior corporate executives to optimise their performance and to maximise business outcomes. Minimal empirical data exists to determine the effectiveness of these programs but qualitative evidence suggests they are effective. An Australian-based high-performance program is the Mindsense program developed by Michael Duff (Duff and Newcombe, 2013). Mindsense has been applied at several blue-chip Australian companies for over a decade to achieve performance breakthroughs. The program incorporates both mindfulness and high-performance thinking techniques. Mindsense works on the premise that successful people and teams have a strong 'sense of themselves'. They have achieved this by working on their 'self-definition' or 'self-beliefs' in order to ensure the best version of themselves presents for the situation at hand. This in turn gives the person or team the best chance at producing their best performance. They also have an intimate understanding on the way their mind functions. The Mindsense program uses mindfulness to allow a higher level of mental awareness to be maintained. This enables observation of the mind's automatic workings and habits, and allows the individual to bring conscious thought to automatic processes. Mindsense works on the concept of a dual mind; the conscious and subconscious parts (Wilson, 2004). This is consistent with eastern mindfulness processes, and is also supported by Daniel Kahneman's (2013) work, *Thinking, Fast and Slow*. Kahneman dual mind explanation, system one and system two, centres more on the nature of each mind type. The subconscious mind is described as the historical mind. It is the repository of beliefs, values, habits and the majority of our behavioural patterns that have accrued over time. It would be where a person's 'sense of self' resides. Consistent with Wilson's observations, 90 per cent of our behaviours and thoughts could be attributed to the subconscious. Kahneman describes this as the system one mind. He adds that system one thinking is fast acting, doesn't double-check and makes confident assumptions. The conscious mind deals with the 'present', which works to problem solve and think rationally in a singular thought process. Kahneman describes this as system two thinking that by nature works slowly, feels like hard work, and deals with one issue at a time. Kahneman's description aligns with eastern style mindfulness as well as Duff's definition of the dual minds. Duff extends on the idea that the subconscious mind requires a level of predictability and will act to keep it this way, avoiding change where necessary. His definition associates the subconscious mind with our 'comfort zone' or our predictability zone. The resistance to change is said to automatically come from the mind itself. Having a force against change within the mind offers explanation for the difficulty people experience when having to break habit and change behaviours. On an organisational level, it may also explain the difficulty encountered when effecting cultural change. By using mindfulness, individuals gain the ability to observe the dualistic nature of mind, in particular an individual's beliefs. The Mindsense techniques work to consciously observe and then manage these beliefs toward more appropriate beliefs aligned to high performance.

Safety culture and the Mindsense Safety Program

Although there are variations in the definition of safety culture, all definitions include a component relating to beliefs and values. Uttal's (1983) definition of 'shared values (what is important) and beliefs (how things work) that interact with an organisation's structures and control systems to produce behavioural norms' captures the essence of most safety culture definitions. Reason's (2000) work in culture noted at least two ways of treating safety culture: as something an organisation is (the beliefs, attitudes and values of its members regarding the pursuit of safety) and as something that an organisation has (the structures, practices, controls and policies designed to enhance safety. Both are seen as essential for achieving an effective safety culture. Reason (2000) also stated that 'an ideal safety culture is the ‹engine› that drives the system toward the goal of sustaining the maximum resistance toward its operational hazards, regardless of the leadership›s personality or current commercial concerns'. Given Reason's insights, the 'resilience' of a safety culture is paramount and should exist within the common structure of the business. The ideal situation would be to integrate both interpretations of safety culture into the one model. That is, embedding structures, practices, controls and policies that are designed to align beliefs, attitudes and values of its members. An attractive aspect of the Mindsense Safety model is that it combines both of Reason's ideals. It works to not only make people mindful of their current beliefs and self-definition by utilising mindfulness,

it provides a structure to consciously condition these beliefs toward an optimum version of the workforce. It also offers a path of less resistance by giving explanation to the 'uncomfortable' aspect of changing our beliefs and values. Extending this paradigm to a team level, a common set of values and beliefs that embody the future state could be seen as a culture. By defining the 'best version of the workforce', we are in fact defining the best 'values and beliefs' of that workforce. The best values and beliefs of the workforce would, by definition be the best safety culture of the workforce. By defining the best safety culture of the workforce, a defined goal is created and the highest-performing culture possible from the current workforce can then be conditioned.

Mindful safety leadership and the Mindsense Safety Program

In order to achieve zero-harm outcomes, organisations will have to change the way they function. The current safety data trends support this assumption. The driving force behind any change in an organisation is leadership. Being able to achieve zero-harm will present new leadership challenges which will need to be considered appropriately. Heifetz (1994) distinguishes two classes of challenge that leaders are likely to face: technical problems and adaptive ones. Technical problems, though possibly complex and difficult, can be addressed with existing ways of perceiving and understanding; they are known problems with known solutions based on past experience. Adaptive challenges differ from technical challenges because both the problem and the solution may not be recognised and understood within current paradigms. Adaptive challenges call upon leaders to grow toward more sophisticated (or simplistic) ways of seeing and thinking, acting and relating. Leadership training thus far has tended to focus on retrospective analyses of past action or on future-oriented creations of visions and goals (Drucker, 1999). Given current incident data (International Labour Organization, 2012) and trends, adaptive leadership will be necessary to facilitate the change to a zero-harm environment. Adaptive leaders cultivate the skills of managing themselves if they skilfully work with others to meet the challenge of adaptive problems (Drucker, 1999; Hunter, 2009). Mindfulness by its nature appears an excellent tool to enable this. Mindfulness would also give increased insight into not only a leader's own thought processes, but the behaviours and thoughts of their workers. Duff's application of mindfulness also gives tools for a leader to understand 'change resistance'. The leader can see resistance as an issue rooted in the nature of mind, rather than a fault within the person's motivation. This insight allows for a more empathetic leadership approach as opposed to the manipulative approach that is often resorted to. Understanding the nature of mind may also offer solutions to common leadership challenges such as stress management, conflict management, managing reactive emotions, cultivating empathy, making better decisions and being creative and innovative.

PROJECT INFORMATION

Research site – Appin coalmine

The Appin coalmine (APNM) is located in the southern coalfields of New South Wales, 25 km north-west of Wollongong. It is an underground coalmine that started using a longwall mining technique in 1969 and continues to mine use this method today. APNM is owned by South32 through its wholly owned subsidiary, Illawarra Coal. Illawarra Coal also owns and operates Dendrobium coalmine, which is located in the New South Wales southern coalfields. The company operates two coal processing plants, one at Port Kembla and the other at the North Appin Colliery. A new project, the Appin Area 9, has effectively replaced the West Cliff domain. When operational, the Appin Area 9 Project will increase Appin Collieries production by 3.5 Mt of coking coal a year. The Appin Area 9 Project included the construction of roads, ventilation infrastructure, reconfigured and new conveyors and other mine requirements. The mine employs approximately 1500 workers with approximately 40 per cent of these workers being contractors.

Over recent times, there has been significant change in the coal mining landscape worldwide. A significant period of growth and expansion has quickly ceased with a severe retraction in demand and coal price hitting the coal industry hard as a whole. Several large mining companies have had large profit downgrades, major restructure, mine closures and in some cases, voluntary administration. Illawarra Coal (South32) and Appin Coalmine have not been immune to this with significant change occurring at all levels of the South32 business. A summary of the major changes

that are culturally significant at Appin Coalmine is detailed in Table 1. Typically, this level of change within a workplace impacts on safety culture and on safety performance. As the change could be perceived as negative, a negative trend in the safety performance and cultural metrics could reasonably be expected during the project period.

PROJECT METHOD

Project set-up

The Mindsense Safety Program was conducted as a pilot intervention in the Area 9 development section of the mine. The project involved delivering the program to 49 participants in both operational and leadership positions. The cross-section involved all levels including the general manager, senior managers, superintendents/under-managers, supervisors and operators. A control group was established as a way to capture factors that impact the site's safety culture (and consequently, safety performance). This allowed the impact of the intervention to be measured against a group that did not undergo the program. The control group was selected to ensure that a direct comparison with the project group could be made. The factors considered included work type, work location, crew structure (numbers), crew systems and group demographics. The control group contained

TABLE 1
Appin coalmine site event log.

Date	Event
Pre-August 2014	Significant expansion in the Appin coalmine (APNM) from 700 people to a total of 1500 workers. The plan is to amalgamate both APNM and West Cliff Mine (WCM) into a single operation mine. Both mine sites have operated independently for an extended period (20+ years) and have developed a unique culture at each site.
Pre-August 2014	Severe downturn in the coal industry with a large coal prices retraction. This places pressure on the industry to make changes to rein in costs to operate profitably.
Pre-August 2014	Extensive cultural change programs conducted at WCM in order to arrive at a culture that aligns with Illawarra Coal's just culture aims. This does not occur at APNM at this time.
August 2014	Announcement made to divest Illawarra Coal into a new company (South32).
August–December 2014	Initiation of process to restructure of Illawarra Coal (BHP Billiton subsidiary) to new South32 structure.
December 2014	Integration of APNM and WCM sites commences. This involved two mines with specific cultures and structures together to form one mine site.
December 2014	New General Manager announced at Appin Colliery (AC) General Manager was previously working at WCM.
February 2015	New General Manager announces new APNM lead team.
February 2015	A new culture model is launched at APNM.
February/May 2015	Initiated 'Working Together' workshops at APNM as an act to integrate the two sites. These involved the 'what good looks like creation and experiences' programs. These were held with APNM lead team initially, followed by each manager with their superintendents, then superintendents facilitated a similar experience with supervisors. Town Hall meetings were held for general staff and operator/trades to cover the 'Working Together' outcomes.
May 2015	Illawarra Coal divested from BHP Billiton as a part of South32.
December 2015	Mindsense Safety Program commenced.
August 2015 – January 2016	Enterprise bargaining agreement negotiated and finalised.
January 2016	Corporate roles for South32 finalised.
January 2016	Workforce reduction of approximately 300 people announced. Approximately 70 employees to be involved and the rest are contractors.
March–May 2016	Restructure processes commenced. A number of staff jobs are made redundant and new company structure implemented (with 300 less people).
June 2016	Restructure processes finalised. The HSEC function was restructured and now report to corporate.

HSEC: Health Safety Environment Community.

19 participants with in both operational and leadership positions including senior managers, superintendents/under-managers, supervisors and operators.

Project activities

The project was made up of three phases. The first of these was a Safety Culture Review that acted to reveal culture related issues on-site that could impact on the project and give an assessment of the maturity of safety systems on-site. This was followed by safety skills training that acted to provide technical risk management skills to manage safety risk. These training programs were aligned to government-defined competencies. The final component was the Mindsense Safety Program with two subcomponents. The initial part of the program involved crew-based workshops in mindfulness and high-performance thinking strategies in order to form a 'team cultural code' that embodies the 'best version of the crew'. The second component involved extended Mindful Leadership training and coaching for leadership positions to 'coach' and 'embed' the high-performance thinking strategies.

Measurement of project results

In order to measure the effectiveness of the intervention, both lag and lead indicators were utilised. These included incident data and real-time cultural and leadership data derived from an online culture and leadership survey tool. Each measure was recorded for both the project and control groups to allow relative comparisons to be made between the two groups. Injury metrics were measured over the period of the study for both project and control groups. The nature of the available data has meant that the most appropriate incident frequency rate would be calculated as:

Incident frequency rate = injuries / person / time period

The goal of this calculation was to compare before and after measures for both the project and control groups. The rate (or percentage) of change would then act as a measure of the ultimate effectiveness of the intervention. The two survey types were engaged to measure project impact were a safety culture index (SCI) and a safety leadership index (SLI).

The SCI comprised of 56 base questions and five additional customised questions. The nature of the questions related to the site's culture and most questions were not personally focused (that is, about the individual). The survey contains several key attitude measures, including organisational context, social environment, individual appreciation and work environment. The organisational context included several subdimensions. The management commitment dimension measures the perceptions of management's overt commitment to health and safety issues. Included in this dimension is the way management acts toward a safety issue or incident and their attitude to employee safety. The communication dimension measures the nature and efficiency of health and safety communications within the organisation. This dimension covers both upwards and downwards communication about safety. The priority of safety dimension measures the relative status of health and safety issues within the organisation including the issue of productivity versus safety. The safety rules and procedures dimension measures the efficacy and necessity of rules and procedures including how committed the organisation is to the rules and procedures in place. The social environment attitude measure included several supportive environment and involvement measures. Supportive environment involved the nature of the social environment at work, and the support derived from it including the interaction of employees at work in a safety context. The involvement dimension measured the extent to which safety is a focus for everyone and all are involved. The individual appreciation component measured the individual's view of their own health and safety management and need to feel safe, along with how individuals view the risk associated with work. The work environment dimension measured the perceptions of the nature of the physical environment, examining whether the time and equipment is available for a task to be completed safely.

In addition to these dimensions, 14 key drivers underpin these results. These include safety values, employee involvement, just culture, teamwork, hazard and risk management, perception of workplace, production versus safety trade-off, top down communications, bottom up communications, training outcomes, systemic approach, work conditions and rewards and recognition.

Each question (item) required one of five responses: strongly disagree, disagree, neither agree or disagree, agree and strongly agree. This 'five response' result was then mapped to five point scale of very negative, negative, neutral, positive and very positive. Some of the items in the survey were negative items, that is, an agree response would be a negative result for the safety culture, and a disagree response would be a positive result. The SCI was then calculated in three steps. The positive index is calculated by adding up all the positive and very positive answers and dividing by the number of respondents, then multiplying by ten. A negative index is calculated by adding up all the negative and very negative answers and dividing by the number of respondents, then multiplying by ten. The SCI is the (positive index minus the negative index) multiplied by ten. Each answer was scored from 1 to 5 and a SCI was calculated from the results by subtracting the percentage of disagree and strongly disagree from the percentage of agree and strongly agree responses and then multiplying by one hundred. This results in an index that ranges from -100 to 100.

The SLI comprised of 35 base questions. The questions related to the individual's leadership style, essentially a self-assessment of their skills in this area. As a consequence, the results from the survey are highly subjective and influenced by the leaders' perceptions of themselves. The SLI reports the level of safety leadership capability as assessed by the survey respondees in this group. Questions are grouped into seven characteristics including lead by example, set clear expectations, involve others, demonstrate care and commitment, provide feedback, alignment and awareness and skills and capability. Leadership is described on a 100 point scale ranging from novice to high performance. The answers given are scored from 1 to 5, 1 being the weakest answer and five being the strongest answer. Each characteristic as described above has five questions to be answered. A score (from 20–100) for each characteristic as described above is calculated based on the minimum score of the questions in that area. That minimum is then increased toward the boundary with the next level descriptor based on the score of the other questions in the group of five. The same technique is applied to the scores across the seven characteristics to create an individual score.

RESULTS

Safety culture review

A safety culture review was conducted prior to the commencement of the program. The review revealed a number of issues that were affecting the culture. General uncertainly was an issue due to the vast changes that were occurring at all levels of the mine, the workforce was experiencing stress originating from high levels of uncertainty and change. Cultural perceptions showed a level of distrust existed due to the new management team being perceived to be from a specific culture, creating an 'us and them' situation. Resource management was highlighted due to the mine being stretched in the areas of equipment availability and manning. Planning was challenged with the merging of systems between the two mines had disrupted the normal planning processes. Problems with variation in leadership and accountability existed, stemming from the mine management structural changes, clear management alignment was found to be lacking and was being worked on within the senior leadership team. The systems around change management were not coping with the large amount of change. As a result, organic change approaches were being conducted. Communications and feedback was a key issue across all levels of the business. The communication systems were struggling at a time when the need for information was particularly high. The issues in training related mainly to the leadership and supervisory levels with variation across different areas of the business. The melding of the two mine's systems had meant that a clear standard for operation was not yet finalised. This was frustrating the workforce as it was difficult to manage work quality. System implementation and effectiveness displayed various levels of maturity and functionality.

Incident data

Given the nature of the project and control groups and limited data on working hours, the comparison of most value is the injury per person frequency rate. An assumption was made that the hours worked per person before the project is the same as the hours worked during the project.

Table 2 shows a comparison of the project group and control group incident frequency rates. The data is categorised into two measures; before and during the project.

TABLE 2
Project group versus control group – incident per person per month frequency rate.

Group	Incidents before (26 months)	Incidents during (6 months)	Number of people	Incidents/ person/month (before)	Incidents/ person/month (during)	% Variation
Control group	29	7	19	0.023	0.0294	26.10
Project group	10	3	49	0.021	0.023	8.90

The data shows that both the project group and the control group incident rate rose during the project period. The results indicate a 26.1 per cent increase in incident rate for the control group compared to an 8.9 per cent increase in incident rate for the project group. This would indicate that the project group exhibited more resilience against the incident-causing forces within the business over the period. The cause of the incident increase could be from various sources. Detailing the causes of each incident was not within the scope of this project, but given that the project and control groups have had similar construct and environment, the gap in results could reasonably be attributed to the Mindsense Safety Program.

Safety culture index data summary

Three surveying events were conducted for both the project and control groups; before, during and after with approximately three month periods between each survey. Survey participation rates ranged from 67.3–83.7 per cent from the project group and 57.8–68.4 per cent for the control group. Participation rates were best in the initial survey and plateaued in the final two surveys. A comparison of the SCI results across the various dimensions for the project and control groups is contained in Table 3.

TABLE 3
Comparison of safety culture index (SCI) results.

Control group	SCI (before)	SCI (during)	SCI (after)	SCI (change)	Project versus control
SCI index – total	*61.3*	*24.17*	*50*	*-11.3*	*16.41*
Management commitment	64.42	43.75	56.82	-7.6	11.7
Communication	60.26	29.69	36.36	-23.9	19.97
Safety as a priority	76.92	90.63	59.09	-17.83	17.48
Safety rules and procedures	50.77	-81.25	40	-10.77	24.37
Supportive environment	69.23	85.94	59.09	-10.14	5.68
Involvement	66.67	-12.5	50	-16.67	26.73
Personal priorities	95.38	90.63	96.36	0.98	0.18
Personal appreciation of risk	44.87	-3.13	37.88	-6.99	14.53
Work environment	36.54	-1.56	26.14	-10.4	27.19
Project group	**SCI**	**SCI**	**SCI**	**SCI**	
SCI index – total	*43.16*	*29.69*	*48.27*	*5.11*	
Management commitment	35.67	36.36	39.77	4.1	
Communication	48.37	45.45	44.44	-3.93	
Safety as a priority	57.93	90.91	57.58	-0.35	
Safety rules and procedures	16.1	-36.36	29.7	13.6	
Supportive environment	59.76	81.82	55.3	-4.46	
Involvement	39.43	-54.55	49.49	10.06	
Personal priorities	87.32	90.91	88.48	1.16	
Personal appreciation of risk	39.43	-36.36	46.97	7.54	
Work environment	17.68	4.55	34.47	16.79	

Figures 1 and 2 show a comparison before and after the program for the project and control groups. The graphics clearly show the project group results have increased and the control group results decreased across all metrics.

This appears to show that intervention was not only able to resist negative cultural forces over the project period, but improve the culture under difficult circumstances.

Safety leadership index data summary

Two surveying events were conducted for both the project and control leaders; before and after the program. Survey participation rates ranged from 75–83.3 per cent from the project group and 55–66 per cent for the control group. A definite decrease in participation results was noted. The reason given for this was the increased workload and challenging priorities placed upon leadership deriving from the restructure. Obtaining SLI surveys from both the project and control leadership groups proved difficult. A comparison of the SLI results across the various dimensions for the project and control groups is contained in Table 4.

PROJECT DISCUSSION

The purpose of this discussion is to utilise the various data outlined above in an effort to answer the two project questions proposed:

1. Can a mine define and move toward a zero-harm safety culture utilising mindfulness based high-performance thinking techniques?
2. Can a mine track and benchmark their safety culture in real-time?

Question one – can a mine define and move toward a zero-harm safety culture utilising mindfulness based high-performance thinking techniques?

The safety incidents results show an overall increase in the incident rate for both the project and control groups. The control group incident frequency rate increased by 26.1 per cent whilst the project group increased at 8.9 per cent. This demonstrates that there were forces within the business

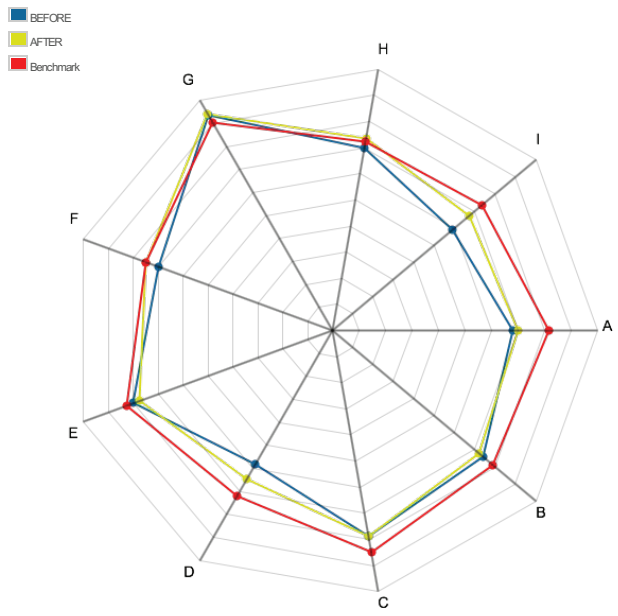

FIG 1 – Project group safety culture index (spider diagram) – before and after.

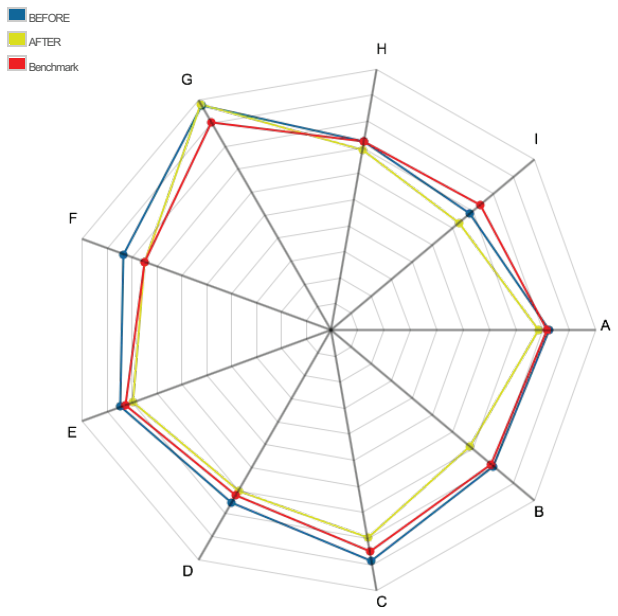

FIG 2 – Control group safety culture index (spider diagram) – before and after.

TABLE 4
Comparison of safety leadership index (SLI) results.

Group	SLI (before)	SLI (after)	SLI (change)	Incident frequency rate
Control group	64.27	82.44	18.17	26.1
Project group	66.94	74.37	7.43	8.9

environment that were strong enough to increase the incident rate on-site. The list of changes indicated in the project background section showed a high degree of change and this may be a cause for the increase across both groups. It also indicates that factors such as safety systems play a major role in safety performance.

The incident frequency rate results indicated that the project group were less affected (or more resilient) to the incident-causing factors than the control group. The control group recorded an incident frequency rate increase that was 2.93 times that of the project group. The results also demonstrated that the intervention was not sufficient to overcome all incident-causing factors within the work environment. The reason for incident-rate increase could be related to several causes that are not discussed in detail in this report.

One point was the length of the program (six months) being quite short. The time taken to enable the change in belief systems to be adopted varies between individuals, but longer sustained immersion generally allows for an opportunity for belief change to occur.

The safety culture index metrics indicated an increase in the SCI in the project group and a corresponding decrease in the control group SCI. The project group recorded a 5.1 increase in the SCI with the control group experiencing a -11.3 reduction in SCI. This accounts for a 16.4 point difference between the two groups. These results generally parallel the incident FR results mentioned above.

The individual subsets of the SCI results show that the project group improved in all areas relative to the control group. The area of highest change was in the work environment metric with a 26.73 point differential. Given that the work environment of project and control groups was identical during the project, this result could be attributed to perception change. The work environment is seen to be less positive for the control group. This may indicate a level of acceptance in the project group.

The involvement metric came in as the second highest subset with a relative change of 26.73. This metric related to the extent to which safety is a focus for everyone and all are involved. The next highest change was in the safety rule and procedures area. The rules and procedures are common to both groups so could again indicate a positive perception change for the project group. Significant relative movement was also recorded in the area of communications (19.97), safety as priority (17.48) and personal appreciation of risk (14.53).

The key drivers underpinning the SCI dimensions also showed a positive relative shift for the project group. The project group increased across all areas with the most significant shift occurring in the perception relating to work conditions. This driver moved from a ‘unsustainable’ level of -25 to a maturing level of 5. In comparison, the control group saw reduction across all areas with the driver of ‘rewards and recognition’ moving from ‘maturing’ to ‘unsustainable’ level. Just culture also reduced by almost half, which reflects a loss of openness and trust. This driver more than doubled for the project group reflecting an expansion of trust and openness. The most profound reduction from the control group was in the ‘top down communication’ driver. This driver showed a fourfold reduction and indicates a disconnection between the leadership and workforce paradigms.

The SLI results have shown a minimal change within the project group. The project group results show a 7.43 point increase over the six month period from 66.94–74.37. Interestingly, the control group had a significant increase of 18.7 from 64.27–82.44. The relative ratio between the project and control groups shows a 2.51 times increase toward the control group. Comparing this to the ratio of incident frequency rate, the control showed a 2.93 times increase compared to the project group. The increase in SLI for the control group coupled with a higher increase in incident frequency rate and lowering in SCI suggests a level of disconnection of the leadership group with the workforce. This in turn has driven a negative safety result.

The nature of the SLI questions are self-reflective and may illustrate that the leadership have an unrealistic perception of their leadership. A 180 degree peer review step is normally evident within the SLI framework but was absent for this research project. The leadership group would believe their results to be true but the supporting data appears to have suggested otherwise. The poor ‘rewards and recognition’ and ‘top down communication’ results in the key drivers section, also support this argument. This is difficult to assess without management of peer review processes in place. The project group also exhibited an increase in the SLI that, coupled with a lower incident rate increase and improved SCI results, suggests that the intervention has led to stronger alignment

of the leadership and workforce. The results also indicate that the leadership are more in touch with the workforce and have arrived at SLI numbers that have more objectivity.

Question two – can a mine track and benchmark their safety culture in real-time?

The SCI and SLI metrics have exhibited responsiveness to the intervention. The SCI has captured specific movements between the project and control groups and has broadly given correlation to the incident frequency rate data collected. The SLI appeared to have a weakness in that it is a personal and subjectively focused tool.

The subjective nature of the survey exposes itself to personal bias and in an situation of disconnection between leadership and the workforce. Utilising the additional manager review component would definitely reduce the subjectivity. The manager review was not conducted for this project. Correlating the SLI metrics with SCI metrics does allow an extra level of objectivity.

CONCLUSION

Evidence collected over the six-month project period found the Mindsense Safety Program improved the safety culture, improved leadership/workforce alignment, improved safety leadership and lessened the impact of the unstable restructuring workplace environment on the incident frequency rate. The program did not negate all injury-causing factors but did introduce a level of safety resilience within the project group compared to the control group. The program also functioned to minimise cultural impact during a highly challenging business period.

The Global Safety Index cultural measuring program used to monitor cultural and leadership trends worked well to track cultural data in real-time and provide evidence of the program impacts.

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How Leadership Can Create an Enduring Safety Culture

J Ross[1]

ABSTRACT

The foundation of effective leadership is communication. You can have all the leadership theories, models and training you want, but in the end it is all about leaders talking to, listening to and understanding the point of view of those below and above them.

The foundation of effective safety is peoples' behaviours. Every incident, every near miss and every safe act comes down to what one person does and how that affects themselves and others. We tend to focus these behavioural considerations on the people at the 'coal face', those most in harm's way. But it is the individual behaviours of everyone in the organisation, particularly those at the top, which are just as (if not more) important.

The foundation of effective safety leadership in the mining industry is that it starts at the top, with the individual behaviours of leaders. The behaviours of each and every leader will be reflected in their teams. And where their teams are made up of leaders, these leaders will pass these behaviours on to their teams and so on. It's the sum total of what people see their leaders do and what they do as a result, that creates the 'culture' of the business – and it's this culture that makes or breaks how safely people work.

INTRODUCTION

The path to long-term safety improvements in the mining industry has been paved with successful and unsuccessful initiatives and ideas. Many of the stages the industry has gone through in its safety journey are still relevant and still important, but have still not proved to be the 'silver bullet' in creating a lasting culture of proactive, positive safety.

The mining industry has taken many steps forward in safety performance through a range of different approaches over the years. Beginning with prescriptive legislation and moving on to the development of safety management systems and the increased use of procedures and work instructions. More recently the concepts of hazard identification and risk based approaches and finally the concept of behavioural-based safety and an independent safety culture.

Each of these new ideas has seen step change improvements upon their introduction, slowly decreasing in impact over time. Injury and fatality frequency rates have continued to decline as each new safety initiative or concept is introduced and as the industry as a whole becomes more mature in its approach to safety management.

But recently safety statistics have begun to plateau and in some cases start to trend in the wrong direction. Is this a case of a natural limit to safety performance being reached, or can the industry find the next step which will again see safety performance improve? Where will safety leaders find this next idea or concept and how will they make sure it is relevant to the unique characteristics and culture of the mining industry?

SAFETY CULTURE

What makes a safety culture at a mine? What creates safe work and worker safety?

Is it equipment? Procedures? Environmental conditions? Training? Supervision? Discipline?

Certainly all these are components of any system and important components of an effective safety system. But this paper will propose that behind 'safety' and behind all accidents and injuries, are people's behaviours. And the most important of these behaviours are the behaviours of leaders.

Most commonly when discussing behaviours in relation to safety, the discussion is about behaviours of the frontline workers on the job. The guy that sticks his hand into the moving belt to grab a piece of steel out. The guy that doesn't isolate because it's only a quick job. The guy that balances on a drum because he can't find a ladder.

But sometimes it is the behaviours of people somewhere else in the organisation, potentially long before the incident, that were part of the cause of the injury or fatality.

BEHAVIOURS AND SAFETY

Recent years have seen the rise of behavioural based safety management programs. The principle of these programs being that a focus should be put on the way people act 'on-the-job' and on observing and managing their behaviours to ensure they are not putting themselves or others at risk.

These systems have recently come under fire from many safety professionals as not being the silver bullet once thought and taking focus away from the other key elements in a safety system – systems, processes and equipment (Pater, 2005).

Behavioural-based safety programs commonly involve some type of observation process by which people observe

1. MAusIMM, Director, MiningMan.com, 9/33 Parkhill Road, Kew Vic 3101. Email: miningman@bigpond.com

others working and then provide feedback to the person on the safety-related behaviours they have observed, with both positive feedback and areas for improvement. Usually the programs operate on an anonymous or 'no-blame' basis and hence are designed specifically with a focus on improving the way people work rather than attempting to catch people doing the wrong thing (MiningMan.com, 2010).

There are several aims of a behavioural safety program. The first is to create safety habits, by getting people talking about safety and communicating with people in their teams about safety. It is the habits of safety thinking which will activate in the moments before an incident occurs and allow the person in the firing line to see the hazard and take action.

Secondly, behavioural safety programs create a forum for coaching between leaders and their teams. They provide prompts and a formalised process to make it easier for leaders to discuss unacceptable behaviours with their teams and to provide coaching on what is acceptable.

Finally, safe behaviours programs and observations create a further system through which deficiencies in safety procedures or equipment can be identified. An observer may identify unsafe behaviours, but through the discussion that follows, it may be identified that the necessity for such behaviours has been created by systematic, organisational, or environmental factors beyond the control of the person being observed. Good safe behaviour programs will facilitate easy reporting of these improvement opportunities and allow the mine to identify and act on holes in their systems.

Safe behaviour programs are not a quick win though, with the benefits coming slowly and progressively, one observation and one safety discussion at a time.

IMPROVING SAFE BEHAVIOUR OBSERVATIONS

Here are seven suggestions for improving the quality of safe behaviour observations:

1. Focus on the discussion

The main value to be found in the safety observation process is in the discussion which takes place, not in the observing or the paperwork (although these are key parts of the overall process). By engaging in a discussion about safety, the interaction not only addresses any specific issues that were observed on the job and gives the person feedback, but also helps make a habit of thinking and talking about safety – one of the biggest keys to a great safety culture.

2. Ask lots of questions

A person performing an observation doesn't need to be an expert on the particular work area or task being observed. In fact, sometimes the best observers are those who are not familiar with the work being carried out.

The best way to start a discussion with the person being observed is with a question, something like: 'Tell me about the job you are working on here.' This can be followed up with more questions to find out what is going on, why people are doing certain things and what they have thought about in regards to hazards and controls. Questions such as these are quite useful:

- What hazards have you identified on this job?
- How could someone get hurt doing this job?
- Is there a procedure for this job?
- How could someone get hurt later on after you've left the area?

Through probing with questions more can be learnt about the job itself, the hazards involved and the reasons behind people's behaviours or lack thereof. Safety observations should be less about telling and more about asking and engaging.

3. Focus on behaviours

An observer should always focus only on what can be physically observed – hazards, environmental conditions and behaviours. Discussions or assumptions on people's attitudes, thoughts, or intentions are to be avoided. The safety discussion as part of the observation should focus on the specific behaviours that have been physically observed and why those behaviours are considered safe or not. If the focus remains on facts and behaviours and the discussion involves asking questions instead of giving instructions, the observee will be much more open to discussing their own behaviours and suggesting improvements.

4. Work in pairs

A great way to improve the effectiveness of observations is to complete them in pairs. Of even more value, is pairing with someone from a different part of the operation. For example, a person from the processing plant may accompany someone doing observations in the mine or vice versa. Or a maintenance supervisor may accompany an operations supervisor in the field. The benefits of this include a fresh set of eyes looking at how people are working and also the opportunity to obtain feedback from each other on how well they complete the safety observation process. As an added bonus, people are much more likely to go out and do the observations and find valuable ones, if they've made an appointment with someone else to do them at a set time.

5. Go to a variety of workplaces

The workshop just outside of the office is an easy place to do safety observations – it's close by and there's always something going on. But it is important to get out to all the different parts of site and seek out people doing jobs that would not normally be observed, one-off jobs, or jobs that you are unfamiliar with. Also people should try going to work areas that they do not normally visit, like the processing plant if they work in the mine or vice-versa.

6. Give praise when it's due

There is an early perception at sites when safe behaviour observations are introduced that they are only aimed at catching people doing the wrong thing. But they are also an excellent opportunity to catch people doing the right thing. Praise and positive feedback should be given when things are observed being done correctly, hazards being controlled, or instances where people have gone beyond the procedure with safety ideas they've thought of themselves. Certainly the safety discussions need to address areas of non-compliance or where improvements are needed, but with a little positive feedback included in each observation, people begin to look forward to being observed.

7. Train all employees

Finally, it is important that mines train all employees in the behavioural safety processes. People need to be trained to perform observations, not just be observed. Several studies have shown that employees who conduct behavioural safety observations subsequently perform the safety practices on the checklist much more consistently than they did prior to participating in the observation process.

Behaviour based safety systems have certainly helped make improvements to safety in the mining industry over the last decade or more. They are a tool which focuses on people and focuses on people communicating about safety.

However, they appear to not have been the silver bullet some had thought, sometimes through the implementation of the

programs, but also through the fact that they mainly address only one level of the organisation – the front line workers. Front line workers inherit their habits and behaviours from the culture of the organisation and from the behaviours they see in their leaders. The next step in safety improvement needs to focus on leaders and their behaviours.

LEADERSHIP AND SAFETY

If safety is the outcome we desire, leadership is how we get it. This may sound easy, yet despite years of leadership programs, performance reviews, workplace inspections, behavioural safety inspections and millions of Take 5s and JSAs, we still rely on systems, procedures and hardware as our main safety tools.

We see behaviours as the weak link and develop our systems and equipment to address this. We try to proceduralise and supervise. We observe and discuss. We tick boxes and fill out forms.

But why are behaviours seen as the weak link; why can't behaviours be the strong point? Why can't behaviours be the thing that protects us when systems have holes or when equipment fails?

What if the answer to achieving safe behaviours in our teams came down to some simple behaviours of the leaders themselves? What if it came down to leadership?

And what if this leadership thing wasn't as complex as it sounds? What if it was all about communicating constantly, acting fairly and consistently and having standards for what will and won't be accepted?

Behaviours are important, in fact the most important, but not just the behaviours of the frontline worker or the person in the firing line. It's the behaviours of people right up the organisation that are important and most importantly the leaders in the business – from executives to frontline supervisors.

An overwhelming amount of research points towards leadership as the key factor to better and long term sustainable safety in the workplace. It is the leaders closest to the front line which can have the biggest impact, but each of these leaders also has a leader and those leaders have leaders and so on.

Further research shows that leadership for safety is needed at all levels of organisations to ensure not only an alignment of values throughout organisations but also to ensure that frontline leaders have the necessary skills to practically translate organisational values into daily practical actions (Connect SL, 2008).

Leadership is also a necessary ingredient in the success of other safety systems. The best safety systems in the world will fail in practice if leaders don't implement, support and encourage them.

Safety leadership begins at the corporate and senior management level. At the top levels of the organisation is where overall safety objectives and directives are set. Corporate levels outline the criteria and key elements that will be used to develop site safety management systems. Corporate levels create the unity in an organisation that allows for best practice to be shared and for contributions from right throughout the organisation to be heard and included in developing safety systems. But again, 'corporate' is just a group of people, leaders of the organisation, whose behaviours and decisions create these directives and objectives.

Additionally, the corporate structure of the business is also the part usually responsible for auditing site performance and holding the sites to account for their performance. The absence of strength in this area may not weaken a site's commitment to safety or its safety performance, but there is no doubt that a strong corporate 'director' and 'policeman' will act as a positive influence to safety on site.

THE LEADER'S TOOLKIT

So what are the behavioural areas that excellent safety leaders are best at and that all leaders in the mining industry should be focusing on improving? The following eight areas are the main tools in an effective leader's toolkit and assist leaders in improving safety, production and individual performance.

1. *Talk only about behaviours*

Whether discussing a performance issue or a safety issue with a subordinate, it is critical that a leader focuses on the things he can physically observe, not the assumptions he makes about people's intentions. When leaders give corrective feedback they must talk in objective terms about behaviours and outcomes only, never about people's attitudes or intentions. A person will naturally get defensive when challenged on their attitude and feedback can quickly turn to argument as neither party has any physical evidence to support their statements or assertions. When we talk in terms of behaviours that were witnessed, however, we are talking about facts and people are much less likely to get defensive and much more likely to take the feedback on board.

It is important, however, to understand the reasons and context behind a person's actions before giving corrective feedback. We should state what was observed and why that is a problem, but then be open to hearing the other person's reasons or mitigating circumstances. In the end, these cannot change the behaviours that were observed, so the feedback should still be given, but it is important for a leader to get any context that they did not observe prior to making judgements about a person's actions.

2. *Set expectations*

Before a leader can effectively provide feedback on behaviours or hold people to account for their actions, they must be clear on what they expect from their team. Many conflicts between leaders and team members stem from misunderstandings of expectations.

As uncomfortable as it may be, it is critical that a leader sit down with their team and be frank and clear about their expectations. The leader should also take the opportunity to get feedback on these expectations and engage in enough discussion to ensure all team members understand them and agree to them. It is better to discuss and agree on expectations early on than to have to provide corrective feedback or discipline at a later point.

An expectation setting discussion is also an opportunity for the leader to find out from the team what their expectations are of the leader.

3. *Hold people to account*

Once expectations have been set by the leader, it is critical that the leader holds the team to account against these expectations. Through the expectations discussion the team members have agreed to a set of expected behaviours. If these are not being met, the leader must act quickly but fairly to give feedback where corrections are needed. The original expectations may need to revisited and further commitment obtained from the team member.

A leader must also ensure they give their team member fair appraisals and balance positive with negative feedback. A leader needs to act fairly between different team members and consistently over time when faced with similar situations.

4. Give them feedback

Overwhelmingly, team members constantly desire more communication with their leaders and more feedback. Too often feedback is left until the annual performance review, where any positive feedback the leader may have is overshadowed by any corrective actions or performance management discussions.

The preference should be to give feedback one-on-one rather than in a group setting, especially for negative or corrective feedback. Positive feedback can be given to an individual in a group setting if the leader is confident the individual and the team are suited to public praise.

5. Celebrate reporting

The key to getting people to repeat desirable actions is to give feedback as soon as that action occurs the first time. Leaders should give feedback as soon as possible when near miss reports or hazard reports are received, when a person does a safety observation for the first time, or when a person does a particularly good job of a safety report. The feedback helps with managing performance, but also demonstrates to team members that the leader puts focus and value on these safety documents and hence safety overall.

Small amounts of praise frequently go a very long way to creating lasting positive behaviours in team members. Small corrections more often are much better than large amounts of feedback on an irregular basis.

6. Create habits

Safe behaviours at the front line are developed through habits. One of the main aims of many safety programs is to create these positive habits and reinforce habitual safe behaviour.

A leader needs to use the tools already at their disposal in the operation to help create these habits. The tools might include Take 5s, JSAs, on-the-job risk assessments, safe behaviour observations, wearing the correct PPE at all times and filling out tags completely and correctly. Sometime safety systems can seem inappropriate or a waste of time to front line workers – it is the leader's job to explain how these systems help to create safety habits, even though they may not have a direct and visible impact on any one particular job.

7. Listen safety

Many of the tools listed above involve the leader 'talking safety' to their team. But it is also very important for a leader to 'listen safety'. A leader can never spend too much time discussing safety and listening to what people have to say about safety. By paying attention to concerns and hearing people out when they have an issue to report, the leader demonstrates his commitment to and interest in, safety and the wellbeing of their team.

A leader must encourage input from their team and should develop systems to do this, whether via regular meetings, informal discussion in the workplace, or 'suggestion box' style reporting systems. A leader must make sure they encourage honest and complete information, even if it is unfavourable. We learn and improve much more by finding out the things we can do better, than by hearing about the things we are already doing well.

8. Behave yourself

This is the most powerful tool in the toolkit. We don't want 'do as I say, not as I do' leaders. Not only is this counterproductive to a good safety culture, it also requires a lot more work! It is much easier for a leader to demonstrate and model the behaviours he wants from his team, than to write memos and hold performance discussions to keep people on track, while they are all the while thinking – 'but he doesn't do it'!

For example, research has shown that when managers and supervisors participate in conducting safety observations, a greater percentage of employees also participate in safety observations. Personally conducting observations places leaders in the role of walking the talk and in doing so they encourage employees to actively participate in the safety observation system.

Through a leader's own behaviour they demonstrate to those below and around them how they expect others to behave. They demonstrate what is acceptable and demonstrate how deeply interested they are in safety. People are always watching a leader and they should lead by example regardless of who is around, what their role is, or what their position title is.

MEASURING LEADER'S BEHAVIOURS

Leaders need to create a way to measure their own safety behaviours, the same way as we attempt to measure our employees' safety behaviours in the mine through programs such as behavioural safety observations. Leaders should have a checklist for their own behaviours and a list of things they will do each day, week and month to support the safety management system and the safety culture.

We need to develop a way to observe and give feedback on a leader's safety behaviours, in the same way we use safe behaviour observations on our operators and trades. The trick is that the safety-related behaviours for a leader cannot be observed in a 'snapshot' on the job site, they occur continually over time in their normal daily work. None-the-less, the challenge is to put systems in place that make leaders look at the leaders in their team and provide measures and feedback for how they are behaving in regards to safety.

So how do we assess and manage leaders' behaviours when our systems are focused at the front line?

At an underground coal mine in the Illawarra region of New South Wales, the leadership staff in the development production teams had daily and weekly checks for safety related behaviours.

Daily checks would include items like checking the hazard reports in-tray, counter signing inspection reports and verbally reviewing any incidents from the previous 24 hours. Weekly they would be asked to provide both positive and corrective feedback to an employee on safety, to respond in writing to a hazard report or Take 5 form, to complete a safety observation and to make a safety improvement around the mine. Each week the leader of the team would review the number of completed checks to obtain a 'score' for the week. Tracking of these scores and the percentage of checks completed allowed the leader of the team to provide feedback on how his leaders were behaving in regards to safety.

The tracking also included a graph of the whole team's total score – this drove a culture of holding each other to account in the team to make sure the weekly total was as high as possible. The overall goal of this program was for the entire team of leaders to demonstrate safe behaviours to those below and around them.

PRODUCTION AND SAFETY

It is a fact that safety performance does impact production performance. Consider the common performance objective of employee engagement. The objective is for employees to be fully engaged, not only physically but also psychologically and intellectually. We want employees to contribute with their greatest potential. We want their ideas, their innovation and, in some instances, their discretionary time. We want employees to be active, ongoing contributors in how we work and how we do it safely.

In order to do that the employee needs a sense of safety and security as a foundation. If employees are concerned for their own physical safety in the workplace how can we expect that they will develop the capacities outlined above? How will they be able to contribute to the extent that we want them to? It's in this sense that safety is foundational to each individual.

In the same way that safety is foundational to the performance of the individual it is also foundational to the performance of the organisation. Employees perform better in teams and individually when they have a sense that the larger organisation is concerned about them in general.

One way to convey this sense of concern is by making the workplace safer. When the workplace is perceived as unsafe we actually convey, whether we intend to or not, just the opposite. When we demonstrate the care of the organisation for the employee we in turn generate a sense of unity and engagement that leads to higher organisational performance. In fact, if our task is to improve the overall organisational culture, safety is an ideal place to start because it is highly visible, it has obvious meaning, it is relatively easy to get people to buy-in to and it sets the tone for other kinds of general performance improvement.

The more an employee perceives that the organisation values safety goals, the more likely they are to invest in those goals themselves.

CONCLUSIONS

The challenge goes out therefore, not to the leaders in general, but to the leaders' leaders and their leaders. 'Walk the talk' and demonstrate the safety values you hold. Hold the leaders that work for you to account and make sure that their behaviours demonstrate safety commitment to those below them.

Safety leadership means simply behaving in ways that demonstrate that the value of safety is primary to your personal goals and that the health and well-being of the people who work for you is more important than getting something done unsafely. The leadership tools and traits discussed above are the key to organisations taking the next sustainable step in safety improvements. The mining industry has done all it can do with systems, procedures and safety programs. We have started on the right track to enduring safety improvements by looking at peoples' behaviours over the last decade, now is the time to focus on the behaviours of those who have the most impact on safety, culture and business performance – our leaders.

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‘She’ll be Right Mate’ – Culture and Safety

P Milnes[1], N S Melkoumian[2], D Mather[3], T Milnes[4], A Stewart[5] and L Tan[6]

ABSTRACT

While improvements in occupational health and safety (OHS) in the mining industry have decreased fatalities and accidents, little attention has been paid to the cultural confound of ‘safety’ in the increasingly multicultural mining industry. Occupational health and safety processes often contain assumptions of cultural understanding that may not be shared or understood by mining employees. There are potentially dangerous and costly implications of cultural difference in the mining environment.

Some people have been enculturated with high levels of anxiety concerning catastrophe and uncertainty while others have a more *laissez faire* attitude to accidents and disaster. The level of cultural anxiety about uncertainty can be a major factor in the acceptance of OHS processes. OHS manuals based on a comprehensive set of rules and procedures may assume that the authority of ‘rules’ is shared by all employees regardless of a variety of cultural understandings when this may not be the case. Similarly, cross-cultural employees may not share a background or acceptance of expensive technological innovation and so resist/avoid the application of new safety equipment. Then too, OHS staff may not realise the significance of religious belief or personal responsibility on employees’ attitudes to safety in the workplace environment. A lack of consideration of these cultural elements could have fatal and expensive results.

This paper explores the impact of cultural difference in the understanding of OHS in the Mining Industry, presents a model to improve the understanding of the cultural confound in safety, improves analysis of OHS in practical multicultural situations, provides assistance for those involved in OHS training and may become a basis for developing OHS policy and procedure.

INTRODUCTION

Based of the infamous ‘Stanford Prison Experiment’, Zimbardo (2004) suggested that behavioural changes are a result of the situation and the situation is determined by the system. The person adapts to the situation, which in turn adapts to the system of power. Conversely, the system exercises coercion over the situation and the situation exercises coercion over the person.

Similarly, occupational health and safety (OHS) systems organise situations and modify personal behaviour. While OHS principles and practice may seem obvious to policy makers, workers in the system may not share their concerns and may behave differently in specific situations. Cultural differences give rise to how individuals avoid uncertainty, how this uncertainty manifests in anxiety and how they tolerate ambiguity.

This paper combines four methods that humans use to avoid uncertainty. A ‘cultural kite’ diagram is constructed to compare the uncertainty avoidance strategies of the individual worker, the situation and the system. The size of the cultural discrepancies between system, situation and individual become immediately apparent. Management can then target training and select effective interventions to improve OHS outcomes.

PERSON, SITUATION AND SYSTEM

The concept of person, situation and system was first systematically researched in 1972 when Phillip Zimbardo set up the now infamous ‘Stanford Prison Experiment’. The research was designed to

1. Consultant, Belco Consulting, 4 James Street, Gilford WA 6055. Email: peter@belco.com.au

2. Lecturer, School of Civil, Environmental and Mining Engineering, Computer and Mathematical Sciences, The University of Adelaide, SA 5005.

3. Senior lecturer, Western Australian School of Mines, Locked Bag 30, Kalgoorlie WA 6433. Email: D.mather@curtin.edu.au

4. Psychologist/Senior Clinical Intervention Officer, Department of Corrective Services, Post Box 93, Moonyoonooka WA 6532. Email: timothy.milnes@correctiveservices.wa.gov.au

5. Senior Lecturer, School of Biomedical Science and Exercise, Edith Cowan University, WA 6231. Email: a.stewart@ecu.edu.au

6. Psychologist Registrar, Psychology Australia, 10 Grosvenor Road, Mount Lawley WA 6050. Email: lemueltan@hotmail.com

observe the difference that could be achieved in human behaviour by a change of situation. However, after six days Zimbardo had to call off the experiment, which was supposed to last two weeks, because of the profound changes in the normally healthy university students who as 'prison guards' became increasingly cruel and sadistic and 'prisoners' who became pathological, depressed and psychotic (Zimbardo, 2007). Dr Zimbardo, who was later the President of the American Psychological Association and an expert witness at the investigation into the use of torture in Iraq, noted the similarities of his 'guards' to the cruelty of American soldiers in charge of prisoners in Abu Ghraib, Iraq. He suggested (2007: 10) that the behavioural changes were a result of the situation and the situation was determined by the system.

OHS operates within a system that organises situations and modifies personal behaviour. These three levels of OHS can be observed in the following illustration:

> *A local mining company had a carefully devised, practical, periodically revised and appropriately enforced OHS* system *where staff were well trained in the rules and respected them. The workshop* situation *was well-appointed, appropriately equipped with safety facilities and tools and staffed by people who were well-trained in the OHS system. However, during an in-service course, one person admitted that when he was working at home he may consider welding without appropriate clothing and protective shoes – particularly if he wanted to get a job done and did not have the clothing and shoes with him – even though he would not dream of welding in this clothing in the work situation.*

When work routines encouraged observance of OHS principles and required clothing was readily available, he had no difficulty with compliance. Removed from the influence of the work system and situation, he had no problems in adapting his behaviour toward the expedient. The situation and the system have the power to change people's attitude and compliance to safety and this could be for better or for worse.

UNCERTAINTY AVOIDANCE (UA)

All people live with uncertainty resulting from catastrophes such as crop failures, natural disasters, accidents, acts of war, financial corrections and personal tragedy. Hofstede (2008) labelled the resulting anxiety about safety as 'Uncertainty Avoidance' (UA):

> *Uncertainty avoidance deals with a society's tolerance for ambiguity. It indicates to what extent a culture programs its members to feel either uncomfortable (anxious) or comfortable (relaxed) in unstructured situations* (Hofstede, 2008).

Hofstede's definition included two aspects of uncertainty avoidance/anxiety and tolerance of ambiguity.

Cultural levels of anxiety

While people from all cultures live with uncertainties of life, the anxiety that it creates is not tolerated by all cultures in the same manner. Some cultural groups are High UA exhibiting high levels of anxiety and expend great effort in their management of uncertainty while other cultural groups are Low UA exhibiting a higher level of toleration towards misfortune and a more fatalistic attitude to life's events.

These attitudes concerning safety and avoiding uncertainty should not be classified as 'good' or 'bad', but simply different. For the people involved, their attitude to safety is 'natural' because it was part of their enculturation. Among the first things a child learns are the distinctions between 'clean/safe' and 'dirty/dangerous' but these definitions vary widely from one society to the next and even between families within the same society.

The British-American anthropologist Mary Douglas (1966) argued that 'dirt' is a relative concept, which is matter that is out-of-place while 'dangerous' are things are to be avoided. Some cultural groups may have a relaxed attitude to 'dirt' and 'danger', while others teach a strict code of avoidance. In strongly avoidant cultures, parents discourage risk-taking, try to protect their children from 'danger', teach them a sharp distinction between good/clean and evil/dirty and discourage contact with 'different' people. In lower avoidant cultures, classifications of 'dirty' and 'dangerous' are more flexible and parents are prepared to give the benefit of doubt to unknown situations, people, ideas and deviant behaviour. They would encourage their children to explore their surroundings even if danger is present and teach risk management rather than risk avoidance.

Hofstede (1991) claimed that the level of anxiety concerning uncertainty manifests itself in behavioural cultural characteristics:

In countries with strong UA, people come across as busy, fidgety, emotionally aggressive and active. In countries with weak UA people give the impression of being quiet, easy-going, indolent, controlled and lazy. These impressions are in the eye of the beholder: they depend on the level of emotionality to which the observer has been accustomed in his or her own culture (Hofstede, 1991) (Table 1).

TABLE 1

Cultural anxiety contrasted adapted from Hofstede (1991) and Milnes (2007).

High anxiety cultures	Low anxiety cultures
• The uncertainty inherent in life is felt as a continuous threat which must be fought	• Uncertainty is a normal feature of life and each day is accepted as it comes
• Low tolerance of risk-taking even in situations and circumstances may require it.	• Greater acceptance of risk-taking especially in responding to particular circumstances
• High stress; subjective feeling of anxiety	• Low stress; subjective feeling of wellbeing
• Aggression and emotions may at proper times and places be ventilated	• Aggression and emotions should not be shown
• Acceptance of familiar risks; fear of ambiguous situations and of unfamiliar risks	• Comfortable in ambiguous situations and with unfamiliar risks
• Tight rules for children on what is dirty and taboo and 'What is different, is dangerous'	• Lenient rules for children on what is dirty and taboo and 'What is different, is curious'
• High levels of legal remedy sought in the courts for correcting misfortune	• Social remedies are sought for correcting misfortune
• Emphasis on choice and an assumption that humans can control their environment and so work towards changing it	• Emphasis on fate and an assumption that humans cannot control their environment but simply adapt to it

Although Hofstede has managed to quantify anxiety levels of cultural groups, personal levels of anxiety may vary considerably within social groups. For this reason tests such as the DASS21 (Lovibond and Lovibond, 1995), a 21-item self report instrument, are useful in measuring three negative emotional states of depression, anxiety and stress within individuals. This psychometric test can be used to quantify personal stress levels and compare results between individuals.

Tolerance of ambiguity

Budner (1962) defined ambiguity as uncertainty in real life: novelty (insufficient cues), complexity (too many cues) and insolubility (contradictory or indistinguishable cues). Norton (1975) summarised the causes of ambiguity as:

- multiple meanings;
- vagueness, incompleteness, or fragmentation;
- probability;
- unstructured;
- lack of information;
- uncertainty;
- inconsistencies and contradictions; and
- lack of clarity.

Tolerance of ambiguity can be a reflection of personality (Ely, 1995) where people with higher tolerance of ambiguity are likelier to feel comfortable in uncertain conditions (Budner, 1962). Huber (2003) points out that tolerance of ambiguity results in attributes of flexibility and creativity and that these are increasingly valuable to businesses addressing the unpredictability and change process of globalisation. On the other hand, Anitsal, Anitsal and Elmore (2009) found that people with higher levels of tolerance of ambiguity were more likely to cheat. Kajs and McCollum (2009) have presented a summary of the research indicating that while tolerance of ambiguity in one situation could be beneficial, there are other situations when a greater intolerance of ambiguity is beneficial (Table 2).

OHS policy makers need objective measures of their employees' UA levels in order to predict employees that share, or are trained to share, similar UA levels to the company. OHS officers involved in multicultural work situations need to:

TABLE 2
Tolerance and intolerance for ambiguity characteristics (Kais and McCollum, 2009).

Tolerance for ambiguity characteristics	Intolerance for ambiguity characteristics
Cultural disposition Collaborative as well as receptive to working in cross-cultural environments (Bakalis and Joiner, 2004)	*Cultural disposition* Dogmatism, authoritarianism, conformity, rigidity, and ethnocentricity (Bakalis and Joiner, 2004; Geller *et al*,1993)
Personality style Thrives on challenges (Taylor, 2000), is resilient and flexible (Patterson, 2001), psychologically aware (Beitel, Ferrer and Cecero, 2004); tends to avoid seeking feedback except in contexts of job advancement (Bennett, Herold and Ashford, 1990)	*Personality style* Overwhelmed by challenges (Taylor, 2000), is stressed and anxious in reaction to uncertainty; tends to seek feedback, except when job-specific (Bennett, Herold and Ashford, 1990)
Uncertainty avoidance Views uncertain situations as desirable (Budner, 1962), suspends closure, tolerates failure, takes risks, is relaxed in monitoring self (Blau, 2003)	*Uncertainty avoidance* Views uncertain situations as threatening (Budner, 1962), finds only one solution to bring closure to a process instead of multiple alternative solutions, tends to be rigid (Furnham,1994)
Learning style Predisposed to critical thinking, open-mindedness, flexibility, independence and integrative thinking; positive approach to generating solutions (Furnham, 2003); enjoys instruction that helps to explore new perspectives (Sallot and Lyon, 2003)	*Learning style* Attracted to structured elements in learning (Furnham,1994), uncomfortable with unstructured courses, flexible grading criteria, and tasks with multiple answers/options (DeRoma, Martin and Kessler, 2003)
Thinking style Flexible, discovery-based, creative and reflective. Believes that action-based research, lifelong learning and leadership are intertwined (Huber, 2003). Personal belief in solving complex problems (Sallot and Lyon, 2003)	*Thinking style* Stereotyping favored over probability thinking (Geller *et al*, 1993), has a tendency to refuse to identify and admit uncertainty in contexts (Sallot and Lyon, 2003) and has a tendency to distort information (Yurtsever, 2001; de Roma 2003)
Management style Has a 'development' style of management that emphasises interpersonal relationships (Yaffa, 2003), favors motivational methods and interpersonal relations over professional behaviours (Norr and Crittenden, 1975)	*Management style* Has a tendency for benevolent and/or autocratic style of management and has a task-orientation (Yaffa, 2003) and upholds traditional hierarchical and class structures (Norr and Crittenden, 1975)
Working style Entrepreneurial, adaptable, creative and innovative (Lane and Klenke, 2004)	*Working style* Successful with repetitive activities; mechanical, rule-driven (Lamberton, Fedorowicz and Roohani, 2005)
Decision-making style Risk taker, low anxiety, self-confident, creative, open to new ideas, explore options of cognitive complexity and abstract thinking (Stoycheva, 2003). Could engage in risky, foolhardy or short-cut options. Conceptual approach and analytical decision-making style to find alternative solutions (Williams, 2006)	*Decision-making style* Avoids risks, has tendency for insecurity and anxiety; poor regard for humanistic issues and idealism (Stoycheva, 2002). Conservative, systems-based decision-maker who prefers traditional techniques to solve new problems

- be qualified to observe the cultural differences that may affect attitudes toward safety,
- be able to describe the differences objectively,
- analyse potential misunderstandings that may occur at the cultural interface,
- find solutions that avoid possible cultural conflict, and
- implement and maintain optimum safety policies.

By describing and understanding different approaches to safety and appreciating cultural safety rationales, efficient mechanisms can be developed that ensure the safety of all people in a multicultural working environment.

Impact of anxiety and tolerance of ambiguity on occupational health and safety

Occupational health and safety (OHS) is concerned with the maintenance of safe physical working environments and the avoidance of catastrophe and while OHS principles and practice may seem obvious to policy makers, workers in the system may not share their concerns. Organisational systems and employment situations are rarely simple and clear-cut.

Usually large elements of ambiguity confront the individual in new situations and in complex and contradictory situations at all levels of a system. While sometimes prizing an employee's ability to be 'creative', OHS systems also expect conformity and intolerance of new approaches. This tension needs to be acknowledged when implementing OHS systems or presenting OHS inductions.

There is great value in knowing about ambiguities and tensions that are inherent in the workplace situation and the broader system so that these can be appropriately addressed in OHS policy and training. Similarly, there is great value in knowing about the personal levels of anxiety and tolerance that employees have. This information will assist OHS officers to know how to target training, select instructional elements and tailor their approach.

For this reason, administration of psychometric tests such as the DASS (Lovibond and Lovibond, 1995) and Budner's (1962) Tolerance-Intolerance of Ambiguity Scale can assist policy-makers. Budner's 16 item Tolerance-Intolerance of Ambiguity Scale measured on a Likert scale provided seminal work in the area in 1962 and is a reliable instrument. Since then other instruments of high construct ability include: the Nutt (1988) instrument consisting of 15 questions about ambiguous personal and work situations, Rydell and Rosen's (1966) 16 item true false, McDonald's (1970) AT-20 and McLain's (1993) MSTAT-1. Obviously privacy issues need to be addressed but these can be overcome by anonymous testing or permission being granted. Also, measures of these characteristics should not be viewed pejoratively because they simply represent other ways of viewing and feeling about the world.

CULTURAL ATTITUDE TO UNCERTAINTY AVOIDANCE

It is a fact that high anxiety about the future and intolerance of ambiguity is a feature of western orientated OHS. However, while the OHS officers implementing safety policy may be very concerned about the possibilities of catastrophe, people who work in the organisation may have differing views and anxiety levels about these possibilities. For example, some may believe that 'Gods will prevail' and there is little use in worrying about the uncertainties and possibilities of catastrophe and is thus more productive to consider the more predictable features of their lives. The simple example above illustrates that cultural differences in the workplace are important in policy-making, training and implementation of OHS.

There are four fundamental avoidance methods (Hofstede, 1991) that can be usefully employed to measure cultural attitudes to uncertainty avoidance. Different cultural groups establish and react to rules, relationships, religion and technology differently. In addition, within the cultural group these strategies have 'moral authority' because:

- they make sense to people who live in that society,
- individuals accept the effectiveness of the strategies, and
- most people in the group are usually compliant.

These can be analysed holistically and can be represented diagrammatically.

Rules

Legalist cultures those who trust that codes, rules and laws are necessary to avoid (or at least manage) uncertainty. Jeito finding cultures are those that trust the individuals to work out ways to overcome difficulties and distrust the processes of law-making – it is a Portuguese word used in Brazil to denote 'the way around the rules'. For example, while compliance to western occupational health and safety codes may be seen by some a mandatory regardless of circumstance (Legalist), other cultural groups may be relaxed in adapting the codes to suit the situation and the circumstance (Jeito). The dependence on rules in uncertainty avoidance is represented in Table 3.

TABLE 3

Dependence on rules in uncertainty avoidance.

Legalist cultures	Jeito (expedient) cultures
• Tight rules for children on what is dirty and taboo	• Lenient rules for children on what is dirty and taboo and broad definitions of acceptable behaviour
• Many and precise laws and rules because there is an emotional need for rules, even if these will never work	• Few and general laws and rules and a belief that there should not be any more rules than is strictly necessary
• If rules cannot be respected, they should be revised	• If rules cannot be respected, they should be ignored or ways found to go around them
• Conservatism, extremism, law and order	• Tolerance, moderation and practical outcomes
• In times of crisis, legal systems and organizations are sought out to assist, fault is assigned to failing systems and legal remedies are devised to prevent a repeat of the effects of crisis	• In times of crisis and blockage, individual and social means are sought to overcome obstacles whether or not these are strictly legal

For those from a Legalist culture, there is a belief that through rules the uncertainty of human behaviour can be made to be more predictable because the variations of behaviour are minimised. As a result effort is put into the creation, application and interpretation of rules. Alternatively, people from a Jeito society pride themselves that many problems can be solved without formal rules. In such cultures Hofstede (2008) claims that there 'seems to be an emotional horror of formal rules and rules are only established in case of absolute necessity'.

OHS policy makers from Legalist cultures may find themselves frustrated with those from Jeito cultures. While they may prescribe compliance and obedience to their handbooks to ensure avoidance of uncertainty and legal consequences, their workers may ignore their rules, try to find their way around them, or find other ways of doing things.

Misunderstandings are bound to occur in multicultural situations involving people from both Legalist and Jeito cultures. Legalist officers would develop high levels of anxiety with a non-compliant and risk-taking workforce with relaxed attitudes and behaviours. Alternatively, Jeito OHS supervisors would develop resentful behaviour patterns towards workers who are highly anxious, rigid, officious and finicky.

Technology

Technocratic cultures are those who emphasise human control over the environment by modification, technical solutions and research to minimise the effects of catastrophic events and make the environment to predictable and certain. User cultures begin with the premise that the environment cannot be controlled, have limited faith in technological solutions, are content to adapt their lives to the physical environment and 'use' whatever tools, materials and resources that come to hand. For example, while westerners may demand higher benchmarks for safety construction to withstand cyclonic conditions in northern Australia (Technocrats), Indigenous people may take a more fatalistic attitude to construction, use whatever is available and reason that the big winds are destructive anyway (users) (Table 4).

TABLE 4
Technological dependence in uncertainty avoidance.

Technocrat cultures	User cultures
Belief in experts and specialisation	Belief in generalists and common sense
High value placed on the acquisition and maintenance of tools, resources and materials	Tools, resources and materials are valuable if they are useful
Good quality tools are carefully maintained and tools are used for specific purposes	Any tools available are used and may be adapted for a variety of functions
Lending tools, resources and materials is frowned upon – tradesmen have their own tools	Borrowing tools, resources and materials is encouraged – tradesmen share tools.
Emotional need to be busy; inner urge to prepare for possible calamities	The *laissez faire* approach to environment results in less emphasis on preparation
Familiar risks may be acceptable but ambiguous situations and unfamiliar risks are feared	Comfortable in ambiguous situations and with unfamiliar risks
Lots of time, expense and effort put in to creating controlled environments and people believe that the accumulation of material is important to guard against the unknown	Lots of time is spent in uncontrolled environments and people are content with less material. People may readily use and discard resources and appear to be unconcerned with breakages

OHS policy-makers from Technocrat cultures may be frustrated by people from User cultures who do not treat or value tools, materials and resources in the same way that they do and be appalled at their willingness to do without technological resources when they are uncomfortable or difficult to use. For example, while safety glasses may be an excellent means of avoiding possibilities of eye damage, people from extreme User cultures may find them uncomfortable and a hindrance to output and so avoid wearing them. People from User cultures will only find technological solutions viable if they are on hand and useful. Meanwhile, OHS User cultures may find Technocratic dependence on technological solutions over-expensive and cumbersome and so avoid implementation of their solutions.

Religion

Secular cultures believe in human transcendence and utilise scientific methods to observe the world. Transcendentalist cultures believe in a theological/mystical worldview and observe religious rites and integrate metaphysical understandings into the very fabric of their cultural identity. For example, while fertility ceremonies may not be accepted by many westerners (Secularist) as a meaningful strategy for avoiding water shortages they are in central Australia (Transcendentalist). The moral authority of Indigenous ceremonies increases compliance and participation for Indigenous people (Table 5).

TABLE 5

Dependence on religion on uncertainty avoidance.

Secular culture	Transcendentalist culture
• View the environment as physical and mechanical	• View the environment as spiritual and organic
• Scientific observations leads to a rationally understood world that is controllable and technologically adaptable to human requirements	• The world is spiritually known and mystically understood and believe that religious rites may be required to avoid catastrophe
• Humans are perceived as apart from nature and therefore have a right to modify and utilize the natural environment	• Humans are perceived to be a part of nature and so accept natural order of the environment
• In times of crisis, humanistic solutions are sought	• In times of crisis, religious rituals are observed

Religion represents human attempts to manage perceived transcendental forces that either control human affairs, bring acceptance when defenseless, certainty to life after death, or victory over one's opponents. Moral codes are developed in addition to theological constructs to explain and maintain consistency in human affairs so that certainty can be acquired in spite of the supernatural uncertainties of life. Against a cultural worldview where people see themselves as an integral part of the environment, the western tradition has emphasised a separation derived in large part by the epistemology of positivism – a concept popularised by August Comte (in Seymour-Smith, 1998) during the nineteenth century.

Examining the characteristics of positivism assists understanding its impact on western consciousness (Kincheloe, 2001). All knowledge is scientific knowledge (only scientifically produced information should be regarded as authentic human knowledge) and facts and values can be kept separate and objectivity is always possible (allowing for value-free 'proclamations that project the illusion of political and moral neutrality) (Garrison,1989). The influence of scientific positivism results in a Secular culture. Other cultural groups continue to believe in the moral authority of the theological and metaphysical aspects of life. Often, however, there is a mix of Secular and Transcendental views. For example, even within largely Secular cultures, there are many who continue to believe in a theological worldview, observe religious rites and train their children in their own way of thinking.

OHS policy-makers from Secular cultures may become frustrated with people from spiritual cultures who fatalistically accept 'God's will', want time off to work engage in religious rituals and generally have a transcendental worldview. On the other hand transcendentalists could be outraged by the idea that humans ultimately control nature and take a utilitarian approach to the Earth's resources, without due regard to religious considerations and transgress moral laws.

Relationships

In Collectivist cultures, people see themselves as 'we' (part of large extended families) and in times of misfortune they expect others to look after them and obligated to look after others. In Individualist cultures, people see themselves as 'I' (or part of a nuclear family) and in times of misfortune are largely responsible for themselves (Milnes, 2007) (Table 6).

For some cultural groups, catastrophe is managed through the development and maintenance of relationship while for other groups catastrophe is managed by individual effort (Hofstede, 2008) or external insurance agencies. Most Western cultures, such as mainstream USA, Australia, the UK and New Zealand, are highly individualistic. Maintenance of individual rights to pursue one's own happiness and freedom is paramount and is usually protected by law. In Collectivist societies, people are integrated into strong, cohesive in-groups which protect them in exchange for unquestioning loyalty. The interest of the group prevails over the interest of the individual.

TABLE 6
Dependence on relationships in uncertainty avoidance.

Collectivist cultures	Individualist cultures
• Personal and social networks are the 'insurance' systems for occasions when calamity strikes	• Impersonal company insurance systems and political organisational systems are developed for occasions when calamity strikes
• People are born into extended families or clans which protect them in exchange for loyalty	• Everyone is supposed to take care of him/herself and his/her immediate family only
• Collective economic responsibilities define rigid or demand expectations that resources are distributed according to obligation so that there is enough for everyone	• Individuals take economic responsibilities for their own and immediate family and distribute and consume resources according to self-interest
• Private life is invaded by others	• Everyone has a right to privacy
• Generosity is a valued personal attribute	• Achievement is a valued personal attribute
• Mutual obligation and reciprocal sharing is demanded	• Personal responsibility is demanded
• In times of crisis, people who are known are sought out for help	• In times of crisis, experts are sort out for help

While most ancient religions emphasised the collectivist ideals of the responsibilities of humans to each other, the ideal of individual 'rights' has a much shorter history from the *Magna Carta* (1215) to the *Universal Declaration of Human Rights* (1948) that begins: 'Whereas recognition of the inherent dignity and of the equal and inalienable rights of all members of the human family is the foundation of freedom, justice and peace in the world …' Children from individualistic families grow up in 'nuclear families' and are educated to be independent, freethinking and gauge success on the degree to they can make it on their own, be their own boss and in control of their own destiny.

For Collectivist OHS officers, safety is the responsibility of the group so that it is expected that in times of crisis, the group will take care of each person. Care is reciprocal so that when disaster strikes one, the whole group is fixed into lines of obligation and people can demand that others comply. On the other hand, an Individualist may narrowly define the rights and responsibilities of workers without understanding the power, obligation or influence of the group. By demanding strict personal obedience to codes designed to ensure the safety of others, they may not understand the actions from Collectivist cultures and vice-versa. Frustration may arise when the neat Individualist systems run counter to the Collectivist responsibilities.

A MEASURE OF CULTURAL UNCERTAINTY AVOIDANCE

The four strategies (rules, technology, religion and relationships) that humans use to avoid uncertainty are combined along a two axis plane. Bringing into consideration the aspects of the person, the situation and the system, three 'cultural kites' can be constructed to create a visual representation of potential and specific problems and issues in the OHS environment. The size of the cultural discrepancies between system, situation and individual also become apparent. Management can then target specific training or other interventions to improve OHS outcomes.

Psychometric testing for anxiety and tolerance of ambiguity are well developed, but at the time of writing no single set of tests are easily available to measure individual, situational and system cultural kites. It is, however, possible to conduct a simple qualitative measure based on scale estimates of each of the four strategies. The estimates are then plotted onto a two axis plane, as illustrated on Figure 1.

Figure 1 is represented with the technocratic, secular, legalist and individualist strategies in the centre. The purpose is to portray a western orientated culture in which most mining companies seek to operate. The system thus will be represented by a small kite (System Kite) very near the centre of the diagram – illustrated by red lines on Figure 1. Construction of a situational kite is more specific to the workplace and the individuals who interpret the system, ie, the OHS officers. A situation where there is some laxity in the rules and a strong system of 'mateship' exists is represented in blue on Figure 1. Finally, an individual who is Secular in outlook (scientific), shares similar 'mateship' and technology characteristics as the situation does, but displays a deep mistrust of the rules (Jeito) is represented in black.

What is immediately obvious from Figure 1 is that the situation (in blue) is different from the system (in red). The situational environment allows limited breaking of rules because it recognises

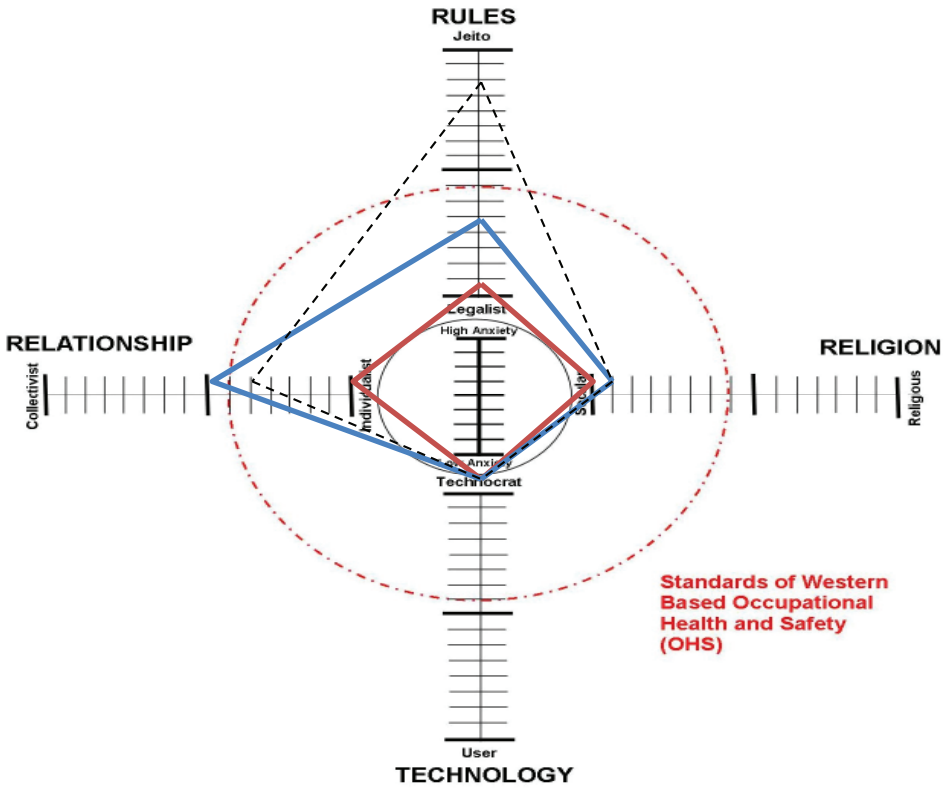

FIG 1 - A measure of cultural attitudes to uncertainty avoidance.

the importance of some degree of collectivism (mateship). This phenomenon could create tension between management (system) and the OHS officers (situation) – assuming that the OHS officers create the system. The area between the red and blue kites illustrates the severity of the issue, perhaps indicating that education on the importance of rules needs to be presented to the OHS officers. The individual in this case (in dashed black) has a high disregard for the rules, but falls more or less within the situational bounds of relationships, technology and religion. Training is important to bring the individual in line with the rules established by the situation. It must, however, be noted that within a situation there are many individuals who will display different cultural kites. For example, if an individual has a high user score, then technologically orientated training is needed.

CONCLUSIONS

The uncertainty or risk and management interventions, associated with OHS can to some measure be attributed to cultural differences. Further, OHS is designed according to a system that sets the rules and regulations, but it operates in unique situations and with individuals often from diverse cultural backgrounds. Taking this into consideration and identifying the methods that humans use to avoid uncertainty and deal with ambiguity a qualitative model is developed. The model seeks to measure the conflicts that might materialise from a system imposed on a particular situation and between various individuals. Quantitative psychometric methods are being developed to formalise the model.

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What can safety learn from neuroscience?

C Sylvestre[1]

ABSTRACT

Most organisations think of personal safety in terms of hazards, knowledge or conscious decisions. The physical environment of the workplace or the employee's knowledge and understanding of hazards typifies this approach. Although these ways of thinking about safety certainly have some merit, and may be part of an overall solution, they are not enough to prevent many accidents/incidents. So, what is missing?

Neuroscience estimates that 95 per cent of what we do is subconscious. That is, the majority of our actions, even whilst undertaking seemingly high risk tasks are mostly done while on autopilot. We are conscious that we are carrying out a task, but not necessarily making active decisions in carrying out each step. This is not about psychology; it is about the biology that has resulted from human evolution.

One way the human subconscious brain interacts with the world can result in unintentional errors or mistakes which can cause incidents. The solution is not just about understanding how our brain works; it is about applying methodologies to engage with people's subconscious mind in a way that enables them to become habitually safer. After all, we are creatures of habit.

Drawing on the latest neuroscientific research, this paper attempts to explore the large role played by inattention and distraction in the cause of personal safety incidents. It also attempts to deal with the causes of inattention, primarily rushing, frustration, fatigue and complacency. If people can become aware of and understand (without blame or fault) how unintentional errors come about, and how these can be minimised, they can potentially engage more fully and be able to comply more with current safety management systems and make 'safer' choices. This enables people to contribute with more purpose to a positive safety culture, thereby improving safety performance. After all, personal safety is more than just following the rules.

INTRODUCTION

Why do so many people still get hurt at work even though we do so much for their safety? For instance, it is estimated that workplace incidents cost the Australian economy $61.8 billion per annum, representing 4.1 per cent of gross domestic product in the 2012–2013 period (Safe Work Australia, 2015).

Most organisations think of personal safety in terms of the physical environment of the workplace, the employee's knowledge and understanding of hazards or their conscious decision-making capabilities. Although these ways of thinking about safety certainly have merit, and are part of the overall solution, they are not enough to prevent many incidents, even serious ones. So, what is missing?

There is strong evidence that unintentional mistakes such as inattention, or human error as it is sometimes referred, are an important factor when incidents occur. A 2009 study (Patterson and Shappell, 2010) conducted by Clemson University for the Queensland Department of Mines and Energy reviewed 508 reportable incidents in Queensland mining during 2004–2008 and concluded

1. Founder, Habitsafe, Parramatta NSW 2150. Email: cristian@habitsafe.com.au

that human error leading to an unsafe act was an underlying cause of 95 per cent of accident and incidents in Queensland mining.

It is therefore possible that the role of inattention, or human error, could be understood better and used to prevent incidents?

We suggest that competency – having the required skills to do a task – alone is not enough. Other internal cognitive factors have the potential to get in the way of performing a task without incident. Using road safety as an example, car incidents are not the result of people forgetting how to drive safely all of a sudden. Data from a 100-car naturalistic driving study (Dingus *et al*, 2006) – these studies measure real-life driving using in-car video cameras, eye trackers and sensors – found that inattention was a factor in 78 per cent of all crashes and near misses. This included secondary task distractions (for example, in-vehicle use of mobile devices), glancing away from the road in front, fatigue and other non-driving related eye glances (for example, mind wandering).

Hazards are not just limited to times when we drive, they are everywhere, at work and away from work, but we need to appreciate that there is no potential for harm unless there is exposure to the hazard. One thing that increases the risk of exposure is inattention. In other words, traditional safety management and the principals of safe design are important in incident prevention but there is always some residual risk. Managing inattention may be more about reducing the residual risk by limiting the potential for exposure.

People are accustomed to blaming tiredness, problems at home, outside distractions and other external factors that are outside the control of the workplace for inattention. Some of these factors could be dealt with as part of a traditional safety management approach, however, there is also an opportunity to minimise inattention by teaching the individual what cognitive system drives their actions and providing training in what they could change to become more attentive or at least alert them when this occurs.

WHAT WE DO IS KEY, BUT NOT WHAT WE DO CONSCIOUSLY

Most organisations have worked out that what people actually do 'in the moment' (as opposed as to what they planned to do) has a lot to do with incidents and injuries, even with the serious ones. There is an unstated belief that incidents result from people making a deliberate and conscious choice. This approach focuses on the self-management functions of the conscious mind as having the greatest influence on what we do. Many workplace initiatives such as safety leadership, safety observations programs or cultural programs provide approaches which are based on improving conscious thinking. Of course, this helps but may not be enough to prevent the types of incidents we seek to reduce.

Neuroscientific research has revealed that the vast majority of our everyday actions are subconscious. Leonard Mlodinow, author of Subliminal, states that 'some scientists estimate that we are conscious of only 5% of our cognitive function' (Mlodinow, 2012, p 34). Other research states 'stimuli can assume control even when to do so triggers action at odds with the goal set by the higher order control' (Toates, 2006, p 78). This is the reason why we have all experienced getting in our car and driving to where we normally drive (home, work, wherever) when we needed to go elsewhere (the goal). In other words, even a complex operation that is being done repeatedly like driving a car, can be done with little involvement from our conscious mind.

More recently, research by Daniel Kahneman, author of Thinking, Fast and Slow (Kahneman, 2011), validates Bargh's finding and explains that as soon as the conscious mind is satisfied with a task or activity, it writes a 'script' and hands it to our subconscious mind to execute automatically. When we think about it, we realise that a good deal of what we do is below our conscious awareness – getting out of bed in the morning, taking a shower, brushing our teeth, how we put our clothes on as well as all sorts of everyday things happen without a lot of conscious thought. In other words, sometimes we know what we are doing through our conscious awareness of it – but at other times it is the subconscious processes that drive what we do, something people refer to as being in the 'autopilot' mode. So, if we want to keep ourselves safe, we must be aware of how our subconscious mind works and ensure that what we do habitually is aligned to what we understand is required to be safe.

THE AUTOMATIC PATTERN THAT LEADS TO INATTENTION

It has been reported (Wilson and Higbee, 2012) that when people who had been involved in an incident were asked how they hurt themselves, at work, at home or on the road, most of them replied that they made an error or a mistake doing something they had done plenty of times before. When these people were asked what errors and mistakes they made that lead to them getting hurt, over 95 per cent of the responses identified four 'critical errors':

1. eyes not on task
2. mind not on task
3. line of fire
4. (a loss of) balance, traction or grip.

When people were asked what was going on with them when they made one or more of the four critical errors, over 95 per cent of the responses identified four 'states of mind' or attention 'disruptors':

1. rushing
2. frustration
3. fatigue
4. complacency.

Once people are made aware of this, many realise for themselves that they are most likely to make one or more of the four critical errors while in one or more of the four states of mind. When they make one or more critical errors they are increasing their risk of harm, as illustrated in Figure 1.

Traditional safety management practices that include elimination, engineering controls and the use of barriers keep the person separated from the hazard, reducing the probability of an interaction between the two. The problem is that there is always some residual risk and inattention increases the overall risk by increasing the potential for exposure when (for any planned or unplanned situation) the traditional risk mitigation is breached. It is also worth noting that inattention, in and of itself, could be the cause of this breach.

There are two main ways that people come into contact with a hazard. The first is when the hazard is moving towards them. Under these circumstances, traditional safety management practices are typically effective because we can guard or separate people from the hazard. The second is when the person is moving towards the hazard. Under these circumstances, if the person is not looking or thinking about what they are doing (eyes/mind not on task) many everyday things can become a hazard. For instance, people bump into tables, they slip on wet floors and they trip on uneven surfaces. When there are hazards with potential for considerable harm, the consequences of these critical errors also increase considerably. Research (Shibuya, Cleal and Kines, 2010) investigated injuries that were primarily related to movement on and around the truck (for instance, falls from heights, moving around truck while unloading, getting in and out of the truck as well as others) and found that only 14.7 per cent of injuries could be attributed to defects or a malfunction of equipment.

The issue is that most of the time, when we are inattentive while moving – eyes/mind not on task – nothing bad happens, so we become used to not looking and not thinking while we are moving. That is, it becomes a 'script' the subconscious mind executes automatically, or what we refer to as a habit.

While we may be able to address the sources of the states of mind more often than not, we cannot eliminate them. Unfortunately, telling people not to rush, not get frustrated, not to get tired or not become complacent just does not work. To get people to pay more attention, or move more mindfully, we need to enable them through repeated practice and routines to deal with the four states of mind as they arise, 'in the moment'. But before we can do that we need to understand how the four states of mind influence our cognitive abilities.

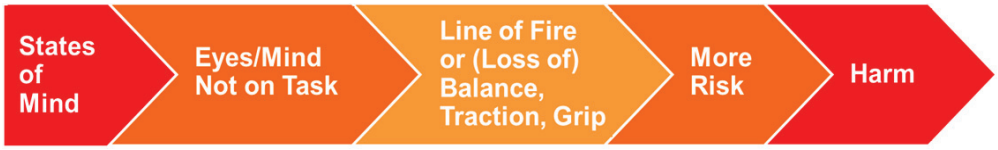

FIG 1 – The states of mind and critical errors increase the risk of harm.

HOW RUSHING AND FRUSTRATION COME ABOUT

When we start to rush or become frustrated, physiological changes take place within our bodies and we start to feel different. Research at the Yale School of Medicine (Arnsten, Mazure and Sinha, 2012) found that our non-essential neural systems for survival, like our ability to reason, are sidelined to prepare us for action. This diminishes our cognitive ability to process information, making our focus narrower so that we can deal with the immediate threat more effectively.

The processes that are involved are complex but they all start with the cue for rushing or frustration being recognised. This includes when we are going to be late, when we won't finish our designated task on time, when people are getting in our way, when things are not functioning how they are supposed to as well as many other causes.

Our brain responds quickly to cues that it has learnt to associate with a threat. These are not just from the physical environment, but also those we have learnt to associate with how people perceive us (for example, arriving late could make people think of us as unreliable so we need to rush to avoid being late). Irrespective of where the cue comes from, an automatic physiological response follows the cue as soon as it is recognised.

The research showed that neurons in the prefrontal cortex (where conscious cognition resides) disconnect and stop firing after being exposed to high levels of neurochemicals such as norepinephrine and dopamine. This effectively shuts it down. Even small changes in the level of neurochemicals can instantly weaken connections. What this means is that the higher the level of neurochemicals, the more impulsively we act and the more difficult it is to consciously override or control what we do.

HOW FATIGUE COMES ABOUT

Fatigue is an unavoidable physiological condition that cannot be overridden. A good night's sleep is always desirable to start the day fatigue-free, but fatigue also builds up during the day.

The body's lymphatic system collects and discards waste products, but because the brain is so densely packed with neurons, this system does not extend into the brain. The brain's wastes were thought to be dealt with only by diffusion where high concentration of waste products would progressively dissipate from the brain.

Research at the University of Rochester (Iliff *et al*, 2012) discovered a new waste product disposal system on mice brains (which are remarkably similar to human brains). This new 'glymphatic system' uses cerebrospinal fluid (or CSF, the fluid that surrounds our brain) to flush away wastes. Although the diffusion of waste products is always happening slowly, this new system is a once-off process that pushes large volumes of CSF past all parts of the brain to carry away waste more effectively. Because the brain is always so busy when awake, it is only activated during sleep and could be responsible for the 'waking up refreshed' feeling we get after a sound night's sleep.

It appears that the feeling of fatigue is the result of waste products in our brain hindering normal electrochemical activity. For example, 'brain fog' could be caused by the waste build-up that results when the rate of diffusion cannot keep up with the rate of accumulation. When the mind works hard for a sustained period it generates more wastes than can be diffused away and this progressively hinders the firing of neurons in our neural networks, manifesting itself in the 'brain fog' feeling we get. When the mind works hard for a short time, the neural impairment may be unnoticeable, but as time passes the levels of waste products increase and the neural impairment becomes more pronounced. One of the effects of this waste accumulation is the reduced ability to concentrate on a task, which is when many incidents take place. The afternoon nap (popular in Latin countries) or the recommended power nap may be ways by which we can 'buy time' for our diffusion process to catch up with the build-up of wastes before sleep comes around.

Research at the University of Groningen assessed the effect of mental fatigue on our ability to be attentive. It found that 'goal-directed attention is shown to be negatively affected by mental fatigue, while stimulus-driven attention was largely unaffected' (Boksem, Meijmen and Lorist, 2005, p 114).

The research found that, when driving a car while mildly fatigued, the driver's ability:

- to focus on the road and other vehicles (goal-directed attention) was diminished
- to operate the car (stimulus-directed attention) was not affected.

In other words, because the activity of driving (operating the car) is not inhibited while we are mildly fatigued, we think that we are paying as much attention as we normally do and this is 'enough' to drive safely, when in fact, this is unlikely to be the case.

HOW COMPLACENCY COMES ABOUT

Although it is enticing to believe that we can get people to always think consciously about all their actions or to always make conscious decisions or deliberate choices, we need to appreciate that this is working against our underlying biology.

In our distant past resources were a lot scarcer than today, our brains built a preference for doing thing automatically, its lower energy operating mode. The ability to do things automatically or habitually helped us to survive and was passed on to our descendants, the ones that were not were taken out by natural selection. The result of this is that we have a brain structure very similar to our ancestors.

A way to look at how this happens is provided by Charles Duhigg, the author of the book *The Power of Habits*. He defines habits as:

> *… the choices that all of us deliberately make at some point, and then stop thinking about but continue doing, often every day.* (Duhigg, 2012, p xvii)

He introduces the concept of the habit loop – an association between a cue, a routine and a reward. Through repetition, the cue and the reward become intertwined until a powerful sense of anticipation results that he refers to as a 'neurological craving'.

Research at the Okinawa Institute of Science and Technology (Wickens *et al*, 2007) has uncovered the role of dopamine, referred to as the 'pleasure chemical', in habit formation. Dopamine plays a significant role when we are learning new things but subsides once the cue-reward association is established. Dopamine acts like the spark plug that helps to increase the focus and attention required to build the neural networks that will enable the habit. Once the habit is established, the role of dopamine diminishes as the neurological craving takes over. The reason why this is an important brain function is that what we do habitually, we do more reliably and more energy efficiently.

The problem, of course, is that whatever habit we establish tends to drive our actions. Most of these are fine, but people do end up with habits that are not the safest.

THE EVIDENCE FOR A DIFFERENT APPROACH

There is no silver bullet to keep people safe, and anything we do to mitigate the risk associated with a hazard is worthwhile. We do not argue against the need to influence the conscious decisions people make to improve safety, but the neuroscience is indicating that this is as little as five per cent of the issue. We do argue though, that the subconscious processes that drive as much as 95 per cent of what we do are relevant and these processes do not get the same degree of focus in current safety initiatives.

Although recognising the states of mind and the critical errors is the first step, this alone does not result in people doing things habitually safer. The reason is that the states of mind and critical errors are 'baked into our brain' through endless repetition over the years – neither the states of mind nor the critical errors can be 'decided away' very easily. They are part of our DNA, our autopilot mode.

If we want people to be safer, we also need to influence the subconscious processes that drive the autopilot mode. This is a very different approach to training people to have the right knowledge or make a safer conscious decision or just be informed of how the brain works. We need to get people to change the 'scripts' they run to safer ones – this is not just a matter of training people but getting them to practice specific techniques that help them avoid getting in the line of fire and a loss of balance, traction or grip situation.

Attention improving programs have been implemented in a variety of industries (manufacturing, power generation, construction, mining, service providers and others) and local governments with comparable results. Refer to Figure 2 for an example in the mining industry. A typical program implementation involves five sessions of two hours each rolled out over a period of 12 weeks. The sessions explain how mistakes are made and what can be done to make fewer of them. The program uses specific language and a series of practical exercises designed to improve personal safety skills.

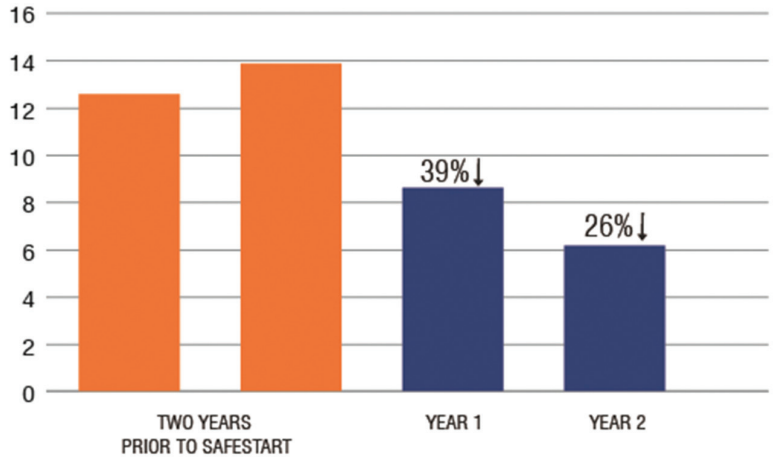

FIG 2 – The total recordable injury frequency rate results achieved by a global coal mining organisation implementing a program focusing on improving attention across ten Australian coalmines.

There is a take home component so that participants can teach these skills to the people they care about the most, their family. At most sites, over 99 per cent of participants rated the program as beneficial or better, evidence by the common use of the specific language.

An excellent correlation was observed between safety performance improvement at each of the sites and the roll out of the attention improvement program. An improvement was also observed in compliance and conscious decision-making activities at the sites with respect to safety and other operational issues (quality, equipment damage etc), indicating that dealing effectively with inattention can also have broader business benefits.

Given the results achieved to date with various organisations in very different industries, we suggest that there is a case for putting a stronger emphasis on minimising inattention to reduce incidents. This would have benefits at work, at home and on the road for most people.

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The Social Psychology of Risk, Safety and Leadership Maturity

R Long[1]

ABSTRACT

The founder of social psychology is sometimes identified as Kurt Lewin. In a 1947 article, Kurt Lewin coined the term 'group dynamics'. He described this notion as the way that groups and individuals act and react to changing circumstances. Lewin theorised that when a group is established it becomes a unified system with unique dynamics that cannot be understood by evaluating members individually. The discipline of social psychology really emerged out of World War II and tackled questions associated with human judgement and decision-making by the Nazis. For a comprehensive look at the development of social psychology look at Abelson, Frey and Gregg (2004).

Social psychology is concerned with the way social arrangements affect human judgement and decision-making. What the author has done is apply the knowledge of this new discipline to an understanding of risk, safety and leadership. This paper will explain some of the developments in social psychology, such as the discovery of the bystander effect, Groupthink, bounded rationality, heuristics, risk homeostasis and the Milgram effect.

The social psychology of risk tackles the way decisions are made about risk in their social context. Unless organisations understand that decision-making is socially conditioned, they are unlikely to be able to tackle the complexities of culture change or the development of risk maturity.

The paper will offer a new understanding of why people do what they do, how risk makes sense and why a 'dumb down' approach to safety is dangerous. A model will also be presented that shows the pathway to risk maturity.

INTRODUCTION

Social psychology is about the study of human social behaviour, with an emphasis on how people think towards each other and how they relate to each other under the influence of social arrangements. As the mind is the axis around which social behaviour pivots, social psychologists tend to study the relationship between the human mind(s) and social behaviours. Social psychology is also the scientific study of how people's thoughts, feelings and behaviours can be influenced by actual, imagined, or the implied presence of others.

In 1908 William McDougall published *Social Psychology*, and Floyd Allport published a book by the same title in 1924. It was Allport's book that sent social psychologists, as distinct from psychologists, off into a wave of experiments to see how individuals were influenced by social arrangements. For a comprehensive look at a history of experiments with people see Abelson, Frey and Gregg (2004). Research exploded in social psychology in the late 1920s and 1930s further supported by *Experimental Social Psychology* (Murphy and Murphy, 1931) and *Handbook in Social Psychology* (Murchison, 1935).

Robert Cialdini (2009) describes how people are influenced and persuaded by social arrangements and identified six underlying social dynamics that affect human judgement and decision-making. Cialdini's six 'weapons of persuasion' are:

1. *Reciprocation* – anthropologists consider reciprocity to be a universal social norm.
2. *Commitment to consistency* – according to Festinger (1957) people are reluctant to behave in ways that are inconsistent with their public commitments.
3. *Social proof* – if we see many other people doing something, we are more likely to do it. The psychology of mass movements is foundational for understanding cults, 'group think', the authoritarian personality, gambling and risk, eugenics, xenophobia and host of social movements/ subcultures in society.
4. *Authority* – if someone is recognised as being in authority we are more likely to do it. The experiments and work of Stanley Milgram (1963; obedience to authority) demonstrated this.
5. *Liking* – people are more likely to be persuaded if they feel liked.
6. *Scarcity* – when we perceive something as scarce we are more likely to buy it, and make the most of the opportunity.

The 'father' of social psychology is sometimes identified as Kurt Lewin. In a 1947 article, Lewin coined the term 'group dynamics'. He described this notion as the way that groups and individuals act and react to changing circumstances. Lewin theorised that when a group is established it becomes a unified system with unique dynamics that cannot be

1. Executive Director, Human Dymensions Pty Ltd, Kambah ACT 2902. Email: rob@humandymensions.com

understood by evaluating members individually. This idea quickly gained support from sociologists and psychologists who understood the significance of this emerging field.

Social psychology has its focus on some of (but not restricted to) the following human factors:

- human relationships
- decision-making
- communication
- persuasion
- influence
- power
- aggression
- politics
- groups
- prejudice
- attraction
- pro- and anti-social behaviour
- community
- helping
- conformity
- authority
- salience
- belonging
- attachment.

The discussion of this paper helps explain some of the core principles and issues that social psychology brings to an understanding, assessment and management of risk and safety.

BELIEF CONGRUENCE

Belief congruence is a foundational idea behind a number of explanations of influence, controlling and non-compliant behaviours. Belief systems are important anchoring points for individuals and identity with groups. Congruence is therefore rewarding and attractive, negative congruence produces negative attitudes. Belief congruence is understood by social psychologists to explain the attraction of prejudice, discrimination and a range of means of differentiation in social identity. Crowd behaviour and dissent from crowd behaviour are explained by the attraction of group and in-group dynamics.

BOUNDED RATIONALITY

First put forward by Herbert Simon (1978), bounded rationality is the idea that in decision-making, rationality of individuals is limited by the information they have, the cognitive limitations of their minds, and the finite amount of time they have to make a decision. The truth is humans are limited by what our mind and social constructs can manage. Humans have to make decisions without all possible information available. When the human's mind is 'flooded' with too much to contain, the natural default is to shortcut, 'tick and flick' or take judgements based on heuristics or intuition.

BYSTANDER EFFECT

Recent studies of the Abu Ghraib incident in Iraq (American soldiers tortured prisoners) confirm many of the findings of social psychology regarding the way we tend to behave in groups. Most of us either conform or passively accept the status quo when under group pressure. Rosenhan (1973), in one experiment, admitted a group of mentally healthy and well researchers (anonymously) into a psychiatric hospital and no one could convince authorities that they were not mental patients. One of the researchers was kept there for seven weeks because hospital staff interpreted everything he did as confirmation of his mental illness.

Extensive research into what became known as Kitty Genovese Syndrome or the 'bystander effect' shows that people make sense of risk differently if they are on their own or in a group. Some people know this as 'Groupthink'. Research followed the brutal murder of Kitty Genovese on 13 March 1964. Kitty was stabbed to death 30 m from her home in Kew Gardens, New York City. She cried for help, and the attacker drove away returning a second time and stabbing her again. There were dozens of witnesses who both heard and saw the event and yet none of them responded. Following the event there was public outrage at the 'apathy' of the 38 witnesses, the lack of response didn't make sense. However, the work of social psychologists shows that we change our behaviour if we are in a large group, because it creates a diffusion of responsibility that is, if others do nothing we identify with them, not the victim. We tend to look around and if others don't assess the situation like us we tend to doubt our own perception.

If you want to assess risks at work, the most effective social strategy is a low level conversation with no more than two or three others. The factors of bystander effect and Groupthink are so strong in large groups that it makes any sense of having properly assessed risk or any dependence on communication of risk highly unreliable.

COGNITIVE BIAS

A cognitive bias is a pattern of deviation in judgement. Individuals create their own 'subjective social reality' from their perception of their engagement with others in groups and organisations. There are more than 250 cognitive biases, effects and heuristics that affect the judgement and decision-making of humans (Wikipedia, 2016). Most biases and effects are socially conditioned.

Some of the most common cognitive biases are:

- *Abilene paradox* – organisations frequently take actions in contradiction to what they really want to do and therefore defeat the very purposes they are trying to achieve. The inability to manage agreement is a major source of organisation dysfunction.
- *Anchoring or focalism* – the tendency to rely too heavily, or 'anchor', on a past reference or on one trait or piece of information when making decisions.
- *Availability heuristic* – the tendency to overestimate the likelihood of events with greater 'availability' in memory, which can be influenced by how recent the memories are, or how unusual or emotionally charged they may be.
- *Dunning–Kruger effect* – an effect in which incompetent people fail to realise they are incompetent because they lack the skill to distinguish between competence and incompetence.
- *Fundamental attribution error* – the tendency for people to over-emphasize personality-based explanations for behaviours observed in others while under-emphasizing the role and power of situational influences on the same behaviour (see also actor-observer bias, group attribution error, positivity effect and negativity effect).
- *Gambler's fallacy* – the tendency to think that future probabilities are altered by past events when in reality they are unchanged. Results from an erroneous conceptualisation of the law of large numbers. For example, 'I've flipped heads with this coin five times

consecutively, so the chance of tails coming out on the sixth flip is much greater than heads'.

- *Hindsight bias* – sometimes called the 'I-knew-it-all-along' effect, the tendency to see past events as being predictable at the time those events happened. Colloquially referred to as 'Hindsight is 20/20'.
- *Hot-hand fallacy* – also known as the 'hot hand phenomenon' or 'hot hand', this is the fallacious belief that a person who has experienced success has a greater chance of further success in additional attempts.
- *Primacy effect, recency effect and serial position effect* – that items near the end of a list are the easiest to recall, followed by the items at the beginning of a list; items in the middle are the least likely to be remembered.
- *Sunk cost effect* – when we have put effort into something, we are often reluctant to pull out because of the loss that we will make, even if continued refusal to jump ship will lead to even more loss. The potential dissonance of accepting that we made a mistake acts to keep us in blind hope.

COGNITIVE DISSONANCE

Developed by Leon Festinger (1957) cognitive dissonance refers to the mental gymnastics required to maintain consistency in the light of contradicting evidence. An understanding of cognitive dissonance is essential if one wants to understand conversion. Cognitive dissonance explains the attempts made to alleviate the feeling of self-criticism and discomfort caused by the appearance of the conflicting beliefs. The idea that compliance forces, power, punishment, incentives and other behaviourist methods 'convert' people from 'unsafety' to safety is naïve. Such belief denies all that has been learned from the psychology of addictions, psychology of conversion, psychology of fundamentalisms, psychology of abuse, cults and religions, suicide ideation and psychology of goals (Moskowitz and Grant, 2009).

In many ways televangelists and safety officers share something in common except televangelists are much better at it. They just have a different view of what it means to 'save lives'. There is not space here to emphasise or map the dynamics of cognitive dissonance and its relevance to safety; the author undertakes a more detailed description of this in his book.

The cognitive dissonance cycle begins as individuals form unconscious and conscious anticipations and assumptions, which serve as predictions about future events. Subsequently, individuals experience events that may be discrepant from their prediction. Discrepant events, or surprises, trigger a need for explanation or post-diction and, correspondingly, for a process through which interpretations of discrepancies are developed. Interpretation, or meaning, is attributed to these surprises.

So it is that people construct frameworks in order to explain, understand and comprehend the stimuli which surround them. When they experience stimuli which does not fit into that framework or cognitive map they experience a sense of cognitive dissonance and causes them to either reframe their thinking or make the stimuli fit their thinking. Sometimes people are able to think through the most amazing cognitive gymnastics to justify a strongly held belief. A study of cults or mass movements is a good place to start.

One of the driving interests in risk and safety is the demand for compliance. The study of cognitive dissonance provides an excellent framework for understanding why compliance is not always achieved in the risk and safety industry. Figure 1 helps explain how cognitive dissonance operates.

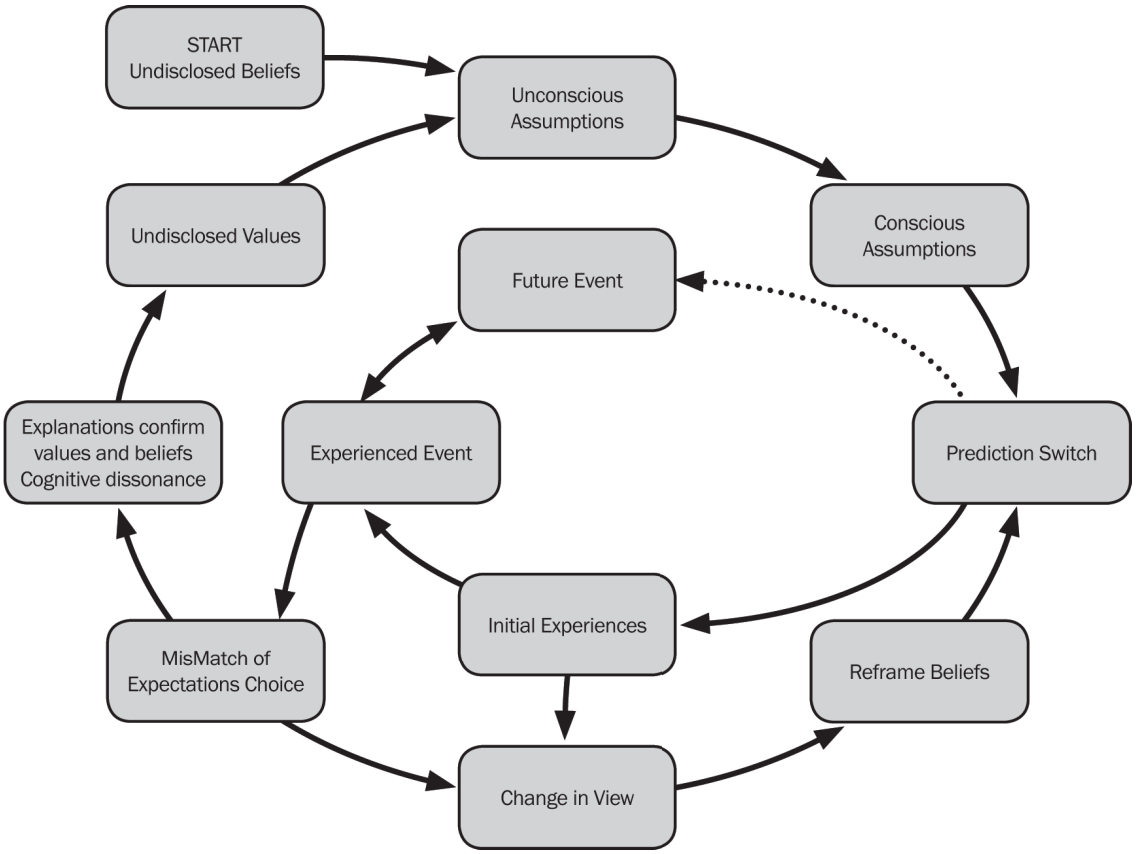

FIG 1 – The cognitive dissonance cycle.

A SPECIAL NOTE ON THE PITCHING, PRIMING AND FRAMING OF GOALS

One of the foundations of social psychology is the idea of priming. Priming is anything that prepares and shapes decision-making. The stimulus for priming can be anything from environment, tactile stimulation, text, language, semantics, space, place or group dynamics. For example: if you play the child's game of making a person spell shop, hop, top, plop and flop, then ask them to answer quickly: what do you do when you see a green light? The person says 'stop'. Many experiments have been undertaken to show how people can be primed with temperature, which is why climate even seems to make a difference in the homicide rate.

Professor John Bargh has been the pioneer in this process and has shown that negative and positive primes can influence decision-making, especially in how one attends to risk. The work of Daniel Kahneman and Amos Tversky (1979) in *Prospect Theory* shows that negative primes tend to increase risk taking. The pitch (level), framing (anchoring and preparation) and 'priming' of language, shapes and influences organisational culture.

The use of language is important in the study in social psychology and risk and safety. This is why the repetition of words and phrases that prime 'dumb down' thinking and poorly defined actions is important, eg the use of phrases such as 'common sense', 'can do', 'get the job done', 'whatever it takes' and so on.

We know from research in sports science that setting achievable goals and priming the thoughts of sports people makes a huge difference in outcomes. This is called 'response priming' and is all about what is called 'visuomotor priming'. Sports people are assisted by various forms of motivation to visualise what they can achieve. They are not given impossible goals, like run the 100 m in five seconds, but achievable goals such as shaving 0.03 of a second off a 5000 m swim.

Failure can come from 'paralysis by analysis'. The language of zero drives such microscopic analysis. In a nutshell, paralysis by analysis occurs when people try to control every aspect of what they are doing in an attempt to ensure success. The results are clear, sports psychologists can show clearly how negative language influences 'choking'. Sometimes you will hear good coaches urging players just to enjoy themselves rather than thinking too much about their score or ambitions. Why don't we believe this applies in the workplace?

The big emphasis in effective goal setting is setting realistic goals to foster motivation and 'ownership'. It is only when you achieve a goal that you are motivated to develop, improve and continue with the effort. Nearly every expert in goal setting discusses the irrelevance of setting goals which are unachievable. Unachievable goals drive frustration, cynicism and negativity, which in themselves diminish effort, energy, resilience and persistence. Setting perfectionist and absolutist goals for fallible humans is therefore counter-productive and 'primes' a culture of failure.

Setting goals and achieving goals requires a social context. Martin Buber (1925) argued that the primary word 'I-thou' points to a relation of person to person, of subject to subject, a relationship of reciprocity involving meeting and encounter, while the primary word 'I-It' points to a relation of person to thing, of subject to object, involving utilisation, domination and control. Goal setting that fixates on objects fails to engage or motivate subjects, people want to have meaning and purpose on what they do and are not machines, neither are they motivated by mechanistic approaches to goal setting.

DISCOURSE ANALYSIS

Attributed to Leo Spitzer, Jurgen Habermas and Michael Foucault, discourse analysis is concerned with the transmission of power in systems of thoughts composed of ideas, symbols, artefacts, attitudes, courses of action, beliefs and practices that systematically construct the subjects and the worlds of which they speak. For example, the language of safety is so important for the construction of meaning for organisations, while the language of 'zero' in safety constructs mindsets preoccupied with reductionism, minimalism and control. The language of Behavioural-Based Safety (BBS) constructs a focus on behaviour-only approaches to safety.

DOGMATISM AND FUNDAMENTALISM

Following the work of Adorno *et al* (1969) on the authoritarian personality, Rokeach (1960, 1968) developed a theory regarding right-wing dogmatism and fundamentalism. Rokeach argued for a more generalised syndrome of intolerance based on closed-mindedness. It is characterised by isolation of contradictory belief systems, resistance to change in the light of evidence and appeals to authority to justify existing beliefs.

HEURISTICS

Kahneman and Tversky (1979) were the first to propose that decision makers use 'heuristics' or 'rules of thumb', to arrive at their judgements. The advantage of heuristics is that they reduce the time and effort required to make decisions and judgements. It is easier to estimate how likely an outcome will be rather than engage in a long and tedious rational process. In most cases rough approximations are sufficient. The idea of heuristics is raised in Standards Australia Handbook 327. The handbook states (2010, p 12):

> *Heuristics are judgmental rules or 'rules of thumb' shortcuts that people use to help gauge situations and help them to make decisions. Three of the most influential shortcuts used when people evaluate risk are 'availability', representativeness' and 'anchoring and adjustment'.*

The handbook also states (2010, p 13):

> *Heuristics are valid risk assessment tools in some circumstances and can lead to 'good' estimates of statistical risk* in situ*ations where risks are well known. In other cases, where little is actually known about a risk, large and persistent biases may give rise to fears that have no provable foundation; conversely, such as for risk associated with foodborne diseases, inadequate attention may be given to issues that should be of genuine concern.*
>
> *Although limitations and biases can be easily demonstrated, it is not valid to label heuristics as 'irrational' since in most everyday situations, rule-of-thumb judgements provide an effective and efficient approach for estimating risk levels. It's not unusual for specialists to also rely on heuristics when they have to apply judgment or rely on intuition.*
>
> *But heuristics often leads to overconfidence. Both lay people and specialists place considerable (sometimes unjustified) faith in judgments reached by using heuristics. In particular, 'awareness' of a hazard does not imply any other knowledge than that the hazard exists, but people may be tempted to pass judgment and make decisions based on this alone.*

Understanding how heuristics affect decisions is critical in developing learning and response in the assessment and management of risk and safety.

IMPLICIT (TACIT) KNOWLEDGE

Implicit (tacit) knowledge was first introduced by Michael Polyani in 1958 (1962) and describes knowledge that is not explicit. Explicit knowledge can be written down, explained and shared whereas, implicit knowledge is sometimes not even known to the user until it is enacted. Implicit knowledge is sometimes known as 'gut' knowledge and explains the kind of knowledge that is developed in the unconscious by experience and intuition over time. Much of our decision-making comes from out tacit knowledge. This was explained in Malcolm Gladwell's (2005) book *Blink* as well as by others like Klein (2003) and Plous (1993).

There are a number of important connections between the idea of implicit (tacit) knowledge and the enactment of the unconscious. The kind of decision-making that uses intuition is said to be non-rational or rational. Non-rational decision-making is not irrational but rather works in a whole new dimension of the mind that may not engage the rational (slow) mind. This has been explains by Kahneman (2011). It is from the unconscious and intuition that a great deal of fast thinking and enactment comes. This is where heuristics (mental microrules and shortcuts) originate.

One of the best books to read on implicit decision-making is by Klein (2003). Intuition is the way we translate our experiences into action. It is why learning by experience is an important mode of learning. Intuition is not a bias that needs to be suppressed, nor is it magic, but rather, it is a non-rational mode of thinking that needs to be better understood.

INTRINSIC MOTIVATION

What are the key drivers of human behaviour, particularly considering groups and organisations? What are the motives which drive human action, thinking, judgement and decision-making? A useful acronym to help remember the six major motives and drivers of human psychosocial action is BUCCET. BUCCET stands for:

- *Belonging* – people first and foremost need to belong, isolation and rejection are major turn-offs to humans. People need to be in relationship in order to survive and thrive. It is from belonging that we develop and establish identity.
- *Understanding* – people need 'to know', this helps them adapt and predict the fundamentals of living. When we know we can construct our reality, attraction and better establish our belonging.
- *Control* – when we belong and understand we then learn to control and manage ourselves, our environment and others in the world. This is how we make sense of self in position to others and out environment.
- *Communication* – the need to engage, interact, connect and attract and reject others is founded on the basics of communication, language and discourse.
- *Effacing self* – people need to more than just belong, they need to feel special, through self-esteem, self-improvement and self-sympathy. Self-enhancing also explains aspects of attraction, attribution, attitudes, helping, aggression and social influence.
- *Trust* – when we trust we can adapt better to the world and others, and with effective communication, cooperate and interact with others. This builds mutual altruism and group loyalty.

These are the fundamental motives and key to grasping what motivates and demotivates others. The social psychology of leadership suggests that getting the context right first is the key to motivation – create an environment where these fundamentals are fostered.

The study of intrinsic motivation was put on the map by Albert Bandura (1977). See more at McLeod (2016) and his work on social learning theory. There are three core concepts at the heart of social learning theory. First is the idea that people can learn through observation. Next is the idea that internal mental states are an essential part of this process. Finally, this theory recognises that just because something has been learned, it does not mean that it will result in a change in behaviour. Bandura demonstrated the effectiveness of his theory through the 'bobo doll experiment' (YouTube, 2010).

An excellent book on intrinsic motivation is Deci (1995).

LEARNING AND STYLES OF LEARNING

The role of learning in risk and safety is the fulcrum on which everything is balanced. Any theory of risk and safety that excludes knowledge or definition about learning is incomplete. One of the best ways to judge the effectiveness of an organisations focus on safety and risk is to see if the word 'learning' appears anywhere or prominently in their discourse. There are many organisations that talk about 'zero' but never use the word 'learning' when discussing risk and safety. Some companies have even substitute the word 'zero' for safety and so 'prime' their population by not even using the word 'safety' when talking about risk.

In 1983 Howard Gardner released *Frames of Mind* and shook the established world of schools, education and learning by proposing that humans have eight or more 'learning intelligences'. Gardner's work shows that even the way we conduct inductions and training in risk and safety doesn't ensure learning. The eight learning intelligences are represented graphically in Figure 2. The fact is, people learn differently and learning effectiveness varies according to learning intelligence. This is why some people learn much better by doing than by theorising. Unless the organisations embrace the concepts of learning, motivation and the perception of risk in their approach to safety, their focus will remain fixated on systems, regulation and the physicality of risk. The idea of safety ownership will remain foreign to such an organisation.

Reciprocal determinism – postulated by social cognitive theorist Albert Bandura. Reciprocal determinism states: that the situation people find themselves in will influence both their behaviour and their attitudes. People's behaviour will influence both their attitudes and the situation, and that people's attitudes will influence their perceptions of a situation and, in turn influence their behaviour.

Risk homeostasis – developed by Gerald Wilde (2001). Risk homeostasis holds that everyone has his or her own fixed level of acceptable risk. The famous Berlin Taxi Experiment first conducted by Wilde in 1981 demonstrates the idea of 'risk compensation'. What this means is that people adjust their response to safety technologies. Safety technologies are not neutral but are interpreted. It is possible that some safety technologies increase rather than reduce risk. This is because humans tend to resist external controls and prefer to 'own' their decisions. The current thirst in society for 'edgework' exemplified in 'X-games' is evidence of risk homeostasis. For further information see Zinn (2008).

THE AUTHORITARIAN PERSONALITY (TAP)

The authoritarian personality (TAP) is a personality type of an individual who puts his or her value in strength and leadership, and believes that those who are not like-minded

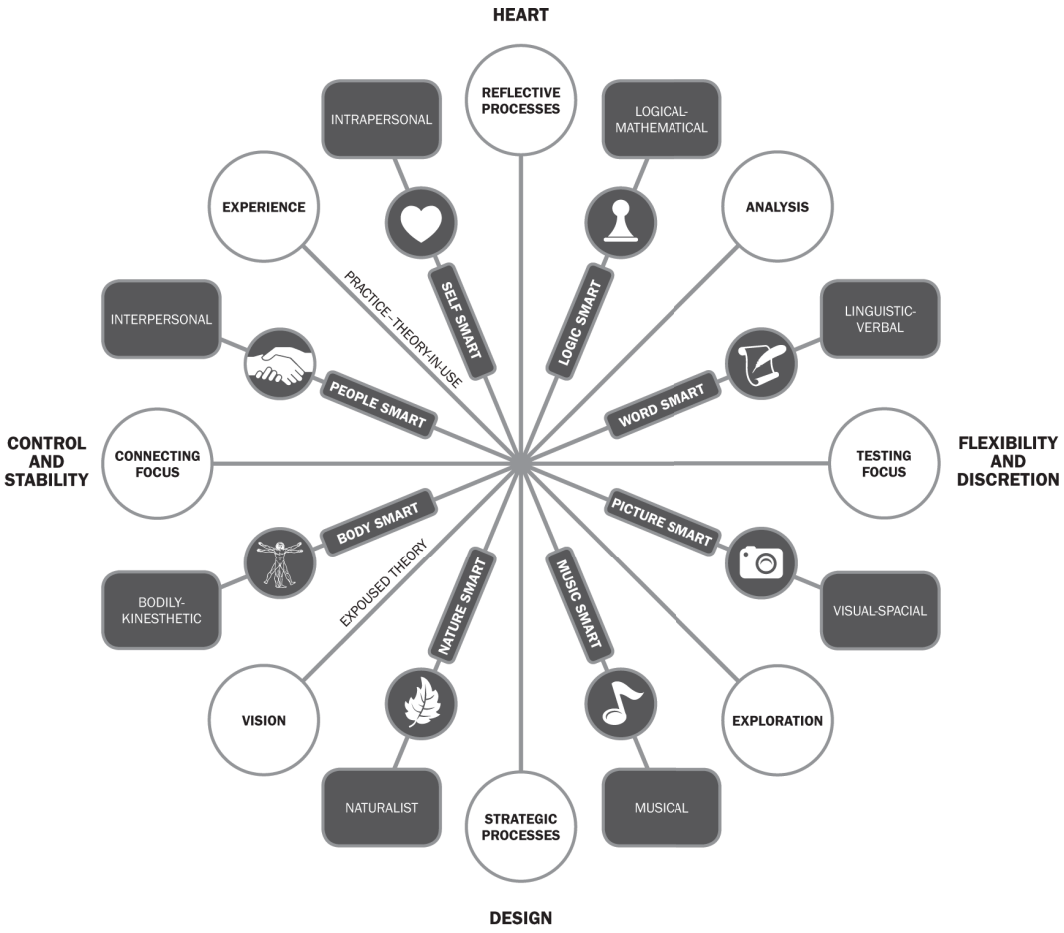

FIG 2 – The eight learning intelligences.

or in agreement are simply weak. An individual with this type of personality is often unwavering and critical, with a superstitious and unfailing belief that a power larger than him or herself is governing fate. During the mid-1940s, researchers first developed theories that racism is also an inherent part of an authoritarian personality.

The Authoritarian Personality (Adorno *et al*, 1969) was written by researchers working at the University of California, Berkeley, during and shortly after World War II. Adorno *et al* (1969) developed a set of criteria by which to define personality traits, ranked these traits and their intensity in any given person on what it called the 'F scale' (F for fascist).' The personality type Adorno *et al* (1969) identified can be defined by nine traits that were believed to cluster together as the result of childhood experiences. These traits include conventionalism, authoritarian submission, authoritarian aggression, anti-intellectualism, anti-intraception, superstition and stereotypy, power and 'toughness', destructiveness and cynicism, projectivity and exaggerated concerns over sex.

TAP (and the work of Milgram) helps explain why the Nazis in World War II were able to be so systematic, efficient and calculated in their extermination of the Jews. TAP also helps explain the dynamics of xenophobia and eugenics.

THE PERCEPTION OF RISK

All risk involves a degree of uncertainty and subjective attribution. Paul Slovic (2000, 2010) has shown that perception of risk varies according to life experience, cognitive bias, heuristics, memory, visual and special literacy, expertise, attribution and anchoring. Slovic uncovered three basic dimensions connected to public perceptions of risk:

1. *dread risk* – a perceived lack of control, dread or catastrophic potential, fatal consequences and inequitable distribution of risks and benefits
2. *unknown risks* – judged as unobservable, unknown and new and delayed in their manifestation of harm
3. *level of exposure* – this refers to the number of people that can be harmed at one time.

Humans tend to attribute greater risk (aggravated risk) when a higher number of people can be harmed in a shorter period of time. People tend to mitigate risk when the risk is unknown or delayed over time with fewer people exposed to the risk.

THE UNCONSCIOUS AND ENACTMENT

Championed by Bargh (2007) shows that many of our decisions and judgements are 'primed' by the anchoring of language or social context. This idea of automaticity (autopilot) is also supported by other social psychologists of risk: Slovic (2000, 2010), Plous (1993), Sunstein and Gardner (1983).

There are strong connections between what has been discovered by Bargh and discourse analysis. For this reason safety culture programs need to take much greater care with safety communications, language, words and symbols. Prof Karl E Weick (1979, 1995, 2001) introduces the idea of enactment in his work, emphasizing the power of the unconscious in decision-making. Weick's work on 'sensemaking' and 'collective mindfulness' are important aspects of the social psychology of risk.

The Weick concept of mindfulness should not be confused with the Buddhist concept of mindfulness advocated by Kabat Zinn. Just as sensemaking is much more than just

making sense of something, so too is mindfulness more than just being mindful.

The following qualities explain mindfulness and how people cope with the problems of external adaptation (integration with culture and environment) and internal integration (consistency with self and values). An examination of how these seven qualities develop debunks the notion that sensemaking is somehow shared or common.

For Weick, mindfulness is the key to making sense of risk in the workplace. Weick's (2001) research into high reliability organisations (HRO) establishes five key qualities needed to manage risk mindfully, these are:

1. preoccupation with failure
2. reluctance to simplify interpretations
3. sensitivity to operations
4. commitment to resilience
5. deference to expertise.

One is therefore mindful if these five qualities are activated. These qualities are based on Weick's research into risk management in nuclear power plants and on aircraft carriers.

Karl E Weick discusses the essential tools and filters we use to make sense of information, these are:

- *Self-esteem* – your own confidence in yourself, personal identity and what you think of yourself in relation to others will affect the way you interpret information.
- *History* – your past story, from where you were born and lived to what got you to where you are. All things in your personal history have some influence in what you know and how you interpret the present.
- *Social context* – Where you are in relation to others, what is happening around you, the nature of those around you and the way they relate to the same information all influence the way you interpret information.
- *Confirming evidence* – We act something into belief, even creating a bias in our minds so that when something happens it confirms the belief. For example, if we rev up our own car in response to the hot car full of young men mentioned earlier, we enact a new scenario which may confirm or disconfirm what we believe. If we hold our finger up or tactically ignore their behaviour, each act brings into being a new act. Something new changes the sense of what is happening.
- *Cues and indicators* – what we see, hear and feel doesn't necessarily carry information with it. We recognise indicators and cues which give us information similar to things we have experienced before. We recognise the importance of the revving motor and know it means power, provocation and aggression. All information is subjective and interpreted.
- *Believability* – isn't it peculiar that when something unexpected happens we express surprise, amazement and disbelief? Our capacity to imagine is directly linked to not only what we believe but also to what we are willing to believe. Our ability to imagine extends or limits our ability to make sense of things. Believability is an important part of prediction, and combines with past experience and cues to help us imagine what is possible. If we don't think something is possible, we don't plan for it and certainly can't imagine the risks associated with it. We now know a tsunami can kill 250 000 people, we now know in Australia that a bushfire can kill 250 people and we now know that an earthquake and tsunami can put a country into nuclear crisis. Such evidence changes the way we interpret new information.
- *Flow* – the final tool we use to make sense of things is flow. The pace and speed of events affects the way we interpret them. Much of what we sense goes quickly to our subconscious and triggers a rapid intuitive response. Our intuition or gut feeling bypasses the need to process things step by step in a slow logical pattern. Our intuition gives us the 'flight or fight' response we need in a crisis.

So much of what we decide is 'enacted' by the unconscious. In other words we do things without 'thinking'. This doesn't mean we do things that are 'irrational' but rather non-rational (aRational). The enactment of behaviour from our unconscious, intuitive (Klein, 2003) or implicit knowledge enables us to manage the complexities of life without having to stop and analyse everything every moment. An understanding of intuition, autopilot and heuristics are critical in the social psychology shaping of behaviour and decisions. These come from minds two and three in the brain as illustrated in Figures 3 and 4 (Long, 2012).

STYLES AND STREAMS IN RISK AND SAFETY

A range of philosophical and anthropological perspectives have emerged in a number of 'streams' in the risk and safety industry. Each stream reveals different anthropological, sociological and psychological assumptions about humans, organisations and material. Each of these streams and styles is compared in Appendix 1, which serves to show what a social psychology of risk and safety considers in its response to human judgement and decision-making about risk and safety.

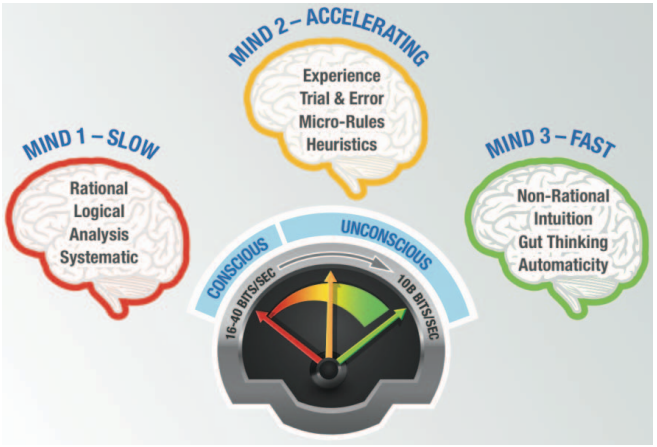

FIG 3 – One brain, three minds.

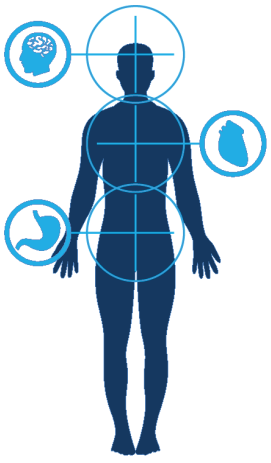

FIG 4 – Head, heart and gut decision-making.

When risk and safety people often debate with each other about what to do about risk, they generally debate from a range of assumptions about what it is to be an educated and functioning human in an organisation/society.

The reality is that we are greatly affected by what happens around us when it comes to assessing and managing risk. The main finding that we learn from social psychology is that conformity, obedience and social perception are all tied to context and situation, much more powerfully than to character. When we attribute how people make sense of risk to personality, hindsight bias, intelligence or 'common sense', social psychologists label this as 'fundamental attribution error' that is, humans tend to overestimate the importance and power of individual personality and underestimate the influence of social situations.

RISK AND SAFETY LEADERSHIP MATURITY

So how does social psychology assist the maturation of leaders? How can an understanding of how social arrangements affect decision-making create mature leadership?

The management of risk and safety is primarily viewed through the lenses of compliance, technology, engineering, legislation and regulation. It is as if the understanding and management of humans and their social context can be viewed as systems with no human component. Even in areas such as 'safety by design', there is little discourse about social psychology.

Figure 5 illustrates what is required to 'step up' to leadership maturity in risk. Unless one 'steps up' from the foundational focus on systems, one will never humanise any system that seeks to manage risk. The matrix shows what steps need to be taken, and what social arrangements require attention, in order for an organisation and its leaders, to mature and become 'world-class'. Leaders need to step up from the fundamental 'controls' in risk to influence a range of social psychological factors that are essential to organisational maturity. (The *Safety Culture Maturity Matrix* is superimposed with the safety culture maturity levels of Patrick Hudson).

As long as an organisation remains in a calculative mindset it will never become 'world-class'. Unfortunately, some while advocating for a generative organisation still fall back to calculative methodologies to explain what they do (Piers, Montijn and Balk, 2009). This is common with many organisations that claim to be 'generative' or 'world class'. It seems so hard for some to let go of mechanistic cultural frameworks and understand the ethic, values and maturity required to become truly generative. Unless a risk and safety management system humanises people or, is people centric, it will focus on calculative outcomes. Unless one is able to suspend the calculative world view and take a step above the red line, there is no possibility of becoming a high reliability organisation (Weick, 1995). A humanising safety organisation should be known by its virtues and ethic. Aristotle stated:

> *Neither by nature, then, nor contrary to nature do the virtues arise in us; rather we are adapted by nature to receive them, and are made perfect by habit.* (Nicomachean Ethics Book 2, para 2)

It was Aristotle who first argued that, virtue is right behaviour, habituated. In other words there is no virtue until there is a habit of right behaviour. One acquires virtue through the practice and formation of habit, of right behaviour or as some educationalists contend: you learn by doing. This means that the beginning of moving from a calculative state to a generative state is letting go of old paradigms and world views and taking a focus on humanising risk and safety management systems. A social psychology of risk enables this change in focus.

CONCLUSION

Much more could be discussed about these and other social psychological influences on human judgement and decision making. There is much more to learn about why some orthodox risk and safety programs and initiatives don't work. Social psychology is no silver bullet; however, it does help explain why there are no silver bullets and it extends the journey to leadership maturity.

Once we get our heads out of silver bullets and begin to be realistic about human judgement and decision-making, then we may better able to make sense of risk, broaden our

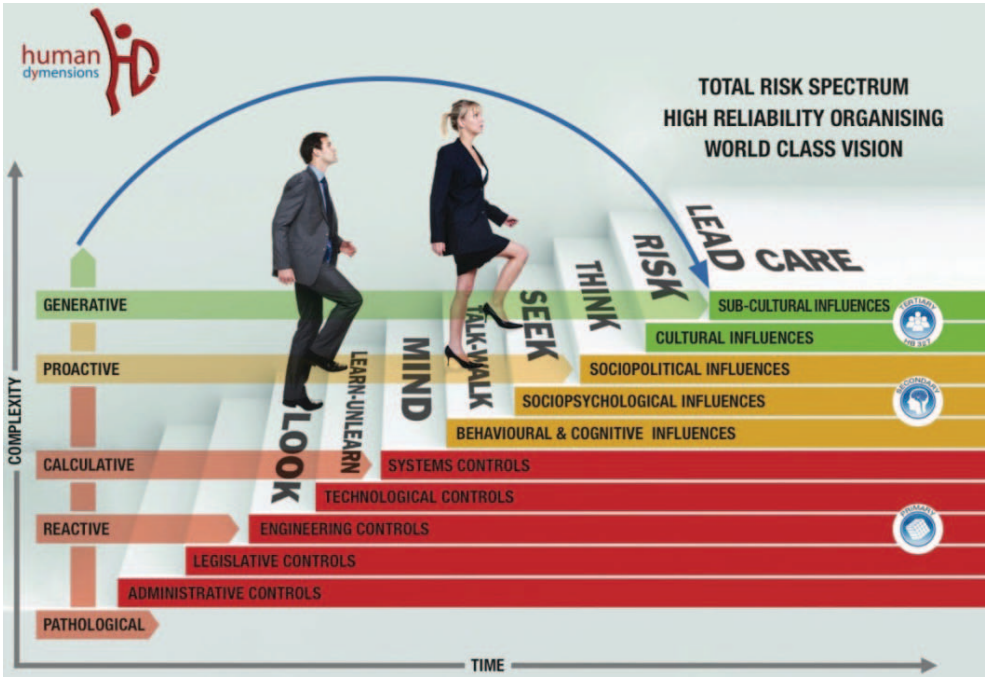

FIG 5 – Risk maturity matrix.

approaches to its understanding, humanise our systems and provide leadership that is people-centric.

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APPENDIX 1 – A COMPARISON OF RISK AND SAFETY STREAMS AND STYLES

Note: This comparison is not intended to limit each stream or style to itself. Some approaches to risk and safety build on other styles and combine aspects of more than one style.

	Orthodox legal	Safety science	Behavioural-based safety	Zero harm	Process-based safety	People-based safety	Psychosocial safety	Social psychological safety
View of humans	Human as servant	Human as object	Human as machine	Human as perfect	Human as part of system	Human as person	Well-being drives decision-making	Social relations drive decision-making
Focus	Rules, regulations and standards	Method, order and supposed logic	Rewards, monitoring, policing	Counting, failure and compliance	Organisation, systems and glitches	Individuals, holistic safety	Well-being, mental health and health	Social psychology, relationships and neuropsychology
Origins and foundations	Robens, Brooks, Bruntland	Taylorism, Heinrich, Bird, Difford	Skinner, DuPont, McSween, López-Mena,	Broken window theory (Wilson and Kelling) DuPont	Reason, Hopkins, Sunstein, Dekker, Petersen, Hollnagel	Geller, Reason, Thomas	Judith Erickson, Dollard, Newman, Cara and MacRae	Bandura, Weick, Plous, Slovic, Maslow, Long
Language	Compliance, rules, punishment, control, consequence, systems, checklist, ALARP, *Reasonable Practicable*	Hazards, barrier, prevention, controls, consequence	Behaviour, prevention, extrinsic, reward, punishment	'All accidents are preventable', aspiration, target, failure	Systemic error-failure, precedence, incubation, systems, methods	Human error, due diligence,	Health, workplace, relationships, mental health, well-being, work life balance	Risks, intrinsic motivation, heuristics, learning, mind, conversation
View of culture	Culture-as-systems	Culture-as-mechanics of systems	Culture-as-behaviour	Culture-as-perfection-controls	Culture-as-organisational-and leadership in systems	Culture-as-groups and leadership	Culture-as-holistic relationships	Culture as social construct
Strategy for Change	Increased policing and systems	Increased barriers and controls	Increased surveillance and policing behaviours	Increased punishment and promotion of failure	Increased organisational intelligence	Increased focus on values	Increased focus on holistic relationships	Increased focus on social constructs and autonomy
Essential concepts	Hierarchy of control	Organisational systems	Observing and conditioning behaviours	Aspiration and target creates reality	Reforming organisations	Tuning into people factors	Improving well-being and balance	Understanding and managing relationships and influences
Focus question	How can safety be organised?	What is the mechanics of safety?	How can people be controlled?	How many injuries would you like today?	How does the organisation affect safety?	How can people minimise human error?	How can we keep the whole person well?	How do social arrangements affect decision-making?
Solutions	More engineering, technology, legislation and regulation	Deconstruct mechanics, bowtie and barriers	Surveillance, training, positive and negative reinforcement	Counting failure, publish failure, preach aspirations	Improve organisations and leadership	Prioritise human factors	Enhance well-being and other aspects of safety will follow	Learning and engagement through social relationships and attending

Winning the Safety Battle

S Hanrahan[1] and S McLaughlin[2]

ABSTRACT

A case study is presented that details the safety journey at a North American project involving two major contracts: a 1000 m shaft recovery and rehabilitation, and the development of a drainage gallery in a large open pit operation. In the early stages of the contracts, there were a number of incidents that created tension between the owner and contractor, which resulted in the contractor being placed on a final warning with almost imminent potential termination. As a result of this, it was agreed to initiate a focused safety recovery plan as a 'last chance'.

Over a period of two years, the engagement and consequent performance of the contractor was turned around, steadily working to set it up for success such that in one of the contract work areas, a record of 'one year LTI (lost time injury) free' was achieved. The journey involved the owner and the contractor teams working cohesively to educate all parties in the safety requirements and, most importantly, providing the context and understanding for certain requirements being put in place. Early on in the process, it was recognised that the owner team unknowingly was an impediment in that they did not fully understand the safety requirements and so was not able to lead the way for the contractor effectively. The journey to rectify the situation was supported and followed up by focused engagement with the project team, which generated a progressive improvement in a very challenging environment.

In particular, the contractor turnaround was significant and of enough value for the contractor to ultimately export some of the safety systems from this site to other contract sites. This demonstrated the ultimate benefit of the contractor understanding and buying into a safety culture and system.

INTRODUCTION

This case study relates to an existing large-scale open pit operation in North America. In support of ongoing operations and to realise steeper slope design criteria, dewatering of the highwall required establishment of a drainage gallery from within the open pit. The highwall dewatering effort involved trackless mining of a horizontal twin portal drainage gallery.

In addition, as part of a longer term prefeasibility study, it was necessary to recover and re-establish a previously capped shaft to a depth of approximately 1000 m. The shaft required an initial caisson type sinking through a consolidated waste dump to expose the previously capped shaft and subsequent opening and rehabilitation. In addition, a combined sinking and permanent headframe and winders were installed to support formal recovery once the shaft cap had been removed.

These two scopes of work were tendered to a number of potential mining contractors and awarded through a standard commercial process. The contracts were awarded on a schedule of rates basis, and an owner team project management delivery style was put in place to manage and direct the works.

Shortly after work commenced on both projects, safety incidents occurred that alerted mine management to the fact that the underground project safety performance was not aligned with the existing operation.

1. FAusIMM, Principal Consultant, SRK Consulting, West Perth WA 6872. Email: shanrahan@srk.com.au

2. Safety Consultant, Safety Services LLC, Salt Lake City UT 84109, USA. Email: safetyservicesutah@gmail.com

Throughout this paper reference to two groups involved in the project is made. For clarity, the following definitions apply:

1. project team – both the owner team and the contractor team
2. owner team – the owner team only, consisting of management and field supervision.

SAFETY REQUIREMENTS

The owner's safety requirements were of a Tier 1 level (the level of safety operation expected of a major resources company), and given the long-standing open pit operation and strong safety culture, it was expected that the incoming underground project team would perform at an equivalent level with immediate effect.

During the commercial tendering process, the safety requirements were provided to the bidding contractors, together with compliance requirements. The safety requirements included site-specific standards and procedures, as well as corporate global safety standards. These documents formed part of the formal executed contract.

Of note was that the operation did not have any recent significant underground experience or capability. With few exceptions, a fresh (external to the company) owner team was brought in to manage the project and provide contractor oversight.

ISSUES

Once the project was initiated, a number of issues became apparent that resulted in an owner reaction and subsequent rectification process between the owner and the contractor.

Incidents

Safety incidents occurred early on in both projects. The level of incidents was higher than expected at the initial stages of the project. Four significant injury accidents occurred during the first 20 weeks of the project; these injuries were sustained within both contractor teams and were sufficiently significant that the persons involved required medical treatment up to and including days away from work. In addition, documenting and filing reports of the injury details to the regulatory agency was required, which then generated an increase in compliance inspections.

At the outset, the requirement placed on the project team by corporate management was to maintain an overall injury frequency rate of no more than 2.55, which was 15 per cent below the published national injury frequency rate at that time. These four injuries during the first 20 weeks of the project placed the project injury frequency rate at 2.88–13 per cent more than corporate management's requirement. It also reduced the owner's confidence in the ability of the contractor to execute the remaining project tasks safely. It is important to note that at this stage, the focus was on the contractor as being entirely responsible for the poor safety results.

Reaction

In support of the strong existing safety culture and performance, management's reaction to the incidents was firm. Mine management engaged with contractor management in a bid to improve safety performance and in doing so, a strong emphasis was put on the contractor to address the issues and hence rapidly improve safety performance. The general understanding was that the contractor had signed up to the safety requirements and expectations; hence could and would deliver on these.

Internally, serious discussions regarding the contractor's safety performance and whether in fact, the contractor should be retained, were held. This resulted in the contractor effectively receiving a final warning and a threat of contract termination, should safety performance not improve to the required level.

As an outcome from these discussions, a monthly safety focused meeting between the owner team and the contractor management was agreed to. At this stage, the owner had a high expectation that the contractor would take it largely upon themselves to improve their safety performance.

Safety requirements

At contract award, a key assumption by the owner was that the contractor understood and would abide by all the safety requirements as issued in support of the commercial tender and contract

award process. In turn, it was implied that the owner team would have sufficient knowledge of these requirements such that adequate supporting safety leadership could be applied.

As a result of the initial incidents and on a deeper investigation, it became apparent that the owner team had assumed that the contractor fully understood all of the requirements, as these had formed a basis of the contract. However, critically, the owner team themselves did not have an adequate understanding of the context and detail of all the requirements. Hence, they were unable to provide adequate leadership to fill any voids in contractor understanding and application that would enable achievement of the required level of safety performance.

In parallel with the owner team, it was clear that the contractor had taken the mandated safety requirements at face value and assumed that their normal safety culture was adequate at this new project site.

The respective approaches by the two parties were shown to be a key error for all parties. The contractor's existing safety culture and owner team's knowledge were well short of that required to satisfactorily operate within the existing open pit operation.

Leadership

At the time of escalating incidents, the owner team leadership had levelled blame on the contractor management and team. To a large degree, the leadership excused themselves from responsibility, which resulted in a polarised project team and unnecessary animosity at a critical time when a unified front was required to address the issues around safety. As discussed, there were clearly shortcomings in the capabilities of both the owner team and the contractor. The owner team did not have adequate knowledge and understanding of the safety requirements to, in turn, lead and support the contractor.

Misalignment

A key issue was poor safety compliance across the project team, which, within a pre-existing organisation with a very mature safety culture, resulted in serious tension stemming from misaligned expectations. Additionally, given the nature of carrying out underground projects within a large-scale open pit operation, for the project team, it was very much like working in a fishbowl – there was nowhere to hide and any sins were very quickly exposed, which in turn increased the pressure on the project team to rectify the issues.

THE JOURNEY

Against the backdrop of the issues described, the owner team's leadership embarked on a journey to address and steadily improve safety performance across both project sites. Given what had been exposed as key issues, it was decided to:

- implement a phased safety improvement campaign
- progressively develop an aligned understanding of the safety requirements
- achieve a sustainable level of compliance in the field.

This would be across all project team members and activities – with the end result of significantly improving safety performance.

The champions to lead this journey were initially the project leader and the safety manager; however, once the journey matured, ultimate success was very much a result of efforts by the whole project team. This made for a very pleasing team result, particularly in the face of intense scrutiny from the existing open pit operation generated by the initial poor performance.

Phase 1 – seek first to understand, then to be understood[3]

On initial review by the project leader (transferred to the project from within the owner's global operations), it was identified that a fundamental problem existed in the owner team not understanding the safety requirements, resulting in a skills deficit for this critical team. At this stage, the owner team was levelling blame on the contractor for poor performance without themselves having first examined how they had set things up and how they were leading the way. The reality of the situation, when honestly reviewed, was that the owner team was guilty of assuming that their imported safety

3. Term defined by Covey (1989).

cultures would be sufficient, while casting all blame on the contractor for the highly visible, poor project safety performance. Based on this finding, the focus was then to address the owner team's shortcomings so that there could be no question regarding their ability to knowledgeably lead.

Phase 2 – rectifying the owner team

The owner team consisted of a management level and field supervisors. With limited exception, this team had not been sourced from within the existing operation, but rather had been externally recruited specifically for this project. As such, the members of the team each brought their own safety experience and culture, and an expectation that, because the contractor had signed up to a contract that included all of the safety requisites, the contractor's compliance would be automatic. With increased pressure due to the safety incidents occurring, the owner team very much regarded these as being the contractor's fault and that they could simply instruct the contractor to fix it. However, the reality of the situation was that, having actively given approval for and appointed the contractor, the owner was not justified in standing back and apportioning the blame. It was obvious in hindsight that the owner had made a number of incorrect assumptions and incomplete or inadequate assessments during the contractor adjudication process. At the time, these errors proved to be difficult to acknowledge for the owner team.

On examination, it became apparent that the owner team did not fully understand the contractual safety requirements. Without a detailed knowledge of the safety requirements, the owner team were not able to coach the contractor on how to improve; they could only effectively issue instructions.

Together, the project leader and safety manager then set about providing the owner team with an understanding of the safety requirements. This consisted of holding focused discussions to provide the owner team with the context for key standards and the requirements for compliance. The aim was for the owner team to have the full background knowledge for them to be able to effectively coach, lead and enforce safety compliance across the project.

Phase 3 – educating the contractor

In parallel with Phase 2, a similar exercise was carried out with the contractor. This engagement started with the contractor management alone and, as with the owner team, aimed to empower the contractor management team with a full suite of knowledge on the standards, and in particular, how they should be applied. As with Phase 2, focused discussions were held with contractor management to walk them through all the requirements until an agreed understanding was reached.

In support of this phase, a formal monthly safety meeting was mandated. In keeping with the focus, only safety matters were discussed, and at each monthly meeting, one safety-related focal point was introduced or reinforced. The idea of introducing a single focal item each month allowed a manageable focus to be maintained, so that the team was not overwhelmed. Of note, as time went on, there was continued buy-in to this approach and at no stage did the contractor show unwillingness to engage.

Phase 4 – ongoing reinforcement (and success)

Once both sides had been educated, it was then a matter of reinforcement. By this stage, the project leader and safety manager had the support of the project team leadership where personnel were now significantly more knowledgeable in terms of safety. The reinforcement consisted of on-the-job safety engagements (more casual) and safety interactions (more formal) during field visits, and formal investigation of all incidents/accidents.

As can happen in these situations, there was personnel fallout due to some parties not wanting to engage in mandatory requirements. This occurred in an instance involving senior personnel; however, the team moved on to achieve significant safety milestones

Throughout this phased engagement, no 'formal' process or high powered safety initiative was used; only direct leadership engagement by the project leader and safety manager to interact directly with the affected parties. Through their previous experience at other owner group operations, their engagement was successful and achieved the required outcome: to educate, gain compliance and achieve required (and better) levels of safety performance. What started as a top-down process successfully became a

whole-of-team engagement and one that all participants could take pride in. It should be recognised that for a number of people involved, this had required a significant personal turnaround.

LEARNINGS

In the process of addressing the initial requirements for action/intervention and the subsequent journey, a number of learnings were apparent.

Engagement – the interface with the contractor was personal and focused. The project leadership team took responsibility and the existing operation/business had limited involvement, other than high expectations that the problems regarding the contractor performance would be addressed one way or another. Initially, the fact that there was a real issue had to be communicated and the source of the problem needed to be determined. The initial focus was on the owner team; thereafter focus moved to the contractor. In reality, given the pressure to rectify, the engagement with the owner team and contractor had to happen in parallel. The process started from the top-down, but successfully became a whole-of-team engagement and very pleasingly, gained contractor management's full support.

Knowledge of safety requirements – it should not be assumed that once a formal contract is in place and formally executed, all requirements will be automatically understood and hence complied with once the work is underway. As became apparent on initial investigation, the owner had assumed that because contract documents (including safety requirements) had been issued, the bidder had by default, fully understood the safety requirements. During the contractor adjudication process, the owner should test this presumption in order to ensure that there is a full and aligned understanding of the requirements. This needs to be robust so that on either side, there can be no excuses, misunderstandings or misaligned expectations. With the benefit of hindsight, it was obvious that there was a large degree of responsibility on the owner for an incomplete adjudication process.

Personnel skills – due to the fact that the owner team was made up to a large degree by personnel who were new to the operation and therefore did not have previous exposure to the corporate safety culture (as was the case with the contractor), both teams were equally lacking in a full understanding and appreciation of safety requirements. A significant shortcoming initially was that the owner team did not have the level of understanding, hence knowledge, to lead and enforce safety compliance well. Without exception, it pays to first look internally to check that all is in order before laying blame externally.

Leadership – to initiate a robust, sustainable safety culture takes leadership and an initial top-down approach until there can be a broader buy-in across the team. In this instance, a key aspect to leadership was to first educate the teams, ie provide context and reasoning for the safety standards. Following that, at a steady and manageable pace, the use and compliance to standards needed to be applied and reinforced by the leadership team. A top-down approach was then gradually replaced by meaningful engagement across the whole team to buy into and work together towards achieving a common goal.

Contractor support – imitation is the sincerest form of flattery. Once successful turnaround was being achieved, the contractor sought to implement some of the safety systems elsewhere within their group at other contract sites – this was very symbolic of the contractor seeing value in taking ownership for the safety requirements. Based on a much improved level of support, the ongoing journey on-site became much easier and workplace relations also improved.

CONCLUSIONS

From a very poor safety performance start on two underground projects, the team performance was turned around through a process of identifying key stumbling blocks and then initiating a methodical recovery process that ultimately led to sustainable improvements.

A significant outcome was demonstrated in the shaft rehabilitation team, which had no significant injury accidents during the remaining 84 weeks of the project task, allowing them to achieve in excess of one year without a lost time injury. The drainage gallery team had three additional injury accidents during their 80 weeks to project completion; however, these injuries were much less severe than the previous incidents. The overall project incident rate fell from an initially unacceptable level to an injury frequency rate of 2.35 – a reduction in the injury frequency rate of almost 20 per cent –

which was in excess of corporate management's requirement to have an injury frequency rate not exceeding 2.55.

Key supporting enablers to the process were the education of the whole project team, so that everyone operated on a similar level of knowledge regarding safety requirements, and contractor support.

Of note was that the team achieved this performance turnaround without external assistance and without high-powered safety programs or engagements. The basis of the turnaround was:

- an initial top-down leadership focus
- honest identification of shortcomings
- re-alignment of the owner team as a priority
- systematic education and reinforcement of safety culture and behaviour.

The contractor did not object to any of the initiatives at any stage throughout this process; this was very significant in being able to achieve a meaningful improvement in safety overall.

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Making Safety Simple, Useful and Effective

M E Webb[1]

ABSTRACT

Safety is a key value in most leading mining companies. Despite years of effort, and significant expense in 'programs', operating sites seem to have been left with no real improvement in either the elimination of fatalities or sustained reduction in injuries.

Safety systems and processes have grown and evolved, often to the point where they have become overly complicated and marginally useful.

MMG Limited, following the consolidation of its Australian operations under a single management structure, undertook a program to effect real and sustained change in its approach to managing safety. The program aimed at improving safety by better engaging its workforce and by making safety processes simple, useful and effective. It defined the role of the supervisor in creating safe work, the role of the people doing work and the role of safe work methods.

A safety diagnostic tool was developed to assess site against safety-critical mindsets, behaviours, cultures and systems. The outcome of the diagnostic is considered by the organisation to be the true lead indicator of safety performance.

While still a work-in-progress, the program at the Australian Operations of MMG Limited shows that challenging common paradigms in safety management can create real change in safety performance.

INTRODUCTION

Safety is a publicly declared value for many of the world's leading mining companies. Safety is also a key element of the sustainability principles of the International Council on Mining and Metals (ICMM), of which most of the leading global mining companies are members. ICMM member-companies are obliged to seek continual improvement in their safety performance.

Companies measure, and publicly report their safety performance. Most see injury rates as the principle measure of success. Considerable management effort is focused on eliminating injuries in companies where safety is a value.

Unfortunately, the safety improvement aspirations of companies are not always met.

MMG seeks to be one of the most respected mid-tier global mining companies, believing that respect is earned by living its values. 'We think safety first' is the first of its five values.

While its safety performance rates well against industry peers, MMG continues to injure its people, and will only be satisfied when injuries are rare events.

While MMG has reduced its injury rates by two-thirds over the last eight years, improvement over the last two to three years has plateaued (Figure 1). MMG believes its injuries are being caused, in part, because it has allowed some of its safety systems to become overly complicated and ineffective. It also believes that further improvement in safety performance will require it to better understand the underlying organisational and individual factors that influence safety outcomes.

This paper outlines the work being done at MMG, starting at its Australian operations, to improve safety outcomes by making safety processes simple, useful and effective. It also outlines a novel

1. General Manager, MMG Limited, Southbank Vic 3006. Email: martin.webb@mmg.com

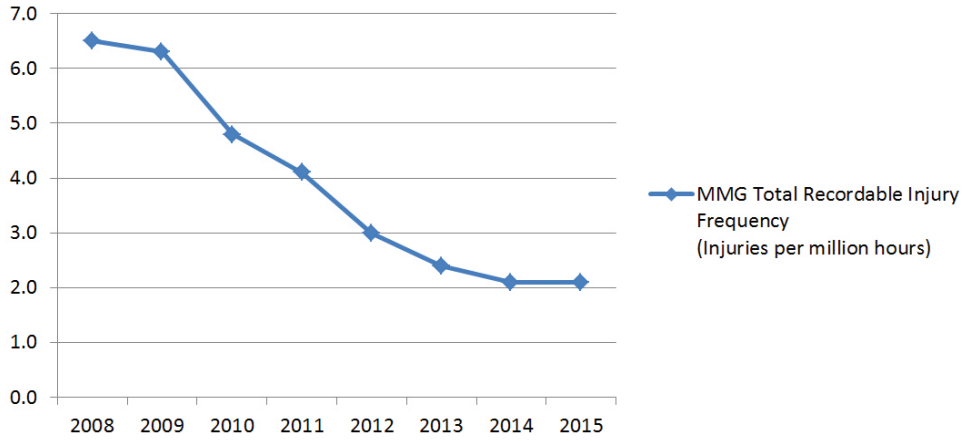

FIG 1 – MMG Ltd total recordable injury frequency.

approach being applied to better understand the individual and organisational inputs, or lead indicators, to safety performance.

The paper makes no claims of success. Success from current work will likely only be seen in longer term trends.

It is recognised that there are two separate, but complementary safety objectives: reducing the potential for catastrophic events and fatalities, and eliminating personal injuries. There is overlap in effort required to achieve each, but they need to be considered as separate objectives. This paper only deals with eliminating injuries. Accordingly, the word 'safety' is used in this paper in the context of injuries.

WHAT HAVE WE DONE TO SAFETY?

Sadly, the focus on improving safety has led to some safety processes becoming far from being simple, useful and effective.

There are two important safety processes: Job Safety Analysis (JSA) and 'Take 5' (and their variants).

JSA is a team-based tool used to identify hazards associated with tasks and to decide the means by which the hazards are to be managed. There are a range of names used for the process, some of which include: job safety and environment analysis and/or task hazard analysis (THA), but they all seek the same outcome.

Take 5 is a tool, or methodology, used by an individual to assess the potential for being injured from their work and work environment. Take 5 is possibly the most widely used personal safety management tool used globally across the mining industry.

Both JSA and Take 5 have evolved over time. Both have gained complexities that seriously impact their potential effectiveness.

JOB SAFETY ANALYSIS

The JSA process is likely to have originated in the 1920s or 30s (Glenn, 2011). Its origins, as explained by Glenn (2011), most likely stem from companies seeking to improve worker efficiency and effectiveness by applying a scientific method to analysing jobs. Worker safety, even then, was considered to be important.

The original JSA was likely to have been a team-based methodology, as it is today. Importantly, however, it was a simple three-column worksheet: task step, hazards and controls. Also, importantly, the focus of the approach was identifying a work method that minimised worker exposure to hazards. The approach to JSAs did not change greatly until the 1980s and 1990s.

Safety gained greater prominence in the 1980s and 1990s due to increasing cost of injuries and the increasingly negative impact on reputation. Companies increasingly employed people at site- and corporate-level to help the organisation better manage safety. The resources then focused on safety, which led to process improvement.

JSAs today take many forms. Few, however, are simple, and few are truly useful and effective.

The most worrying attributes of some forms of JSAs today are requirements that they be done for all tasks, their span and the concept of risk rating hazards before and after controls.

Many sites require a JSA to be undertaken on all tasks, irrespective of whether they are potentially hazardous. As a result, some JSAs are either held on file for work teams to access prior to commencing a task, or work teams spend a disproportionate amount of time developing JSAs for no real safety benefit. For preprepared JSAs, members of a work team are asked to sign-on to the JSA. This is intended to show that they understand the hazards associated with the task. It is also intended to show the commitment by each work team member to apply the required controls.

Some sites allow a single JSA to be developed for a package of work that could span multiple shifts and involve multiple work groups. Some sites use a complex JSA methodology whereby each hazard is rated using a five-by-five or six-by-six risk matrix. In many cases the methodology requires the hazard to be rated before and after the application of the designated controls (Figure 2).

Risk rating is of questionable value, even in high-level risk assessments, because it can under-rank the high consequence, low probability events (which should be the focus of management). It is hard to imagine how risk rating at task level could be a useful tool in assessing the appropriateness of proposed controls.

As a consequence of the improvements in JSAs over recent years we now find that:

- the focus of the JSA is not to find a method of work that exposes workers to the least hazards, it is to attribute hazard controls to a predetermined method of work
- the completed form is the priority, not the conversations and analysis that lead to a work group deciding the safest approach to a task or the control to be applied to residual hazards
- the JSA is developed by third parties and provided to the work group who are asked to read and sign-on to it.

Even more importantly, people are being injured because the process for identifying and either eliminating or controlling hazards in tasks was ineffective.

TAKE 5

Take 5 originated from a Melbourne-located oil refinery in the mid-1990s. It was a simple process whereby people were asked to continually think about what they were about to do and to consider how their work, or the work environment, could impact them. People were provided with a simple two-sided Take 5 pocket card and very simple training (Figure 3). The card was more a prompt, than

LIKELIHOOD	CONSEQUENCE					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
F – Certain	Medium	Medium	High	Very High	Very High	Very High
E- Almost Certain	Low	Medium	High	High	Very High	Very High
D – Likely	Low	Medium	Medium	High	Very High	Very High
C – Possible	Low	Low	Medium	High	High	Very High
B – Unlikely	Low	Low	Medium	Medium	High	Very High
A Rare	Low	Low	Low	Medium	High	High

	JOB STEPS – SEQUENCE	RESOURCES REQUIRED: PERSONNEL	RESOURCES REQUIRED: TOOLS & EQUIPMENT	HAZARDS IDENTIFIED WITH THIS STEP (P – People; E – Environment; E – Equipment; P – Procedures; O – Organisational)	INHERENT RISK: LIKELIHOOD	INHERENT RISK: CONSEQUENCE	INHERENT RISK: RATING	HAZARD CONTROLS (Elimination -Remove hazard completely; Substitution - Replace with lesser hazard; Isolation – All energies and control points; Engineering - Guarding, noise attenuation; Administration - Procedures, training, signage; PPE - earplugs, safety glasses, gloves etc)	RESIDUAL RISK: LIKELIHOOD	RESIDUAL RISK: CONSEQUENCE	RESIDUAL RISK: RATING
24.	MAKE WALKWAY GRATING SAFE	3	HAND TOOLS	HEIGHT WORK	C	4	H	USE HARNESS, CATENARY, AND PERMIT PROCEDURES. HAVE SPOTTER BELOW WHEN WORKING ABOVE ROAD.	A	3	L
25.	S BARDEN 22/5/15			SLIPS/TRIPS ACCESS/NO RAMP	C	3	M	KEEP WALKWAY CLEAR OF TOOLS BE CAREFUL TAKE CARE ENTERING WALKWAY	B	2	L
26.	J. Freeman 22-5-15			PINCH POINTS. CUTS/ABRASIONS	C	2	L	KEEP FINGERS CLEAR OF PINCH POINTS. WEAR GLOVES.	A	2	L
27.	B. Piper 22-5-15			FALLING OBJECTS.	C	H	H	~~BARRICADE~~ BELOW WHEN OVER SPOTTER ROAD.	A	4	M
28.	A Walker 22/5/15 L Millwood 22/5/15			STRAIN INJURY	C	3	M	USE MECHANICAL AID/COME ALONG TO MOVE GRATING AND SUPPORT IT WHILE FIXING OFF.	A	3	L

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FIG 2 – Example job safety analysis with risk ratings.

FIG 3 – Original Take 5 card.

a tool. Take 5 stickers and posters were used to constantly remind people to consider the hazards in their work. Most importantly, it was designed to be used continually, not as a start-of-shift or start-of-task process. Take 5 was designed to be a mindset rather than a process.

Take 5 developed into a useful intervention catch phrase at its site of origin. 'Hey Bob, Take 5!' was the means by which a worker could indicate that he felt that a co-worker was either doing something unsafe, or hadn't properly thought through what they were doing.

Twenty plus years after being created, a five metre high Take 5 hand remains painted on the side of a tank at the prominent intersection at which the refinery is located.

Through industry associations Take 5 was gifted to other multinational oil companies who saw it as a valuable safety initiative. It was then also gifted to customers of the oil companies, many of whom were in the mining sector. Today, Take 5 is possibly the most common personal safety tool used globally in the resource sector. The Take 5 used today, however, is a long way away from its original design.

At some sites Take 5 has evolved into a more formal, checklist-based methodology. It is a once-off start-of-shift or start-of-task process. Most worryingly, it is generally seen as a process that must be completed prior to someone being able to work. Some Take 5 checklists used today require the supervisor to sign-off on the completed checklist (Figure 4).

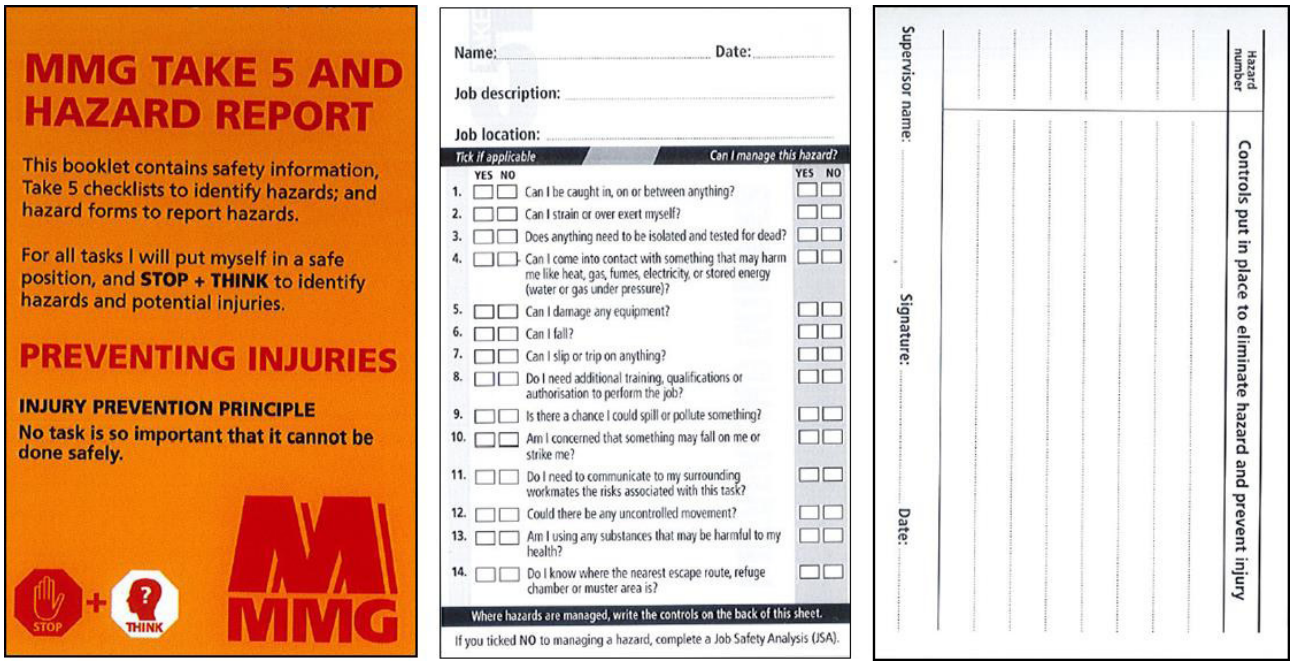

FIG 4 – Recent version of Take 5.

Some sites count and internally report the number of Take 5s completed each day. Some regulators ask sites to also report the number of Take 5s completed at the site. This paper's author has been present at a shift start meeting where the shift crew concluded that their prior shift was safer than the shift before that because they had completed more Take 5s.

MMG'S APPROACH

The approach being taken at MMG to further improve safety outcomes has four key components:

1. clearly define the roles in creating safe work
2. understand the individual and organisational factors that affect safety outcomes
3. simplify safety processes
4. give people the time and opportunity to fulfil their roles.

ROLES IN CREATING SAFE WORK

The key roles in always achieving safe outcomes are with management, supervisors and people doing work. Importantly, MMG has sought to describe roles so that they are easy to interpret and remember. It has sought to keep them simple.

MMG believes, in its simplest form, management is responsible for:

- providing both inherently safe plant and equipment
- providing and maintaining the resources needed to support safe work
- establishing and maintaining systems and processes to support safe work
- establishing and maintaining an organisational culture that supports safe work.

Supervisors are responsible for:

- planning work
- assigning tasks
- holding people accountable.

People doing work are responsible for:

- accepting tasks
- creating and maintaining a safe work environment
- working to plan.

Three safe work methods are supported:

1. procedures and work instructions (for potentially hazardous, routine tasks)
2. THA (for potentially hazardous, non-routine tasks)
3. 'stop and think' (to continually have people consider the hazards associated with their work and work environment).

MMG is training, or retraining, its organisation to better understand their respective roles. It has created a single in-field safety leadership activity, known as a 'field task observation' (FTO). Managers and superintendents use FTOs to test role effectiveness performance of supervisors, work team members and safe work methods.

INDIVIDUAL AND ORGANISATIONAL FACTORS

The integral model (Putz, 2006), has been applied to describe the individual and organisational factors that potentially impact safety outcomes.

The integral model considers an organisation in two dimensions: elements relating to individuals and those relating to the organisation as a whole (the collective); and elements that are internal (unseen) and elements that are external (those that can be observed) – see Figure 5.

Within the model, 'internal' to 'individual' are their mindsets (or beliefs); the 'external' element of 'individual' is their behaviour. 'Internal' to the collective is its culture; the organisation's 'external' elements are its systems and processes.

The integral model is based on a belief that organisational effectiveness can only be achieved by having a focus on all four quadrants. Also, it is believed that change can only be effectively achieved and sustained by considering all four quadrants.

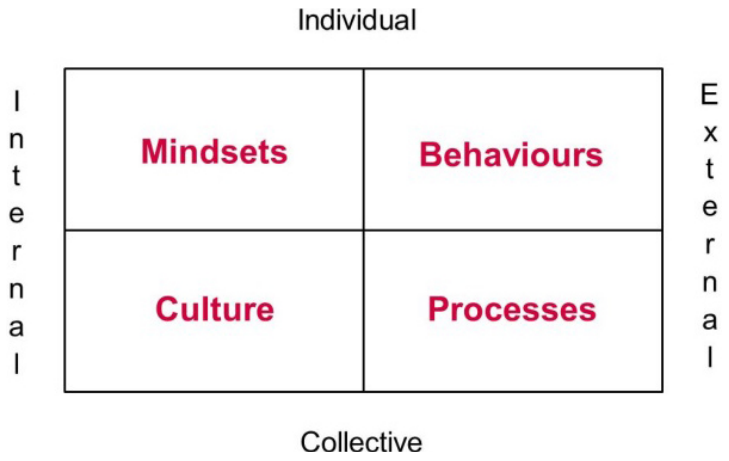

FIG 5 – The integral model.

The integral model has been used at MMG to define the 'ideal' organisation from a safety perspective. The initial focus was at site-level. The methodology is, however, being expanded to separately describe an ideal state for a senior management cohort, a site management team and a site workforce.

MMG's approach at site-level described six core safety-related components in each of the four quadrants of the integral model (Figure 6). The components were selected through a consultative process.

The model provides a means for assessing a site, or elements of an organisation, to be assessed against the ideal state. A safety diagnostic using the integral model is considered to provide an effective 'lead indicator' to an organisation's ability to attain a high level of safety performance.

A pilot assessment was undertaken at an MMG site located in Australia. The assessment was made against three elements in the 'behaviours', 'culture' and 'processes' quadrants, and one element in the 'mindset' quadrant. This cut-down model was used to simplify the assessment process. The ten elements against which the site is to be assessed were selected by a focus group representing the site's management team and workforce. The assessment used one-on-one interviews, a site-wide survey and field observations to assess the site against the selected ten elements. The

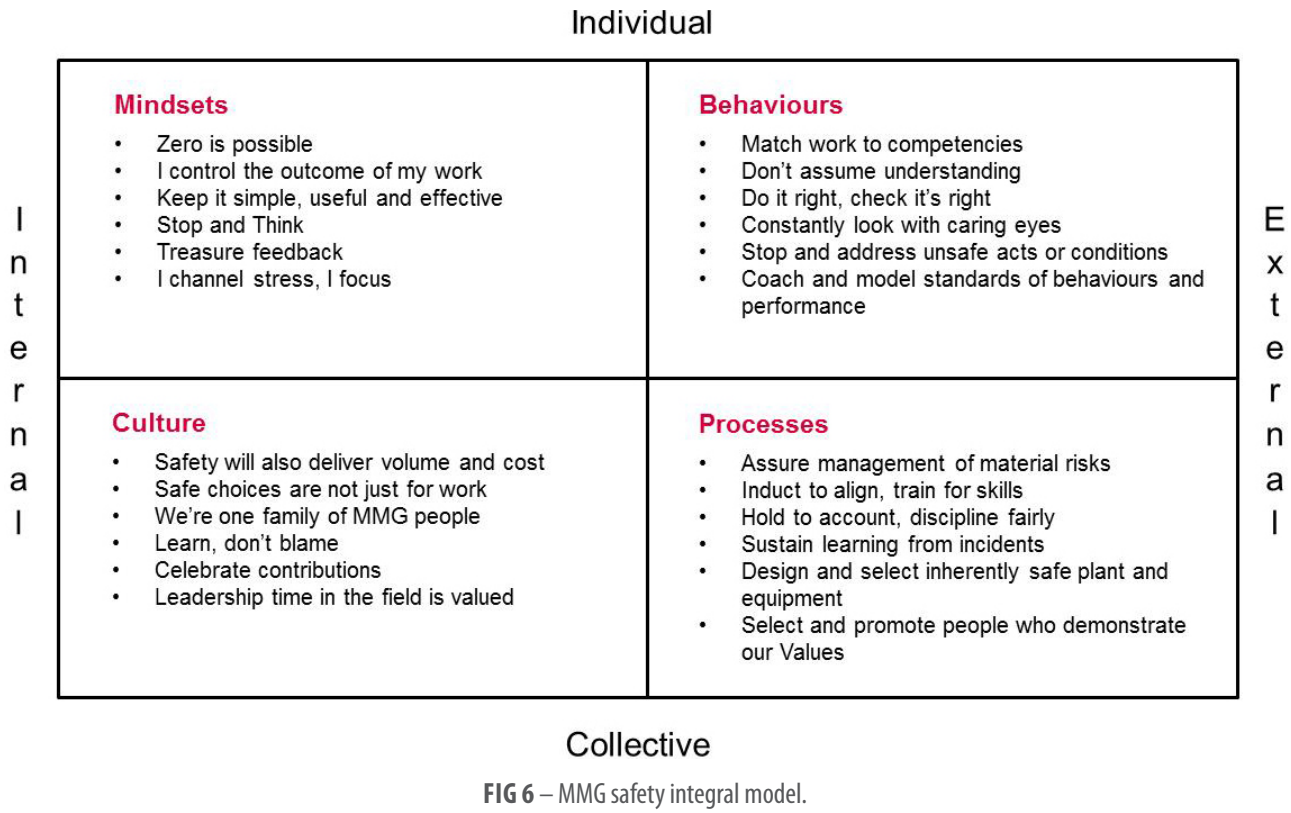

FIG 6 – MMG safety integral model.

assessment was undertaken by an independent team of safety professionals. The results provided the site management team with significant insights into areas where greater alignment in mindsets, behaviours and culture could lead to improved safety outcomes.

SIMPLIFYING SAFETY PROCESSES

Safety processes have been simplified, mainly by reverting them to their original design and intent.

The various forms of JSA have been relabelled as a THA; importantly:

- it is the supervisor's responsibility to specify when a THA is required, and to approve the resultant work method
- THAs are only required for potentially hazardous tasks for which there is no procedure or work instruction
- the THA only needs to cover the elements of the task that are potentially hazardous
- the intent is to have the workgroup identify a work method that minimises exposure to hazards
- a simple three-column worksheet is used
- hazards are not risk rated
- the THA is only valid for the period in which the work is being done, and for the work team that created the THA
- the focus is the quality of discussion and analysis, not the completed form.

The form-based Take 5 has been replaced by a simplified 'stop and think' mindset.

The various forms of in-field safety leadership reviews have been replaced by a single process of FTO. The FTOs are undertaken by managers and superintendents. The FTO focuses on the roles played by supervisors and people doing work in creating safe work. Importantly, they aim to provide managers and superintendents with a realistic perspective of the challenges faced by supervisors and people doing work in consistently executing their respective roles in creating safe work.

CONCLUSIONS

Considerable effort, and time, is required to change individual mindsets and behaviours, and an organisation's culture.

Making safety processes simple, useful and effective requires a change to mindsets and behaviours. In making the changes at MMG, the company has found that it has often been more difficult to have people stop doing things, than it is to have them start doing new things.

MMG's safety diagnostic approach is providing invaluable information that helps understand the safety characteristics of its people and organisation. It helps the company understand why incidents occur. It is helping it understand what it needs to do to create the mindsets, behaviours and culture to make injuries and incidents rare events.

ACKNOWLEDGEMENTS

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Well-being and mental health in Kaikōura rebuild

S H Bell[1]

1.General Manager Health & Safety, North Canterbury Transport Infrastructure Recovery (NCTIR), 205 Annex Road, Middleton, Christchurch 8024. Email: stephen.bell@nctir.com

BACKGROUND

During the 7.8 magnitude Kaikōura earthquake on 14 November 2016: 21 faults ruptured, generating the strongest ground shaking ever recorded in New Zealand. The South Island moved; hundreds of landslides came down; land rose and slumped along the northeastern coastline; transport networks (road, rail and harbour) were devastated and coastal and rural communities isolated overnight.

The North Canterbury Transport Infrastructure Recovery Alliance (NCTIR) was set up in early 2017 to keep traffic moving on the few remaining alternate routes and to restore the original transport networks. NCTIR is a partnership arrangement between the NZ Transport Agency (NZTA) and KiwiRail with Downer, Fulton Hogan, HEB Construction and Higgins. This was the first time NZTA and KiwiRail had collaborated in an alliance with civil construction firms at such scale. At its peak, 1700 workers were involved on the NCTIR project on any given day.

The internationally recognised outcomes were the Main North Line railway was open to freight after just 10 months, the Kaikōura Harbour reopened 11 months after the seabed rose and State Highway 1 (SH1) opened to the traveling public after only one year, one month, and one day. While these were achieved by Christmas 2017 we are still working to rebuild the road and rail networks to make them resilient for the future.

The remote and devastated work environment was unique to NCTIR. While we identified early in the recovery the need to ensure worker safety, health and wellbeing, we were not as prepared for the mental health challenges we faced as we were for safety. The drivers of worker stress were quite different to the earthquake recovery experience in Christchurch (which was our closest emergency event to learn from). Most NCTIR workers faced long hours, compressed rosters, within a daily “controlled” lifestyle, and without direct family contact 24/7. As Kaikōura has restricted medical facilities, and limited evacuation options, we were able to identify most workers who were not coping well with these changes, and the information gathered, and lessons learned, reflects this exceptional “test tube” situation.

There are huge operating and life style challenges that come from working in a remote post-earthquake environment. In addition, since January 2017, over 7500 different workers from over 350 home organisations have worked more than 4,300,000 hours on 180 NCTIR worksites.

Factors identified effecting the mental health of the NCTIR workers were:

- family and social networks being absent at the end of a shift
- the local community expectations and absorbing a temporary 50% increase in population
- the recovery works being difficult to scope and plan, frustrating workers
- a restricted ability to look after ones health due to work hours and travel
- an international and culturally diverse workforce giving different responses to similar situations
- teams of workers developing a “pack” mentality and not integrating
- seasonal changes especially cold, dark and wet winters
- long hours, compressed rosters, good earning opportunities and excessive personal financial commitments
- management of diet was in some cases unhealthy with poor choices being regularly made

- local business management was suddenly asked to increase output and hire employees without the management skills needed, particularly in commercial or personnel areas

WELLBEING

The World Health Organisation describes mental health as a "state of wellbeing in which the individual reaches their own potential, can cope with the normal stresses of life, can work productively and is able to contribute to their community".

To a worker in Kaikōura the stresses were not normal, as home time was not available daily and the community they were working in was not theirs. Most were able to cope themselves or within their work team, others found that their "coping mechanisms" were unsustainable in this foreign environment and changes were necessary. Some obviously succeeded and others struggled, possibly leading to mental ill health.

CONFIDENTIALITY AND PRIVACY

Respecting a subject as sensitive as poor personnel mental health, we ensured a minimum number of people were involved in managing each case. We operated on a need to know basis. We gave specialised help to effected workers immediately and generally passed them onto their home organisation for recovery planning. The recording and reporting of any event was therefore restricted and does not form part of Board month reporting as does Health and Safety. The Board discussed worker stress after the noticeable increase in incidents in early winter 2018, followed by a series of presentations to workers by mental health campaigner Mike King.

EMPLOYEE INITIATED ASSISTANCE

Other organisations rely on independent, specialised and confidential employee assistance companies to undertake this sensitive area of work. Most of these rely on the effected worker to make contact. These companies are not readily available in Kaikōura. Somehow, we needed to not stigmatise mental ill health or just rely on the effected worker to make the initial contact. We needed to investigate the drivers of poor mental health and performance measures of agreed interventions. The cost to the works of mental ill health in Kaikōura is much higher than injury, if measured in incident frequency and time lost.

STATISTICS COMPARISON (APRIL 2017 TO JUNE 2018)

Workers Requiring Immediate Evacuation for Treatment

Work Injury	Medical Reasons	Mental Health Reasons
2	3	5

Significant Worker Lost Time Incidents (3 or more days Lost)

Work Injury	Medical Reasons	Mental Health Reasons
2	2	18

Above Workers Who Returned to Work

Work Injury	Medical Reasons	Mental Health Reasons
1	2	7

These numbers may give the New Zealand construction industry an indication as to the number of mental ill health LTI rate that they are dealing with. In the FIFO (Fly in Fly out) studies in Australia, there is evidence that mental health issues occur in 30% of the workforce, 50% higher than the general industry rate. On that adjusted basis, and using NCTIR statistics, a NZ construction industry serious mental ill health LTI rate would be around 5.2 per million worker hours - six times higher than

the NCTIR significant safety LTI rate (0.86) over the a 14-month period. For NCTIR it meant at least one significant mental ill health challenge every month.

Our health, safety and well-being processes had to work for designers, engineers, ecologists, geoscientists, abseilers, archaeologists, suppliers, helicopter pilots, seal wranglers, tunnellers, traffic management, iwi, and the locals. The initial response focus was on workplace critical safety controls, and naively thinking that by giving a capable, but untrained, local person a titled role of Wellbeing Officer and some guidance it would tick that box. If you agree that for every significant LTI recorded above, there is likely over 50 lessor injuries, we quickly recognised we could not leave wellbeing to one person but that a coordinated strategy between HR, Safety and Communications was required, including the addition of another wellbeing officer, and professional supervision available for the wider wellbeing team.

MOTIVATION AND JOB SECURITY

The New Zealand economy demanded reopening the rail and road transport routes connecting the North and South Islands. There was no alternative route for rail, and the alternative road route was inadequate and unreliable in winter. The NCTIR team was highly motivated and focused on meeting the challenging milestones. With the Kaikōura community having high expectations, the workers had a high degree of tolerance for job related stresses, especially in the first year. Job security was never an issue through the first year.

With the project moving into the budgeted and planned response of 2018, the realisation of a long campaign to complete the project challenged budgets, timetables and created less job security. Stress related issues were more obvious and observed, particularly moving into the winter of 2018.

We sought outside help during this period as to what else we could do to reduce the incidents of mental stress including an external audit, and researching similar situations in the FIFO operations in Australia. While the audit stated we were doing very well in the workforce wellbeing space, both the report and our research highlighted the following improvements:

- mental health first aid training for a small cross section of the workforce, including the wellbeing team
- better internal communications, realising that literacy was poor in 25% of the workforce
- arrangements to allow immediate access to specialised external personnel
- promote self-care and use of the “5 ways to Wellbeing”
- avoid “Motelling” in the Village accommodation, allowing a worker to create their own space
- minimise the amount of control over a worker’s daily lifestyle, offer recreational options ensuring that boundaries are in place
- use work rosters that allow real home time, including access to home commercial businesses
- separate out workers who were showing “pack type” behaviours

WINNING CONFIDENCE

We were rewarded with the selection of the two wellbeing officers, one naturally focused on the integration of the NCTIR workers into the community, and the other with strong individual empathy being an experienced pastor. They quickly won the confidence of the workers by turning up to breakfast at least weekly at the village to just connect and listen, and by taking quick and effective action when needed (ie immediately driving a worker whose brother had suddenly passed away to Christchurch airport to get him home quickly). Winning the trust of workers helps with early intervention and enables the workers to be job focused rather than distracted by unrelated thoughts.

MAINTAINING ALERTNESS

Helping to ensure workers were fit and alert when working in an area as remote as Kaikōura was, in part, delivered through the installation of the NCTIR “Village” and addressing fatigue.

The Village is a prefabricated camp acquired from Australia to house and feed 300 workers, and help create a sense of community within the Kaikoura community. The Village came with a full restaurant, large common room and a gymnasium. Rather than site it remote from the town of Kaikōura it is within walking distance, and a regular shuttle service runs into the town for the evening meal. Lunches are prepacked or self–made healthy and cultural options and collected at breakfast time. We took full advantage of our opportunity to be integrated into the local community with all workers evening meals supplied in the town away from the Village.

The rest of the workers, including most of the supervising staff, were housed in the town itself, taking advantage of the numerous holiday homes available. For them the easy access into the town in the evening, and the various arranged activities after work made the work life tolerable. When the shared accommodation became difficult, workers moved around within reason.

We also developed a Fatigue Management Guideline with which the worker could achieve the balance between working long hours and maximising family home time. We consulted with workers constantly to ensure we were achieving the best outcome on a work team basis. This has been a real success with the development of some “ground up” innovative rosters. Where applicable we have used recommendations from FIFO State Legislative Inquiries in Australia.

The workers were only there to earn better money than in their hometown, and therefore access to high hours of work was important. Home organisations mistakenly try to control fatigue through policies around hours of work rather than considering a worker’s full lifestyle. This created a challenge when trying to set a guideline for NCTIR, as different organisations have different interpretations of what constitutes “an hour of work”, as well as what are the limits. Direct feedback from the workers was “if we are having a day off then our preference is to be home”. A day off in Kaikoura just created the potential to spend the day in town, possibly drinking heavily. For workers who were more than 2 hours’ drive away from their home, a 10.5-day continuous work roster with 3.5 days home was most attractive. However, this created problems where a home organisation had weekly limits for hours of work.

The 10.5 days continuous was relieved by generally an 8 hour Saturday giving some extended recreational time on that afternoon. The learning is that if you work with the workers on how best to manage their time they will have some enterprising ideas. They are well familiar with the risks (avoiding travelling 4 hours home after a 12 hour shift, hence the 0.5 day) and will quickly develop a pattern of lifestyle that suits all, except possibly home organisation policy. The knowledge that they were going to be home while shops and banks were open and the kids at school just made relationships easier to maintain. The added benefit of long daily hours (with appropriate food, water and breaks) was there were much fewer problems on work nights in the town than was anticipated. The Village is a quiet place to rest after 9 pm.

EMPLOYMENT TERMINATION

NCTIR is an Alliance and not a company and therefore does not officially have any employees. NCTIR has relied on the discipline processes from each workers home organisation. NCTIR does have strict rules around being impaired at work, and have a full Drug and Alcohol testing regime. Failure to meet NCTIR standards would result in removal from the project and the workers home organisation informed. We quickly realised that in a remote situation that handover was not as easy as a phone call. We have had instances where the removed employee broke down, went absent themselves, or their home organisation simply declined to have anything further to do with them, leaving them isolated in Kaikōura. We instituted a formal process around “handover” to ensure that while no longer a project employee we at least tried to ensure the worker left with some support. Some home organisations were very good, others frustrating.

CULTURAL IMPRINTS

Such was the unplanned nature of NCTIR’s work scope that we cast a worldwide net for workers, both engineers and construction workers. Some workers have been away from home for over a year and therefore the stress of being absent from family is much greater, alleviated in some part by modern communications. Some workers are sending much of their income home, and therefore on rostered days off, they still relied on NCTIR to provide them with a place to live and food. We learnt

to utilise local societies (i.e. Chinese, Philippines, Argentinian) to assist in making their stay comfortable. Providing direction on Visa issues, interpreting, assistance during illness and providing a communication avenue when natural disasters have occurred in their home country are some examples of special assistance we offered, as well as a friendly face.

RELATIONSHIP STRAIN

Without doubt, many workers family and partnership relationships were the cause of much of the worker's stress, and the wellbeing team worked with individuals to try to keep them on the project but only if the problems were getting resolved. Extra leave was quietly organised. Australian FIFO studies have shown equivalent increase in stress levels above the norm in at-home partners as well as the workers. In one team, eight out of the 16 have lost/ changed partners. The various reasons given were:

- worker has restricted time at home and wants to rest, partner wants to do things
- partner finds that life is better without them (increased independence)
- home partner over spends/ commits / gambles expected savings
- Kaikōura lifestyle of "out to dinner every night" miss-interpreted
- worker not home to help or be involved in family activities and sports
- little information around the full project lifestyle given to partners

WORKER POST-SHIFT STRESS

As discussed above there are team relationship stresses that build as a project continues. Conflict, between workers within teams can move from irritating to destructive quite quickly. This is accelerated not only working long hours together but living and eating together as well. In a small town like Kaikōura you cannot hide, as you might in a city. Workers housed outside the NCTIR Village faced the same issues, as there are only a few places to socialise. Of particular concern, were a few cases that involved a "pack" rather than a team mentality which caused intimidation and challenged worksite and offsite authority. Workers were either in or out of the pack, rather than part of a more tolerant team.

EARTHQUAKE DELIVERY CYCLE

Another form of stress was burnout, where the worker struggled to stay on top of the work scope in the time the project, industry and community demanded. In 2017, the big push to get transport moving did stress those who operated well within process driven projects, particularly considering the design office was three hours from the action. Others thrived on the autonomy that was available allowing for the fastest five span bridge build in New Zealand in 14 weeks. The change from a time driven focus in 2017 to a planned cost driven focus in 2018 demanded mental flexibility that most, but not all coped with well.

ENGAGEMENT

NCTIR's commitment to ensuring our team bought into our health and safety processes has been borne out by two HR surveys where worker engagement with the project exceeded 80% and our commitment to their safety and well-being was in the top five ranked values by the workers. This reflects the engagement workers had over making the whole Kaikōura experience memorable through ongoing consultation around worksite safety, the Village, and overall wellbeing.

NCTIR nurtured strong relationships with local police, Kaikōura medical centre, community services and local food outlets to ensure that the workers did not feel isolated from the community, and that Kaikōura residents felt part of the wider NCTIR family. Considering the impact of having 50% more people in the township, the value of the collaboration maintained a motivated workforce. While the village has recreational facilities (gymnasium, in room TV, functional common room and pool tables), we have encouraged team events away from accommodation to develop wider people interactions.

EMERGENCY RESPONSE

Another source of stress early on was the fear of further earthquakes or cyclones, and the workers isolation from home in the event of serious injury. In order to lessen the worker's concern we developed, communicated and practiced an emergency response plan. The response plan reflected interaction with local emergency services, our access to resources (helicopters) and specialist people (eg prime doctors, abseilers, tunnellers, plant operators). Trauma kits and AED's were set up at regular intervals along the 200 km worksite to allow for workers skilled in first response to have adequate tools to provide care until a 111 response occurred. Regular tests of the response plan were undertaken.

We developed a guide for the treatment and evacuation of a worker in the event of a serious mental health issue as part of the emergency plans revision once we learnt we needed such responses.

RECOMMENDATIONS

- Consider mental health issues and responses when planning remote working. A recruitment strategy including team dynamics is a good starting point
- Develop and implement initiatives to take the stigma out of mental ill health
- Have a cross section of personnel trained in mental health first aid, particularly in recognising symptoms before breakdown occurs
- Encourage the "5 ways of wellbeing", it is a good way to develop conversation and listen to people. It reinforces how a remote team need to work together
- Ensure job security messaging is clear and consistent to avoid workers over committing financially
- Try to have "facetime" level communications for workers with family, it is much more settling than just voice
- Consider simple initiatives for partners, information about remote working expectations, key contact points, pre-plan workers home time to ensure some autonomy, a shared robust financial plan
- Keep communications about the project simple and honest. The same with the community. Messaging to all must be consistent and respect literacy challenges and language barriers
- Consult workers over work and shift rosters, including travel to and from home. There can be small changes that make a lot of difference
- Be wary of "pack" behaviour including harassment and bullying which can override organisation structure
- Monitor seasonal changes and adjust the roster if necessary, ensure all protective clothing worn is suitable, and set minimum expectations for all contractors
- Monitor food type consumption ensuring healthy choices are available and fresh where possible
- When requiring much improved performance by small local contractors, look to how you can support them to grow beyond a "kitchen table" operation. Provide employment advice when employee numbers are increasing fourfold
- Monitor and report mental health performance the same as health and safety, but respect confidentiality
- Select and train personnel to be confidants on a worksite, and give them access to interventions for particular personal issues
- Informally converse regularly with workers on site to gauge fitness and alertness to work safely

- Ensure the safe handover to another party of a terminated employee where they are distressed, treating them with sensitivity and respect
- Develop, communicate and practice emergency responses, it helps reduce stress in remote locations

SUMMARY

The magnitude of changes to an individual worker's lifestyle when moving to work with the remote NCTIR project added stresses they had not experienced before, and they had no personal plans or experience to call on in response to situations. Most have handled this well without help, others have successfully sought assistance, and unfortunately, a few have required treatment and time to recover. Due to confidentiality, and not being the actual employer, NCTIR had to develop a procedure for these incidents to ensure the safe return of the worker to their home organisation, and to ensure their home organisation showed some concern.

The appointment and the training of the wellness officers helped with the early identification and response to stressed individuals, as well as the implementation of a Kaikōura recreation plan for post work activities. We recognise the assistance of the community and services in the way in which the workers were welcomed into the community.

The recognised successes of NCTIR with the Institution of Civil Engineer's People's Choice award in 2018, amongst others, and our efforts in ensuring a fit and alert workforce is another aspect we can be proud of, especially considering the many issues and changes faced by all our workers every day.

The prevalence of mental health problems in the metalliferous mining sector

C James[1], R Tynan[2], J Rich[3] and B Kelly[4]

ABSTRACT

Mental health problems are common in Australia; however there is limited empirical evidence about how these differ across industry settings. Researchers from the University of Newcastle examined the prevalence of mental health problems in Australian metalliferous mining employees in Western Australia and South Australia. This research allowed investigation of the factors associated with mental health problems; the impact of mental health-related problems on the workplace; and the knowledge of, attitudes towards and responses to mental health problems.

Data were collected using a brief paper-based survey consisting of a number of validated scales. Employees' psychological distress was measured using the Kessler 10, a widely used screening tool for the detection of mental health-related problems. Alcohol use was measured using the ten-item Alcohol Use Disorders Identification Test. The survey also contained a series of questions to assess the relation between mental health problems and participant socio-demographic, health, perception of the workplace and structural workplace characteristics.

Across the two sites, a total of 867 participants completed the survey (92 per cent response rate). Participants were primarily young to middle-aged men (35–44 years) from a broad range of employment categories. There was a significant relationship between the perception of stigma and psychological distress, with those who reported higher psychological distress more likely to feel that someone with a mental health problem would be treated poorly in the workplace. A total of 45 per cent of employees self-reported moderate to high or very high levels of psychological distress. More than half of the male (53.7 per cent) and almost a third of the female (29.3 per cent) participants consumed alcohol above the threshold considered risky or hazardous. Self-reported illicit drug use was low, although some did report recent usage of marijuana, synthetic cannabis and other illicit drugs. When considering help-seeking behaviours for mental health, participants were more likely to report contact with non-professional sources of support (eg friend or family member; 46.8 per cent) when compared to professional sources of support (28.6 per cent).

The findings from this study support the importance of a focus on mental health for the mining industry. Mental health problems are clearly common among metalliferous mining employees and at least equivalent, if not higher in some instances, than comparable Australian populations. The findings demonstrate a gap between those with mental health problems and help-seeking behaviour, suggesting potential targets for workplace mental health programs.

1. Associate Professor, Associate Director, Centre for Resources Health and Safety, University of Newcastle, Callaghan NSW 2308. Email: carole.james@newcastle.edu.au
2. Postdoctoral Researcher, Hunter Institute of Mental Health, Newcastle NSW 2300. Email: ross.tynan@hnehealth.nsw.gov.au
3. Postdoctoral Research Fellow, Centre for Resources Health and Safety, University of Newcastle, Callaghan NSW 2308. Email: jane.rich@newcastle.edu.au
4. Aspen Medical Chair, Centre for Resources Health and Safety, University of Newcastle, Callaghan NSW 2308. Email: brian.kelly@newcastle.edu.au

INTRODUCTION

The Australian mining industry employed an estimated 224 000 people in 2016, representing approximately two per cent of the total Australian workforce (Department of Industry, Innovation and Science, 2016). In Western and South Australia, the states where this research was undertaken, there were 120 000 people employed in mining with the majority in Western Australia (Australian Bureau of Statistics (ABS), 2016b) The mining workforce is characterised as a high income, predominantly male workforce, with weekly salaries nearly double the national average, and higher salaries for those working under fly-in, fly-out (FIFO) or drive-in, drive-out (DIDO) arrangements (ABS, 2012; Australian Workforce and Productivity Agency, 2011).

The annual cost of mental illness in Australia has been estimated to be $20 billion (ABS, 2009), including the losses incurred by reduced productivity and labour force participation. It is estimated that blue collar workers accounted for more than half of these estimated costs (Lim, Sanderson and Andrews, 2000). However, with effective early intervention and treatment, many of these costs can be minimised or averted (Harvey *et al*, 2014; LaMontagne *et al*, 2014; Doran *et al*, 2015).

Mental illness accounts for 13 per cent of the total burden of disease in Australia (Australian Institute of Health and Welfare (AIHW), 2014), with anxiety and depression the leading not-fatal causes of this illness burden (Begg *et al*, 2007). The most recent Australian National Survey of Mental Health and Wellbeing (ANSMHWB) showed that these common mental illnesses are experienced by approximately 20 per cent of the population at a clinically diagnosable level in any 12 month period (ABS, 2008). Mental illness is common in working ages with over a third of the total burden of illness in the 15–44 year age group attributable to mental illness (Begg *et al*, 2007).

Suicide was the leading cause of premature death in Australia in 2015 and accounted for 3027 deaths (ABS, 2016a). Male suicide rates are approximately three times higher than those for females, with the number of people who die by suicide highest among those of working age (ABS, 2016a; Harrison and Henley, 2014). Suicide is a complex issue, but mental health problems have been shown to increase a persons' risk of suicidal behaviour, especially when left untreated (AIHW, 2014).

Despite the effectiveness of treatments, only 35 per cent of Australians (aged 16 to 85) with a mental illness seek professional assistance from a health service (ABS, 2008). Barriers to help-seeking for mental health problems which reduce access to treatment include stigmatising attitudes towards mental health problems (Brohan *et al*, 2010), lack of confidence in seeking help or awareness of where to seek help, and the belief that help available would not be effective (Bilsker *et al*, 2006).

Mental illnesses also can have substantial economic consequences with estimates of productivity loss in Australia of $5.9 (2009) billion per annum (Hilton *et al*, 2010a) The Productivity Commission identified that for both men and women, mental illness has the most significant impact on workforce participation, exceeding the impacts caused by chronic or physical diseases (Laplagne, Glover and Shomos, 2007). Therefore, preventing or treating mental illness successfully is likely to have the largest positive impact on labour force participation (Laplagne, Glover and Shomos, 2007).

Mental illness can affect the workplace through absenteeism, presenteeism (less than optimal productivity while at work due to mental health problems), injuries and ultimately lower productivity (Dewa, Thompson and Jacobs, 2011; Goetzel *et al*, 2004; Scheer *et al*, 2009; Hilton *et al*, 2010b; McTernan, Dollard and LaMontagne, 2013). In most developed countries it is estimated that 35–45 per cent of absenteeism is attributable to mental illnesses and/or mental health problems (Fletcher *et al*, 2005).

There is a lack of published empirical evidence of the extent and impact of mental health problems in the Australian mining industry. Given mining is chiefly a male dominated industry, the patterns of mental health problems are likely, at least, to reflect those of males of working age in the general population. Workplace and employment characteristics such as trends towards longer shifts, working in remote settings and its impact on access to health care and social networks may play a role in mental health problems of employees, however evidence regarding the contribution of these factors is limited (Kelly, Hazell and Considine, 2012).

This study, funded by the Minerals Council of Australia, aimed to investigate the extent of mental health problems in the metalliferous mining industry.

AIMS AND METHODS

This study aimed to identify the prevalence of mental health problems, their associated factors and their impact of mental health-related problems on the workplace in metalliferous mines in South Australia (SA) and Western Australia (WA).

Following ethics approval from the University of Newcastle Human Ethics Committee, a cross-sectional study of employees in metalliferous mines in SA and WA was undertaken across two mine sites.

Mining companies were approached to provide consent for their mines to participate in the study and consultation was made to determine the logistical arrangements for data collection.

Data collection

Data were collected using a paper-based survey consisting of a number of validated and reliable scales that enabled measurement of the prevalence of mental health problems, and estimate the impact of mental health problems on the workplace. The research team attended the site at change of shifts, with data collected primarily at prestart meetings. All staff currently working at the participating mines (mine staff and subcontractors) were invited to participate in the study.

Measures

Psychological distress

The Kessler Psychological Distress Scale (K10) is a ten-item instrument designed to measure participants current level of psychological distress. The K10 is one of the most widely used screening tools for detecting mental health problems at both individual and population levels (Slade, Grove and Burgess, 2011).

The scale is based on a series of questions relating to negative emotional states, and is measured using a five-level response scale that asks how frequently these emotional states have been experienced during the preceding four weeks, ranging from 1 (none of the time), to 5 (all of the time). Total scores are calculated by adding the scores of each question, giving each participant a possible score ranging from 10–50, with lower scores indicating low psychological distress, and higher scores indicating high psychological distress.

For comparisons with Australian community based data from the ANSMHWB, the total scores were then categorised into four separate strata including low (10–15), moderate (16–21), high (22–29) and very high (30–50).

Alcohol-related problems (AUDIT)

Alcohol-use disorders were measured by the 10-item Alcohol Use Disorders Identification Test (AUDIT), a widely used measure of hazardous and/or harmful drinking developed by the World Health Organization (Saunders *et al*, 1993). This instrument combines the measurement of the quantity and frequency of alcohol consumption, as well as the personal and social problems associated with alcohol use. The AUDIT includes one item about the frequency of binge drinking, which was defined in this study as the consumption of six or more drinks on the one occasion.

Characteristics associated with mental health problems

The survey also contained a series of questions to identify characteristics associated with mental health problems including: socio-demographic and health characteristics, and work characteristics.

Socio-demographic characteristics

Employee demographics included questions on the participant's age, gender, relationship/marital status, number of dependent children and their level of education. Participants were also asked if they identified as either Aboriginal and/or Torres Strait Islander.

The strength of social and community ties was assessed using the Berkman-Symes Social Network Index (Berkman and Syme, 1979). This measure produces a score based on four sources of social contact, including marital status, number of close friends and relatives, frequency of contact with friends and relatives, and formal or informal group membership.

Health

The survey included a number of questions that asked participants to report any previous diagnosis of depression, anxiety or substance use disorder and also whether they had been diagnosed with a range of chronic health conditions (eg cancer, hypertension, obesity and diabetes). To explore participants current health behaviour, the survey also included questions that asked them to self-report their current smoking status, as well as the frequency, how recently and type of any illicit drug they had used (marijuana, synthetic cannabis, or cocaine/ecstasy/amphetamines).

Work characteristics

Workplace and employment factors that were assessed include the most typical shift length and roster schedule, employment status (full-time or part-time) and the specific role that the individual has at the mine (eg manager, machinery operator, admin), the number of years working in the mining industry and whether employees identify as local or FIFO/DIDO workers. The survey also contained a series of questions about the perception of job security, the reasons for working in mining (eg enjoyment of the work; financial reasons), their satisfaction with the workplace and their perception of the mines commitment to the mental health of its employees.

Knowledge, attitudes and responses to mental health problems

The ability to recognise specific symptoms that might indicate a mental health problem, and also awareness of the types and effectiveness of support/treatments available, are important foundations for promoting early assistance to people experiencing mental health problems or at risk of such problems (eg experiencing major stress). The current study adapted previously developed questions which measured mental health literacy to reflect a situation relevant to the mining industry (Jorm *et al*, 1997). Participants were provided with a scenario describing mine employees exhibiting a number of common symptoms associated with depression. Participants were asked questions to see if they were able to identify the mental health problem and whether a set of sources of support (eg talking to supervisor, general practitioner (GP), friends, family) or treatments (eg anti-depressants, vitamins, sleeping pills, alcohol, antibiotics) would be either helpful or harmful given the outlined situation.

Three questions in the survey were used to identify stigmatising attitudes towards those with mental illness. These questions asked participants to self-report their perceptions about whether they felt that they would be treated differently by their friends, colleagues or in the workplace if they were to disclose that they had a mental illness.

To measure help-seeking behaviour, participants were asked to self-report the number of times they had consulted with various support people to discuss their own mental health within the last 12 months. The questions asked participants to report the frequency of consultation, and the type of support person consulted, including both professionals (eg GP, psychologist) and non-professionals (eg friend or family member).

Data analysis

Data were entered, stored and analysed on firewall and password-protected University servers, with access restricted to approved investigators. The statistical packages used were Excel and SPSS (version 20). The initial analyses were descriptive in nature, focusing on sample characteristics, prevalence rates and broad-based comparisons with available national, regional, community and industry based data sets. Univariate analysis was used to determine the correlation between each factor and the outcome variables.

RESULTS

Participants

Mine employees

Across the two sites a total of 867 participants (Site 1 = 578; Site 2 = 289) completed the survey (summary statistics are shown in Table 1), with a response rate of 92 per cent.

TABLE 1
Summary statistics.

Personal variables	Number (%)	Workplace variables	Number (%)
Sex		*Mine workers*	
Male	747 (87.6)	Fly-in, fly-out	846 (97.8)
Female	106 (12.4)	Drive-in, drive-out	16 (1.8)
Age		Residential	3 (0.3)
<24	55 (6.4)	*Work schedule*	
25–34	336 (38.8)	A regular shift	289 (33.4)
35–44	229 (26.5)	A rotating shift	555 (64.2)
45–54	203 (23.5)	Other	20 (2.3)
55+	42 (4.9)	*Most common shift length*	
Relationship status		8 hours or less	4 (0.5)
Not married or de facto	201 (23.3)	9–12 hours	525 (60.6)
Married or de facto	595 (69.0)	More than 12 hours	338 (39.0)
Separated/divorced/widowed	66 (7.7)	*Employment category*	
Dependent children		Manager	65 (7.5)
No	435 (52.1)	Professional	107 (12.4)
Yes	400 (47.9)	Trades worker	226 (26.2)
Education		Machinery operator	415 (48.1)
Year 10 or less	204 (23.7)	Admin or other	50 (5.8)
Year 12 or equivalent	151 (17.5)	*Years in mining*	
Trade/apprenticeship	241 (28.0)	2 years or less	112 (13.0)
Certificate/diploma	126 (14.6)	3 to 10 years	508 (59.0)
University or higher degree	139 (16.1)	More than 10 years	241 (28.0)

The participants in the research were primarily young to middle-aged men (~87 per cent male), largely reflecting the higher proportion of males within the industry and within each of the mine sites that participated in the study. The age and gender profile of the participants across the two sites closely reflect the age and gender distribution of the mining industry, indicating that the current sample contained a representative cross-section of employees (Workplace Gender Equality Agency, 2016).

Employees were from a broad range of employment categories, with representation across all employment types.

Patterns of mental health-related symptoms and associated factors

Psychological distress

Figure 1 shows the levels of psychological distress categorised into conventional scoring strata. For comparative purposes, the results from the current sample are shown with corresponding psychological distress levels observed in the coal mining industry data which included data from eight sites (Kelly and Considine, 2016; Considine *et al*, 2017) and against an age and gender weighted sample of employed Australians from the ANSMHWB (ABS, 2008).

The results indicate that 45 per cent of mine employees reported moderate to high or very high levels of psychological distress. These levels were higher in the metalliferous mining sample compared with the coal sample and with the Australian gender matched employed community sample (ABS, 2008).

The levels of psychological distress in the metalliferous mine sample were significantly higher than in an age and gender weighted sample from the ANSMHWB at $\chi^2(3) = 137.621$, $p>0.001$.

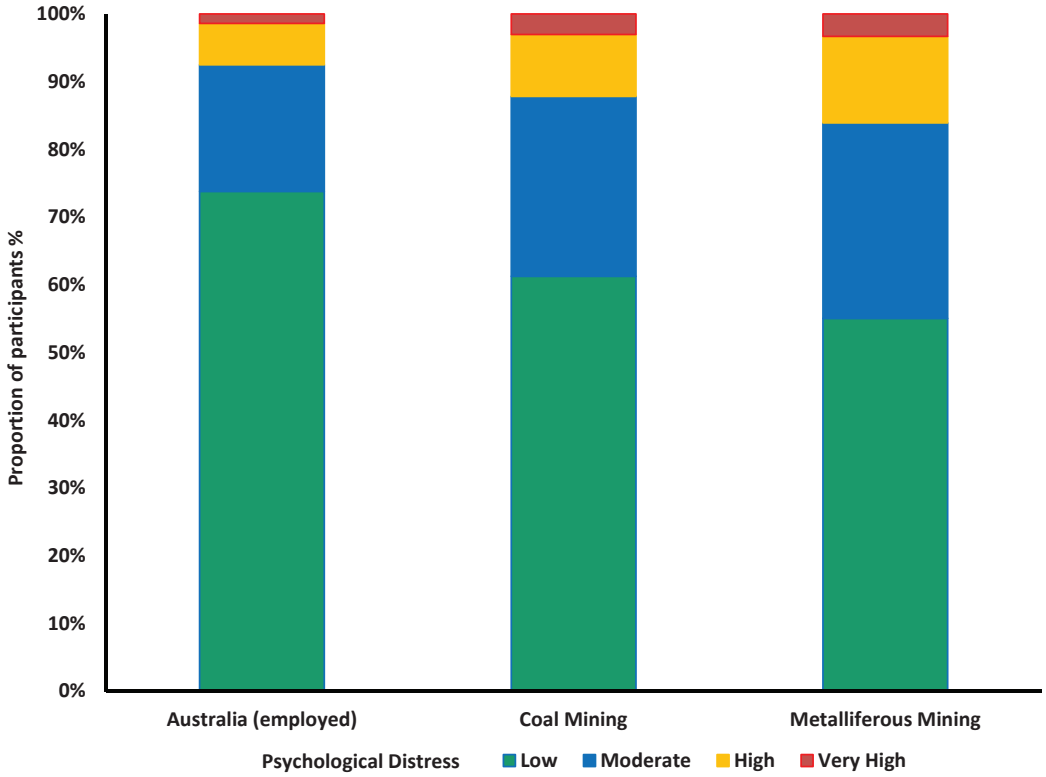

FIG 1 – Psychological distress in metalliferous mines compared with coalmine employees and an age and gender weighted sample of employed Australians.

Factors associated with psychological distress

The associations between the participants psychological distress and their personal, social, workplace and employment characteristics are shown in Table 2. The factors significantly associated (ie $r > \pm 0.15$) with higher levels of psychological distress were: older participants ($p<0.001$); those with fewer social connections ($p<0.001$); those which have a previous diagnosis of depression ($p<0.001$) or anxiety ($p<0.001$); and score higher on the AUDIT indicative of current alcohol-related problems ($p<0.001$) or self-report usage of marijuana ($p<0.001$). In terms of work characteristics, participants who scored higher on the psychological distress scale were significantly more likely to: have less satisfaction with the workplace ($p<0.001$) and be more concerned about losing their job ($p<0.001$); and work in mining primarily for financial reasons ($p<0.001$). Employees were less likely to work in mining because they love the work ($p<0.001$) and hold the perception that the mine was not committed to employee mental health ($p<0.001$).

Alcohol use

Overall, 95.7 per cent of males and 94.1 per cent of females reported that they drink alcohol. More than half (53.7 per cent) of the male and almost a third of female (29.3 per cent) participants scored above the threshold for risky or hazardous alcohol use (AUDIT total ≥8). The association between gender and alcohol use was significant ($\chi^2(3) = 23.76$, $p<0.001$), with males more likely to consume at hazardous levels.

Significant associations were detected between overall AUDIT scores and a number of factors. The factors with the strongest (ie $r > \pm 0.15$) association include age, gender, history of drug and alcohol problems, psychological distress, smoking status and use of illicit drugs. There were also significant associations between AUDIT scores and participants overall satisfaction with the workplace and the perception of the workplaces commitment to the mental health of its employees (Table 3).

Use of illicit substances

Levels of self-reported drug use within the preceding month was low, although some reported recent usage of marijuana, synthetic cannabis and other illicit drugs (Table 4).

TABLE 2
Characteristics associated with psychological distress.

	Psychological distress (K10) score		
	Pearson correlation	**Adjusted r^2**	**Standardised estimate**
1. Socio-demographics		*0.087*	
Age	-0.156[a]		-0.171[a]
Gender (1 Male; 2 Female)	0.037		0.028
Married/de facto versus other (-1, 2, -1)	-0.082[b]		0.046
Never married versus divorced/separated/widow (1, 0, -1)	0.046		-0.033
Dependent children (0 No; 1 Yes)	0.041		0.081
Education	0.040		0.043
Trade versus certificate	0.066		0.081
Social network index (1 Low; 2 Medium; 3 Medium-high; 4 High)	-0.216[a]		-0.248[a]
2. Individual health history		*0.172*	
Chronic physical condition (0 No; 1 At least one condition)	0.082[b]		0.111[b]
Depression (0 No; 1 Yes)	0.280[a]		0.159[a]
Anxiety (0 No; 1 Yes)	0.265[a]		0.138[a]
Drug or alcohol problems (0 No; 1 Yes)	0.102[a]		0.033
3. Health behaviour		*0.203*	
Alcohol Use Disorders Identification Test	0.213[a]		0.143[a]
Daily smoker (1 No; 2 Yes)	0.094[b]		0.031
Marijuana usage	0.156[a]		0.039
Synthetic cannabis usage	0.109[a]		0.019
Ecstasy, amphetamine or cocaine usage	0.156[a]		0.036
4. Work		*0.341*	
Satisfaction with work	-0.392[a]		-0.197[a]
Concern about losing job	0.317[a]		0.184[a]
Work in mining for financial reasons	0.170[a]		0.033
Work in mining because I love the work, and the roster suits my family	-0.240[a]		-0.085
Perception of mines commitment to mental health	-0.293[a]		-0.084
JCQ – perceived job demands exceed job resources	0.124[a]		-0.016
Years working in mining	-0.051		-0.013
Hours travel to work	-0.004		-0.032
Managers versus others	-0.032		0.004
Professional versus technician and machinery operators	-0.009		-0.008
Technicians versus machinery operators	-0.009		-0.013
Employment status (1 Part-time; 2 Full-time)	0.021		0.049
Mine employee versus contractor/subcontractor	0.071		0.029
Regular shift versus rotating shift (1 Regular; 2 Rotating)	0.042		-0.011
Most common shift length	0.058		0.054
Proportion of days at work	0.017		0.052

a. $p<0.001$; b. $p<0.01$.

TABLE 3
Factors associated with hazardous alcohol use.

	AUDIT score		
	Pearson correlation	**Adjusted r^2**	**Standardised estimate**
1. Demographics		*0.079*	
Age	-0.196[a]		-0.213[a]
Gender (1 Male; 2 Female)	-0.169[a]		-0.174[a]
Married/de facto versus other (-1, 2, -1)	-0.029		-0.022
Never married versus divorced/separated/widow (1, 0, -1)	0.046		-0.012
Dependent children (0 No; 1 Yes)	0.049		0.040
Education	-0.046		-0.055
Trade versus certificate	-0.031		0.002
Social network index (1 Low; 2 Medium; 3 Medium-high; 4 High)	-0.054		-0.052
2. Individual health history		*0.157*	
Chronic physical condition (0 No; 1 At least one condition)	-0.049		0.002
Depression (0 No; 1 Yes)	0.029		-0.044
Anxiety (0 No; 1 Yes)	0.079		0.080
Drug or alcohol problems (0 No; 1 Yes)	0.289[a]		0.272[a]
3. Health behaviour		*0.260*	
Psychological distress	0.213[a]		0.133[a]
Daily smoker (1 No; 2 Yes)	0.203[a]		0.124[a]
Marijuana usage	0.337[a]		0.169[a]
Synthetic cannabis usage	0.230[a]		0.013
Ecstasy, amphetamine or cocaine usage	0.320[a]		0.112[b]
4. Work		*0.272*	
Satisfaction with work	-0.128[b]		-0.012
Concern about losing job	0.103		0.026
Work in mining for financial reasons	0.059[b]		0.000
Work in mining because I love the work, and the roster suits my family	-0.055		0.023
Perception of mines commitment to mental health	-0.120		-0.034
JCQ – perceived job demands exceed job resources	-0.006		-0.050
Years working in mining	0.004		0.021
Hours travel to work	0.052		0.053
Managers versus others	-0.020		0.012
Professional versus technician and machinery operators	-0.050		-0.002
Technicians versus machinery operators	0.031		0.041
Employment status (1 Part-time; 2 Full-time)	0.018		-0.008
Mine employee versus contractor/subcontractor	0.033		-0.006
Regular shift versus rotating shift (1 Regular; 2 Rotating)	0.058		0.019
Most common shift length	0.066		0.026
Proportion of days at work	-0.008		0.042

a. $p<0.001$; b. $p<0.01$.

TABLE 4
Self-reported illicit drug use.

	Never tried	Used, but not in last month	Used within last month
Marijuana	54.3%	40.7%	5.0%
Synthetic cannabis	85.2%	13.7%	1.1%
Other Illicit drugs	67.2%	27.2%	5.6%

Knowledge, attitudes and responses to mental health problems

Knowledge

To measure knowledge of mental health problems, based on a case scenario, 82.2 per cent of participants were able to correctly identify the person was experiencing depression. In terms of support, informal or non-professional sources of support were considered to be the most useful: with 94.5 per cent suggesting talking to someone trustworthy; 91.3 per cent felt that talking to friends and family would be helpful. In terms of professional support, most people (87.6 per cent) felt that talking with the GP would be helpful. Speaking with a supervisor was identified as being helpful for 62 per cent, however, 9.9 per cent felt that speaking with the supervisor would be harmful.

Attitudes and stigma

Stigma was measured by participants self-reporting whether they felt an employee experiencing mental illness would be 'treated poorly in the workplace if people found out about it'. Perceived stigma was measured on a five-point scale ranging from 'strongly disagree' to 'strongly agree', with responses categorised as: low stigma (strongly disagree or disagree); unsure (unsure); or high stigma (agree or strongly agree). There was a significant relationship between perceived stigma and psychological distress ($\chi^2(2) = 41.83$, $p<0.001$). A greater proportion of people in the high or very high psychological distress groups perceived workplace stigma as high, when compared with those reporting low to moderate psychological distress.

Responses

Participants were asked to report any consultations to discuss their own mental health with both professional (eg GP, psychiatrist, psychologist) and non-professional support services (friend or family member, colleague or supervisor) in the past 12 months. Participants were more likely to report contact with non-professional sources of support (eg friend or family member; 46.8 per cent) when compared to professional sources of support (28.6 per cent).

DISCUSSION

Twenty per cent of the Australian population experience mental health problems in any 12 month period; however, despite the prevalence of mental health problems there is limited empirical evidence about how, or if, these differ across different industry settings (Hilton *et al*, 2008; Stansfeld *et al*, 2013). For industries to develop mental health interventions and programs in the workplace, the building of such evidence is necessary. This study aimed to examine in metalliferous mining employees: the prevalence of mental health problems; the factors that impact on mental health problems; and the knowledge of, attitudes towards and responses to mental health problems

Levels of psychological distress

The psychological distress and associated factors observed in the current study suggest the importance of addressing mental health problems in the metalliferous mining industry. Our findings showed that 45 per cent of employees self-reported moderate to high or very high levels of psychological distress. The levels were higher than the coal mining sample and in employed Australians in the ANSMHWB (ABS, 2008). The higher psychological distress observed in the current study is consistent with a report by Lifeline which examined mental health problems in FIFO/DIDO mine workers in WA (Henry *et al*, 2013), which found that 36 per cent of FIFO employees reported K10 scores of 20 or more.

Characteristics associated with psychological distress

As with mental health problems in the community, and consistent with other research in workplace settings, the findings from this study in metalliferous mining indicate that factors associated with psychological distress were an interplay of personal and social characteristics and environmental influences, such as those in the workplace and employment arrangements (Stansfeld *et al*, 2013).

Older employees and those with fewer social connections, a chronic physical condition or previous diagnosis of depression or anxiety, with problematic drinking behaviour; were at an increased risk of mental health problems. These personal and social factors associated with psychological distress highlight opportunities for the industry to address and respond to mental health within a broad health and social context.

Workplace and employment characteristics suggest potentially modifiable factors that may guide interventions which aim to reduce the risk of mental health problems. The analysis in this study allowed for investigation of the association between workplace and employment factors and psychological distress, above and beyond the effects of individual participant personal and social factors. Participants who reported high psychological distress were significantly more likely to report low satisfaction with their job and greater concern about losing their job. With current and planned job reductions in the mining sector across Australia, this is not a surprising finding. In Australia and internationally, job insecurity has been commonly associated with adverse health outcomes and in particular, increased levels of mental health problems (Stansfeld and Candy, 2006; László *et al*, 2010). For instance, a Canadian study involving mining communities identified increases in mental health problems that correlated with the deteriorating economic climate (Shandro *et al*, 2011).

There was no significant association between psychological distress and the hours travelled to work from home, shift length and the ratio between days at work and home. The finding regarding ratios between days at work and home contrasts to the WA Lifeline study (Henry *et al*, 2013), which suggests higher ratios are associated with higher levels of psychological distress and poor coping strategies. This study did not examine the association between psychological distress and commute arrangements, as all mine employees were FIFO.

Few studies have examined factors outside the workplace that might be associated with employees' mental health (Beauregard, Marchand and Blanc, 2011). Given that life stressors and significant life events impact on the mental health of the community, it is likely that these factors play a significant role in workers mental health. The results of this study suggest the importance of personal and social factors on the mental health of mine employees and points to the need for a broader consideration of mental health in the context of the complex interactions of personal, social and workplace factors. Similar to this study, a recent Canadian study identified that only 32 per cent of variance was explained by a range of individual and workplace factors on psychological distress (Marchand *et al*, 2015). Stansfeld *et al* (2013) also identified that work characteristics alone could not explain why some occupations have higher rates of common mental health problems than others (Stansfeld *et al*, 2013).

Alcohol-related problems and associated factors

Consistent with the literature, participants who had a sum score of eight or above on the AUDIT were classified as using alcohol at risky or hazardous levels (Inder *et al*, 2012; Saunders *et al*, 1993). This data indicated that 53.7 per cent of males and 29.3 per cent of females had sum scores above eight, indicating their alcohol use was within the range considered as risky or hazardous. One study involving mining personnel from a single mine in central Queensland published nearly two decades ago, found that 37 per cent of males had AUDIT scores of eight or above (Lennings *et al*, 1997). Comparisons specific to the mining industry are limited and comparisons with other populations need to be interpreted with caution.

Substance use disorders are one of the three most common mental health problems (ABS, 2008). It is also important to acknowledge that males of working age have among the highest rates of alcohol use in the Australian community (ABS, 2008). As the population of those working in mining are predominantly male, this may be contributing to the findings. Nevertheless, the overall findings provide guidance to the industry on this as a potential area to target for health promotion and early intervention programs that assist workers in managing alcohol use.

The mining industry has devoted considerable resources in an attempt to minimise the use of alcohol and its immediate impact on safety. The significant levels of alcohol-related problems identified in this study occur in the context of compulsory alcohol testing on most sites prior to work commencement. While alcohol testing may address the immediate risk of impairment due to alcohol use while at work, they neglect the impact of drinking outside of work on the physical and mental health of employees. Frequent and high quantities of alcohol consumption are likely to impact on other areas of workplace health and safety including fatigue, mood and cognitive ability. Important for the industry will be broadening its approach to address alcohol consumption as part of the commitment to occupational health and safety of employees.

The current data found evidence to suggest interplay between personal and social characteristics, as well as workplace and employment factors which contribute to alcohol-related problems. Participants who reported higher alcohol use were significantly more likely to be: male, younger in age, have a history of drug or alcohol problems, have higher levels of psychological distress, be a current daily smoker and engage in the usage of illicit substances (marijuana and ecstasy, amphetamines or cocaine).

The link between alcohol and psychological distress is a key finding in this study. Higher AUDIT scores were associated with higher scores on the K10. The linkage between alcohol and mental health has been known for some time, with many national and international studies reporting the interaction (Boden and Fergusson, 2011; Crum *et al*, 2013; Fergusson, Boden and Horwood, 2009). Given this interaction and that both are significantly high in this sample, an integrated industry response to both these aspects of health is warranted.

Knowledge, attitudes and responses to mental health problems

Workplace mental health literacy is defined as 'the knowledge, beliefs, and skills that aid in the prevention of mental disorders in the workplace, and the recognition, treatment, rehabilitation, and return to work of working people affected by mental disorders' (LaMontagne *et al*, 2014). The results of this study provide an important insight into the knowledge of, and attitudes towards mental health in mine employees, and provide invaluable information to inform the development of interventions and responses to mental health in the industry.

Most participants could recognise depression in the scenario provided, fewer were aware of the most effective treatments or most appropriate type of support, which suggests that tailoring literacy programs to address the attitudes and beliefs about support and treatments may be a constructive strategy. Given national data which indicates that only 35 per cent of people with mental illness access treatment (ABS, 2008), and the frequent underestimation of treatment effectiveness, the finding that just over half of participants (56.8 per cent) reported that anti-depressants could be effective, warrants further education.

The stigma of mental illness and mental health problems is pervasive in the community and in workplaces (LaMontagne *et al*, 2014). Stigma is likely to reduce disclosure of the illness to family, friends, colleagues and supervisors and hence prevent or delay treatment (Harvey *et al*, 2014). Stigma is commonly cited as a barrier which can prevent people from accessing treatment, or contribute to delays in seeking treatment, during which the health and social impacts can accumulate (Harvey *et al*, 2014; LaMontagne *et al*, 2014). The participants who reported higher psychological distress, and thus, were more likely to benefit from accessing support services, might be inhibited from accessing treatment for fear of discrimination. The importance of early intervention for mental health problems suggests the need for mental health programs to address stigma within the industry.

The findings of this study suggest potential targets for workplace mental health programs in the Australian metalliferous mining industry which include: reducing mental health stigma, increasing employee confidence in discussing mental health problems with supervisors, and encouraging use of GPs and/or professional assistance for those in need. Most of the sample indicated that the most commonly used sources of support were informal (eg trusted people and friends). As these informal conversations are already commonly occurring, implementation of peer-based support programs that provide specific training to members within peer groups may make these conversations more effective. Peer-based training should focus on creating supportive networks, whereby all employees are able to identify mental health problems in themselves or colleagues. The relatively low level of

professional assistance for those with highest level of need also suggests the importance of individuals having awareness of appropriate professional services and establishing clear pathways for early access to health care, especially GPs who are not only more likely to be acceptable to employees, but also well placed to assess the nature of the problem and recommend the most appropriate treatment.

Strengths and limitations

This study provides the first empirical evidence regarding mental health problems in the metalliferous mining industry of Australia. The current study used an internationally recognised and widely used screening tool to determine mental health problems, however was limited to data collection in two mine sites.

The age, gender and employment category characteristics of the sample reflect the mining populations in our previous research (Tynan *et al*, 2016a, 2016b), increasing the confidence that the sample contains a representative cross-section of the industry.

The levels of psychological distress among employees in the metalliferous mining industry were significantly higher than a gender matched employed community based sample from the ANSMHWB. It is acknowledged the data from the ANSMHWB was reported in 2008, more than six years prior to the current study. Factors which impact on the health of the community may have changed in this time period. Since the national community survey, the global financial crisis, and the mining boom and bust are particular global issues which potentially impact locally on individuals and on their mental health.

The measures used in the study to determine the psychological distress are considered valid and reliable measures. Importantly the K10 can provide a benchmark to enable comparisons across industry and community data (Slade, Grove and Burgess, 2011). The K10 is not a diagnostic tool, but has been used extensively as a screening tool for mental illness. Similarly, AUDIT has been used in clinical and workplace settings to determine levels of alcohol-related problems (Babor *et al*, 2001). Its inclusion of domains beyond quantity and frequency of drinking provides insight into the impact of alcohol beyond the individual and immediate consumption. The results of AUDIT enable comparisons with other samples with similar characteristics and can guide the industry response to addressing alcohol beyond the immediate impact of intoxication at work.

The study was conducted at a time of significant economic constraints in the mining industry. In particular, redundancies and concerns about job losses are potential stressors which may have impacted on the results.

CONCLUSIONS

The findings from this study support the importance of a focus on mental health for the mining industry, as it is for all workplaces, industries and employers. Mental health problems are clearly common among metalliferous mining employees and at least equivalent, if not higher in some instances, than comparable populations. Identifying factors associated with higher levels of mental health problems can guide industry and company responses to mental health problems. It is important to avoid simplistic explanations that apportion responsibility to the individual or the workplace. These findings indicate the interplay of personal health and social factors alongside work and employment characteristics, as potential contributors to mental health problems.

The research provides opportunities and guidance for workplace interventions: the results indicate the benefit of workplace support relating to mental health. A range of strategies are outlined in the industry focused *National Blueprint for Mental Health and Wellbeing* (Minerals Council of Australia, 2015), drawn from general workplace mental health research and evidence regarding promotion of improved mental health in general. The findings from this study indicate the importance of workplace support, and the preference of employees to consult family and friends most commonly and seek guidance and advice from GPs as the most common professional source of support.

The findings provide support to address alcohol and its impact on health, safety and productivity in the industry. The impact of excessive alcohol use on health and social functioning is well established. Excessive alcohol use and mental health problems frequently co-exist, especially among men of working age (ABS, 2008). While the industry has made substantial gains in implementing policy regarding on-site alcohol monitoring and use, the workplace can shape attitudes to alcohol use more

broadly and bring financial and social benefits through impacts on employee health and function. Hence programs that can assist with both are likely to bring maximum benefit.

The workplace provides a unique opportunity to both recognise and promote effective response to mental health problems, including guiding employees to seek appropriate assistance. Programs that provide readily accessible accurate information about relevant sources of support and care, (for example LaMontagne *et al*, 2014; Martin *et al*, 2009), that improve confidence in seeking help and improve awareness of effective treatments, have the potential to improve employee health and productivity.

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Health Impacts Extend from the Life of a Mine to the Life of a Community – Knowledge Gaps

P Kirsch[1], D Viswanathan[2], R LaBouchardiere[3], J Shandro[4] and P Jagals[5]

ABSTRACT

The planning, design and operation of mines must include the development of positive environmental, community and land-use benefits if it is to achieve good corporate social responsibility and minimise detrimental impacts throughout the life of the mine. Life-of-mine (LOM) planning should, therefore, consider conducting mining activities in the best socially, environmentally and economically acceptable manner, from the commencement of exploration to post-closure of the mine. Current knowledge of LOM activities in relation to public health (life-of-community, or LOC) impacts neither fully captures the full suite of human health and well-being impacts, nor comprehensively informs society on these issues. This knowledge gap is becoming more apparent as public antipathy is increasing towards mining activities within Australia, Canada and globally. The purpose of this paper is to present preliminary and informative results of a literature review to gain insight into the extent of available public health and well-being knowledge associated with mining development. LOM development must also benefit the LOC, in that it must aim to minimise detrimental impacts, and maximise beneficial (including health) impacts on all associated communities. Health planning and programing for mitigation of potential adverse health impacts of mining should extend beyond the scope of work-related injury and illness (resulting from chronic exposure to harmful substances, infectious and lifestyle illnesses), to the health and well-being of workers' families and extended associated communities. By mapping the available but rather scarce literature on LOC areas to recognised LOM stages, this review found shortcomings and imbalances regarding research reporting on mining and its health-related impacts in the worker-to-community continuum.

INTRODUCTION

In many industrial sectors including mining, health and occupational health and safety (OH&S) are often used interchangeably, referring to immediate workplace issues such as accident/injury, as well as acute and chronic exposure-dependent outcomes to stressors (chemicals, noise, dust, vibration, heat, etc). In this sense, workers are commonly the principal focus of any company's health assessment and planning programs, and the main recipients of corporate health budget allocations. This assumption is supported by an analysis of the topics of presentations to the last five years of the Queensland Mining Industry Safety and Health Conference (Table 1).

However, mining projects have the potential to impact the health of both workers, and on those communities in which workers either directly or indirectly interact. For this reason, mining companies are increasingly being asked to consider the broader health and well-being impacts of their projects outside of the workplace, and may be advised (rather than required) to formalise methods to mitigate them (IFC, 2007, 2009). The State of Queensland has the most specific Australian requirements, whereby projects have recently been required to prepare a social impact management plan (SIMP) as part of a social impact assessment (State of Queensland, 2010). However, proponents have considerable discretion as to the matters addressed and potential health impacts are not necessarily examined. The contents of the SIMP are negotiated with the Queensland Government which would enable focus to be directed towards potential public health concerns.

It has been long recognised that the health and well-being needs of communities, directly or indirectly associated with mining developments, may vary relative to different social degrees of connectedness to the mine. These groups include

1. Associate Professor and Projects Manager, Minerals Industry Safety and Health Centre, Sustainable Minerals Institute, University of Queensland, Qld 4072. Email: p.kirsch@uq.edu.au
2. Research Assistant, Minerals Industry Safety and Health Centre, Sustainable Minerals Institute, University of Queensland, Qld 4072. Email: d.viswanathan@uq.edu.au
3. Research Assistant, Minerals Industry Safety and Health Centre, Sustainable Minerals Institute, University of Queensland, Qld 4072. Email: r.labouchardiere@uq.edu.au
4. Post-Doctoral Fellow, Deptartment of Geography, University of Victoria, NBK Institute of Mining Engineering, University of British Columbia, Vancouver, British Columbia V6T 1Z4, Canada. Email: jshandro@uvic.ca
5. Environmental Health Specialist, School of Population Health, University of Queensland, Qld 4006. Email: p.jagals@uq.edu.au

TABLE 1

Distribution of presentation focus at the annual Queensland Mining Industry Health and Safety Conference (2007 - 2011).

Year	Worker				Off-site community	Other (regulatory, legal, etc)
	Safety, injury	Occupational health	Mental health	Wellness		
2011	22	6	2	4	0	4
2010	35	3	0	3	0	2
2009	33	6	0	1	0	3
2008	19	5	1	3	0	7
2007	19	12	0	3	1	4

the immediate mine, workers, workers' families, mining community, broader community, Indigenous communities and regions (Figure 1). The term 'life-of-community' (LOC) is used to encompass this continuum from worker to region. In addition to differences resulting from the degree of connectedness, new impacts may develop and existing impacts change over time during each life cycle stage of a mine's development. These complex factors are currently underrepresented in environmental, social, economic and associated health impact assessment and strategic LOM planning; the focus remaining on occupational health and safety and workforce well-being (Stephens and Ahern, 2001; Downing *et al*, 2002). Recent work including Shandro *et al* (2011a, 2011b, 2011c, 2011d), Hendryx and Ahern (2008), Hendryx, O'Donnell and Horn (2008), Hendryx (2009), Hitt and Hendryx (2010), Esch and Hendryx, (2011), Ahern *et al* (2011a, 2011b) and Zullig and Hendryx (2011) is beginning to address this shortfall.

Several industry and health-related organisations have emphasised the need for assessing and integrating full

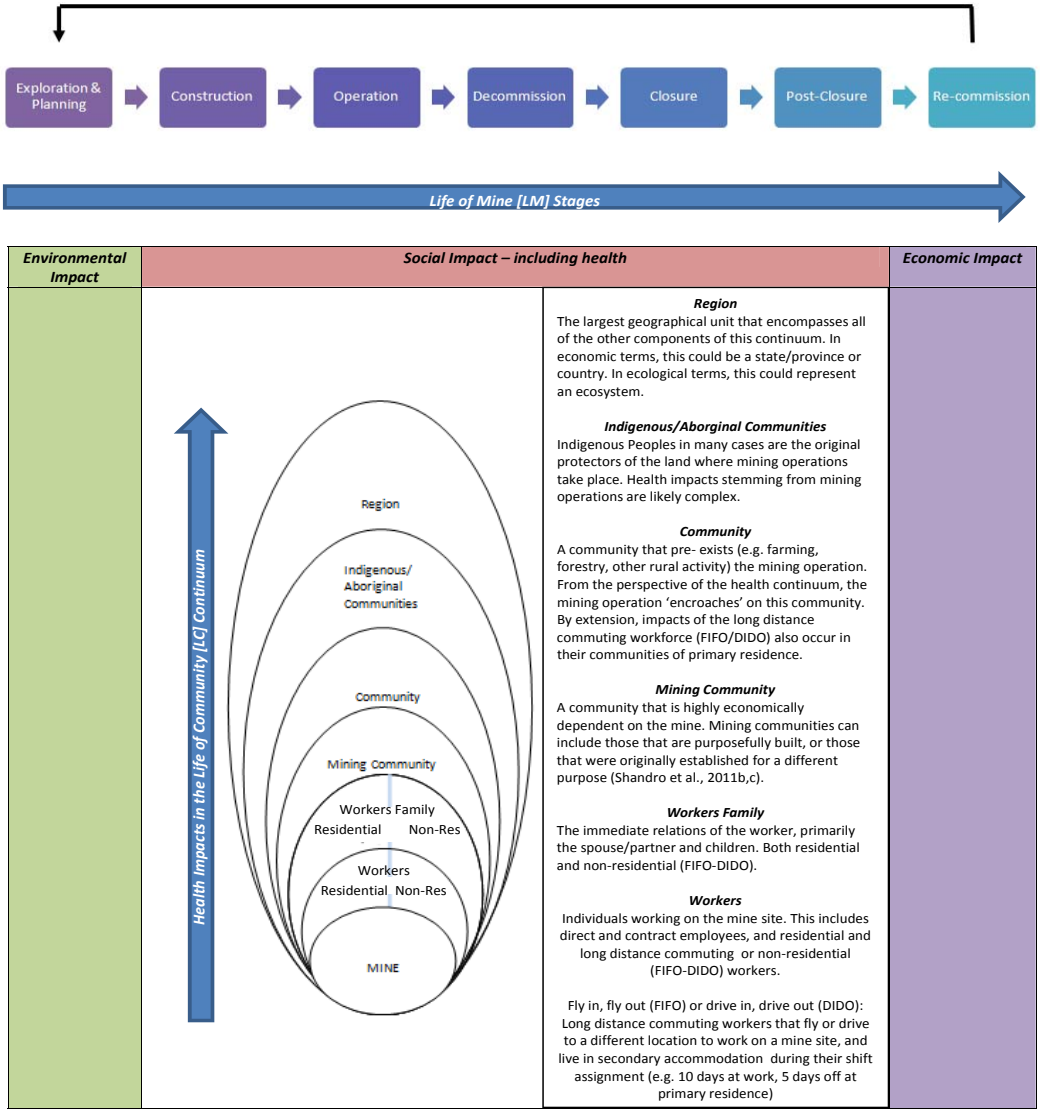

FIG 1 - The life-of-mine/life-of-community (LMLOC) conceptual framework. Health impacts (within social impacts) at different levels from worker to region (life-of-community – vertical scale) can be mapped to life-of-mine stages (horizontal scale). Economic and environmental impacts also exist (vertical columns) and are also affected throughout life-of-mine stages.

health impacts into LOM planning. The International Council on Mining and Metals' 'Good Practice Guidance on Health Impact Assessment' (ICMM, 2010) states that mining company members' positive contributions to the health and well-being of mine workers and communities is of paramount importance. The ICMM (2010) makes a strong case for consideration of *broad* health impacts in mine planning. Recommendations suggest that potential mining-related influences on community health and well-being should be considered in the preliminary planning stages of mine development. Similarly, the Canadian Handbook on Health Impact Assessment (Kwiatkowski, 2004) also encourages that health impact assessment (HIA) be considered as a component of the environmental impact assessment process with subsequent decision making based on the integration of knowledge about economic, environmental and health impacts.

As degrees of public antipathy increase towards mining activities in Australia, Canada and elsewhere in the world (Creamer, 2010), it is vitally important for mining companies to maintain a reputation of strong corporate social responsibility and an ability to respond to community concerns about the impacts of mining projects on the community. That is, they should not only assess and plan to manage their health and well-being impacts across the LOC continuum but also communicate these predicted impacts from their management initiatives to civil society.

This study undertakes a preliminary review of the extent to which science and other literature (including industry guidelines and reports) currently inform the debate about public health and well-being impacts on different tiers of society in relation to all life cycle stages of a mine's development. The primary focus of this study was on reviewing the literature regarding human health impacts. Our review nevertheless also considered that environmental health, as well as social and economic welfare, influences public health and well-being.

CONCEPTUALISING THE HEALTH IMPACTS OF MINING

Our 'life-of-mine/life-of-community' (LMLOC) concept (Figure 1) presents a framework for health research and identifies health impacts of mining on the different tiers of society throughout all life cycle stages of mine development.

The horizontal axis 'life-of-mine' of the LMLOC framework in Figure 1 includes exploration and planning, construction, operation, decommissioning, closure, post-closure and re-commissioning stages of mine project development (EPA, 2011). The vertical axis presents 'life-of-community' and offers a worker-to-community continuum approach to planning for health impacts, ranging from OH&S to regional health impacts.

In 2002, the Main Committee of the World Summit on Sustainable Development (WSSD) drafted a statement, which included support for increased efforts to address the impacts and benefits of mining in relation to health throughout the life cycle of mining projects (Walker and Howard, 2002). The LMLOC framework (Figure 1) highlights both immediate and longer-term impacts, and suggests a proactive approach in planning for positive community benefits while minimising adverse health impacts from mining developments.

It is, therefore, important to incorporate an understanding of the varying degrees of health impacts along both scales of the LMLOC framework, and to recognise the links between improving community health and minimising adverse socio-economic and environmental impacts. However, a quick preliminary scan of the literature with key words such as 'mine' and 'health impact' revealed that most of the literature around mining impacts is focused on the state of the ambient environment (eg water, air), economic feasibility, and worker productivity, efficiency or occupational health. This preview suggested a very limited number of publications on the broader health outcomes of mining within the worker-to-community continuum and almost no reporting on the linkages between this LOC continuum and the stages of LOM planning.

This paper presents our review that seeks to map existing literature related to the topic of public health in mining within the LMLOC framework (Figure 1).

LITERATURE REVIEW

The preliminary literature review was undertaken on different databases (including Web of Science, PubMed, EBSCO) between May 2010 - November 2011. A suite of keywords were selected to identify publications reporting on health impacts of large-scale industrial mining. These were:

- the primary keywords *mining* and *health*
- secondary link words were *resources, minerals, mine community, mining community, health, illness, worker, boomtown, community, environment, pollution, Indigenous, Aboriginal.*

The search was restricted to publications in English, and excluded medical publications on specific mining-related disease etiology or outcomes. After identifying papers and active authors in the field, further searches identified the related literature, which were added to a reference Endnote library collection. Based on the diverse sources of publications, the final analysis in this submission is clearly not definitive, but instead an attempt to document the *relative emphases* of research activities and publications that address health issues in the mining environment.

Using this approach, a total of 409 'mining specific' papers were assembled into the reference library. 'Mining specific' was defined as large scale corporate economic activity, with the resultant exclusion of research publications that explored health issues in artisanal mining and literature regarding similar health issues in other related sectors (such as construction, heavy industry and remote and rural health).

RESULTS – THE BREAKDOWN OF PUBLICATIONS WITHIN THE LIFE-OF-MINE/ LIFE-OF-COMMUNITY FRAMEWORK

The 409 publications were categorised within the LOC continuum and then further linked to LOM stages.

The analysis found that the majority of published research (+60 per cent) is focused on occupational health and/or the individual worker (Figure 2). This is consistent with the breakdown of presentations at an industry conference series (Table 1). The remaining almost 40 per cent of the articles and reports did in some way, and to a varying degree, address health impacts within the LOC continuum.

The articles in each LOC category were mapped against LOM stages to identify those areas with maximum focus and also to elucidate gaps in research. For instance, an article was linked to specific LOM stages if the reported research addressed those different stages. This work shows clearly that, within the LMLOC framework, the major research emphasis is clearly on workers in the operational LOM stage (Table 2). This is further emphasised in Figure 3.

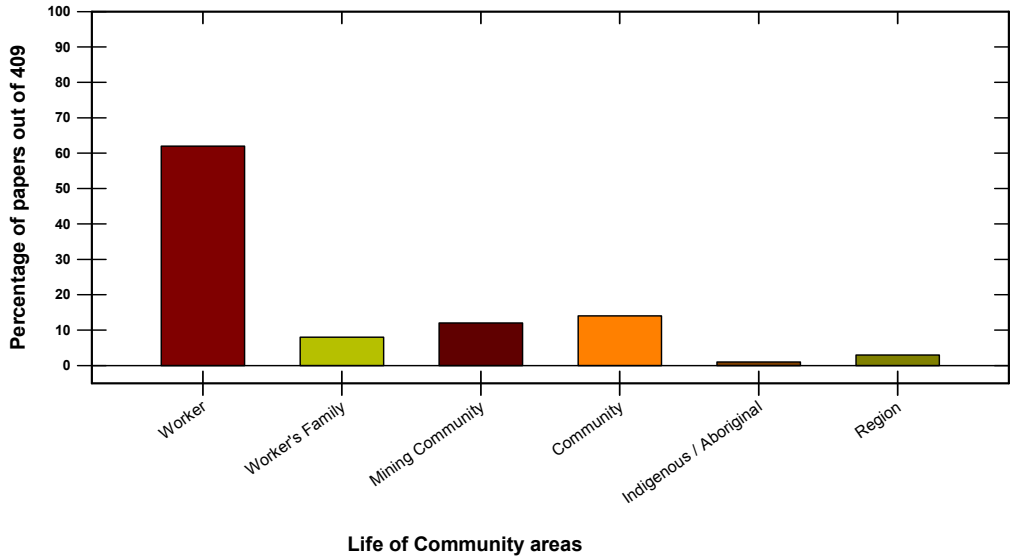

FIG 2 - Distribution of mining and health research publications relative to the life-of-community continuum (publications reported as a percentage of total (n = 409)).

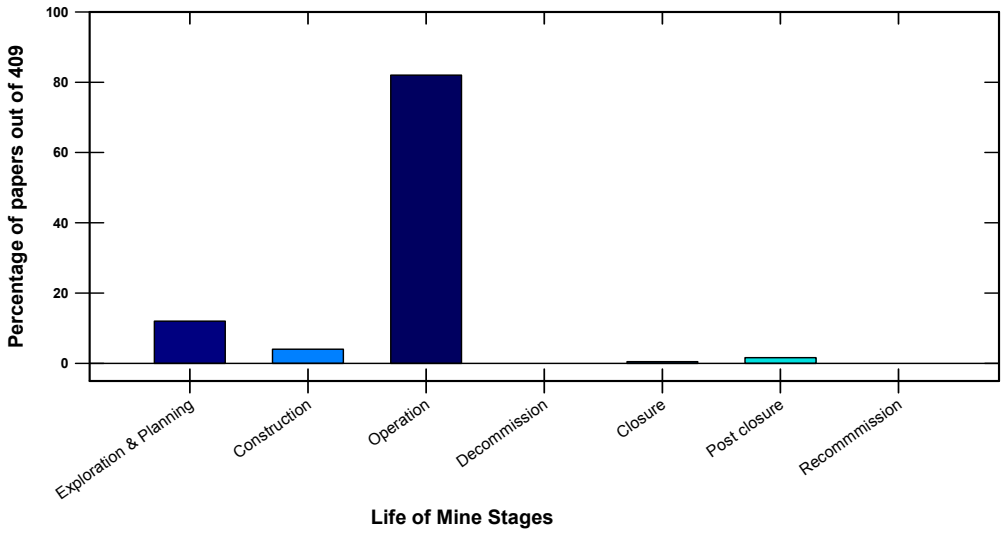

FIG 3 - Distribution of mining and health research publications relative to life-of-mine stages (publications reported as a percentage of the total (n = 409)).

TABLE 2

Distribution of publications specific to mining and health within the life-of-community continuum when mapped to life-of-mine stages (note, while n = 409, the additive total of all cells is greater due to overlap of publications in several stages where relevant.)

Life-of-mine	Worker	Worker's family	Mining community	Community	Indigenous/Aboriginal communities	Region
Exploration and planning	39	0	1	1	2	10
Construction	9	0	1	7	0	0
Operation	222	32	50	46	1	4
Decommission	0	0	0	0	0	0
Closure	0	1	0	1	0	0
Post-closure	2	1	0	4	0	0
Recommmission	0	0	0	0	0	0

With this mapping of the literature against the LMLOC framework, the research emphases and knowledge gaps became readily apparent (Figure 4). This suggests collaboration opportunities for researchers, mining companies, related communities, as well as government stakeholders, to address the gaps and build the knowledge pool on broad community health questions in the mining environment.

DISCUSSION

The vast majority of literature placed within LOC categories was focused on occupational health and/or the well-being of workers (62 per cent) (Figure 2). This finding comes as no surprise as mining companies traditionally integrate OH&S and on-site employee well-being into operational planning

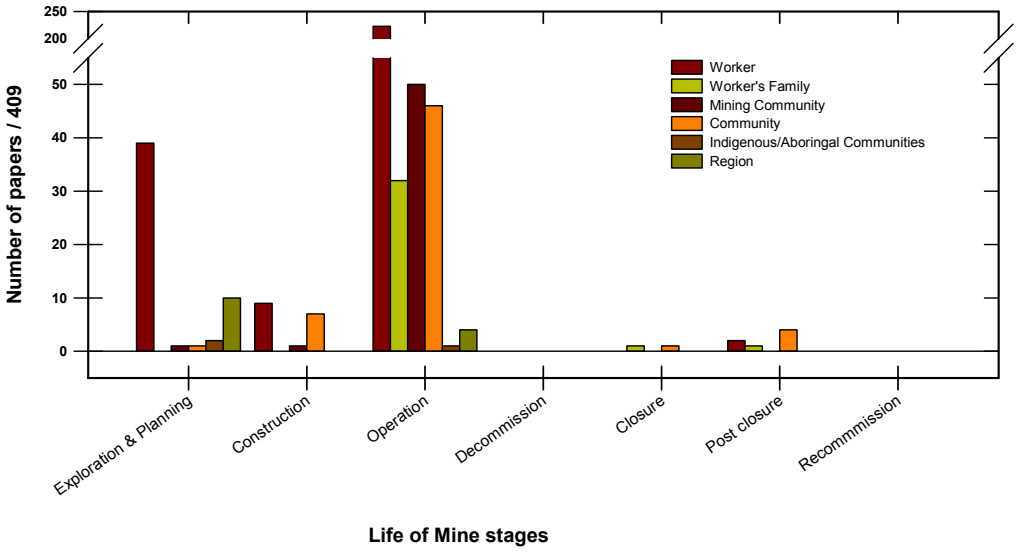

FIG 4 - Distribution of community health-related publications within the life-of-mine/life-of-community framework.

and management. While this is mandated by law in many countries, the maintenance of worker health and safety can also economically impact mining operations and a financial incentive exists to run a safe and healthy workplace.

In contrast, research surrounding the health and well-being of workers' immediate families is minimal, with the majority focused on themes of mental health, impacts on specified groups such as the partners or workers, assessment of exposure and risk regarding heavy metals and air pollutant exposure in children that could lead to chronic disease outcomes. While workers' families are a component of the larger mining community, the pressures of having a family member who works in mines may result in different impacts than for other community members. For example, workers' family members may experience distinctive exposure levels and health impacts in comparison to individuals not directly involved in the mining process (ie other local business owners and their families).

The interactions of LOM impacts on LOC health and wellbeing are further confounded by the increasing dependence of many mining operations on a non-residential (or mobile) workforce (fly-in, fly-out or drive-in, drive-out: FIFO/DIDO) (QRC, 2011), which requires further assessment of health impacts on workers and families beyond the mining community, to locations that are physically remote to the mine site (Sibbel, 2010). While FIFO/DIDO employment has been the recent subject of an enquiry by the Australian Federal Government, little research is available on the health impacts of this mobility throughout the LOC continuum (including workers, workers' families, mining communities and communities where workers permanently reside) (House Standing Committee on Regional Australia, 2011; Newhook *et al*, 2011).

Once distributed into the matrix of the LMLOC framework, gaps in research became very apparent. The vast majority (82 per cent) of articles are linked to the operation stage (Figure 4) followed by the exploration and planning stages (12 per cent). The other LOM stages were linked to minimal or no literature. Motivation for more research in this life cycle stage may be linked to financial incentives associated with creating an efficient mining operation. However, detrimental health impacts can continue due to exposure even after the mine has closed, particularly if remediation processes are slow to take place, ineffective or not implemented. In the LOC continuum, research into the health impacts of mine developments on nearby indigenous communities was most poorly represented (one per cent), despite international human rights law which includes provisions for recognising the rights of indigenous communities (Docherty *et al*, 2010).

Recent research in West Virginia and British Columbia is starting to inform these unknown areas. In studies of the relationship between health indicators and residential proximity to coal mining in West Virginia, higher rates of cardiopulmonary disease, chronic obstructive pulmonary disease, hypertension, lung disease, and kidney disease (Hendryx and Ahern, 2008), elevated probability (16 per cent) of low birth weight infants (Ahern *et al*, 2011b), and significantly higher male and female mortality rates for chronic heart, respiratory and kidney disease (Hendryx, 2009) were found for counties with the highest prevalence of coal mining.

In British Columbia, Shandro *et al* (2011b) have documented:

> *… increases in pregnancies, sexually transmitted infections, and mine-related injuries during booming mine activities. During bust times, mental health issues such as depression and anxiety were reported. Overarching community health issues prominent during both boom and bust periods included burdens to health and social services, family stress, violence towards women, and addiction issues.*

Multi-stakeholder interests in issues surrounding mine closure are of growing importance for the minerals industry, for those communities in which mines are located, for regulatory bodies and for civil society, which is becoming increasingly aware that, although mining may only be a temporary land use, residual impacts can be experienced for many generations after mining ceases (Fields, 2003). The challenge is to ensure mining leaves a positive legacy, and that impacts on human and community health are considered equally important as those on the physical environment or natural ecosystem (Shandro *et al*, 2011b).

Giving consideration to health outcomes extending beyond the worker is crucial during the exploration and planning stages within the LOM stages. Research is needed in order to understand the health impacts throughout the LOM stages, particularly those stages that were found to be underrepresented in this review (ie construction, closure, recommissioning). Research within these fields will enable

the mining industry to make *evidence-based decisions* in future development opportunities during subsequent exploration and planning stages, and for governments to develop appropriate policy responses. Conducting, publishing and considering such research in future decision making will also promote the overall social responsibility of the mining industry, improving public perception and relations – an incentive for a committed investment in these research areas.

Knowledge of mining-related health impacts on specific groups underrepresented in the literature, such as Indigenous communities, would also be of great relevance as such communities are also globally under pressure from extractive industries (eg Taylor and Howard, 2005; Ballard and Banks, 2003). Impacts of mining on Indigenous employment and social well-being of Indigenous communities were considered beyond the scope of this mining + health review.

CONCLUSIONS AND RECOMMENDATIONS

An increased focus on health and well-being impacts within a strategic LOM planning framework should directly result in reduced detrimental impacts such as chronic disease from environmental exposure, and increased benefits, such as improved health service delivery by government agencies, both of which would result in overall improved health outcomes. Improving beneficial impacts at every step in the LOC continuum (ie improved health outcomes) will reflect positively on the mining industry in terms of social responsibility and community engagement (and their social license to operate), as well as directly enhancing the long-term economic sustainability of communities that are economically dependent on mining.

The findings of this preliminary review are consistent with those of Stephens and Ahern (2001) who identified a major shortfall in research around mining and the health of the broader community. Unfortunately, little seems to have changed in the past decade, and there is still little research on this issue published in the literature. However, major mining companies do invest in community health and wellness programs ranging from the provision of social welfare, the management and treatment of infectious disease, funding rural health service and upgrading sporting facilities. The primary author's research team is analysing corporate sustainability reporting within the minerals sector, to establish a database of information about mining company engagement with broader health questions in this LMLOC framework. One aspect of this work (supported by the International Mining for Development Centre) will be to analyse and report on health-related activities undertaken by mining projects in developing countries.

The evident lack of research activity in many parts of the LMLOC framework may be partially due to the lack of statutory obligation. Governments often require some variation of an environmental and social impact assessment (ESIA) to evaluate any potential direct or indirect impacts to the environment and communities; assessments generally include:

> *… ecological, aesthetic, historic, cultural, economic, social, or health [impacts], whether direct, indirect, or cumulative* (CEQ, 2007).

In Queensland, environmental impact statements for resource developments under both the *Environmental Protection Act 1994* and the *State Development and Public Works Organisation Act 1971* are required to include social impact assessment. The terms of reference for Queensland environmental impact statements include a requirement to

> *... address all elements of the environment, (such as land, water, coast, air, waste, noise, nature conservation, cultural heritage, social and community, health and safety, economy, hazards and risk) in a way that is comprehensive and clear* (State of Queensland, 2012).

The State of Queensland's requirement for social impact assessment plans specifies analysis of impacts on:

> *… health and well-being cultural, family, leisure, recreation and community health issues, needs of social groups, heritage and social amenity* (State of Queensland, 2010).

However, despite a clear intention to protect the health of people and the environment, such Acts or ESIA requirements have numerous failings. One of which is that health impact assessments (HIA) are not a requirement, and public health impacts are often discussed narrowly without consideration of the influence of mining on the environmental and social determinants of community health in broader geographical scales (eg a community as being outside the direct sphere of a mine). Increasing governance over community health and well-being (see State of Queensland, 2010), as well as placing the health-and-environment component of public health within the statutory requirements, will result in greater, but also effectively broader focus on health planning and programing for mining activities throughout the LMLOC framework. It is critical to integrate community-level indicators of well-being into collaborative mine planning processes (Shandro *et al*, 2011c). The life of a mine is entwined with the life of a community and we encourage future research to consider the full range of impacts within the LMLOC framework.

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Health, Safety and Sustainability

D Cliff[1] and K Bailey[2]

ABSTRACT

Traditionally occupational health and safety (OH&S) has been managed for the direct benefits of reducing injury and illness to workers on mine sites. In the current skill shortage climate it is important to recognise the value that OH&S management can have in assisting mines in minimising their exposure to this issue. In times of skills shortage turnover is high as mines poach personnel from each other. This leads to loss of corporate knowledge and loss in productivity through the need to train new personnel in mine-specific operating procedures. In addition absenteeism can significantly disrupt production as there may be no ready replacements available for key jobs. Pressure will be placed upon workers to remain at work even though they are not completely fit for work, leading to presenteeism and consequently loss in productivity. In addition to the threats to routine operation, the loss of management and professional staff can significantly increase catastrophic risk through loss of experience and corporate knowledge. There is increased pressure to focus on events that occur regularly in the here and the now and underestimate the rare, or unlikely, events.

The theme of this paper is that by properly addressing OH&S management at mine sites, companies can minimise their exposure to these problems. Put simplistically, a safe and healthy mine is a sustainable and productive mine. Case studies and relevant literature will be used to support this premise.

INTRODUCTION

In mining, as in all industries, there is an ever-present need to maintain, if not improve, the rate of production. Many have postulated that such production pressures and expectations lend themselves to the subordination of safety practices in favour of expedience (Brown, Willis and Prussia, 2000; Probst and Brubaker, 2001; Mullen, 2004). Grunberg (1983) for example, compared two car plants making same car – one in France and one in the United Kingdom (UK). The French factory had higher productivity and a much higher accident rate (approx 60 times) than the UK factory. The evidence suggests that this was due to the high level of organisation of the UK workers and their militancy.

Brown, Willis and Prussia (2000), while exploring safe employee behaviour in the steel industry, found that during times of increased production, employees felt that the need to meet production quotas abated safety procedures, and that their bonuses and jobs may be placed in jeopardy if they were to follow these procedures. The authors proposed several issues at work here, including lack of time to eliminate hazards (Brown, Willis and Prussia, 2000). A further issue at play is linked to whether it is communicated to, or perceived by, employees that their employer emphasises production first and foremost, with safety understood to be a lesser priority (Probst and Brubaker, 2001). McLain and Jarrell (2007) investigated the outcomes of compatibility between safety and production. In line with theory, this research suggested that safety-production compatibility (and thus conflict) was linked to safe work behaviours and the extent to which hazards interfered with tasks performed (McLain and Jarrell, 2007). Such research suggests that employers need to consider safety-production compatibility in job design, in order to ensure that employees do not feel the need to cut safety corners in order to keep up with job demands.

Others have found that there is a trade-off between productivity and safety in terms of the costs of maintenance and repairs to improve safety at the expense of production (Cowing, Paté-Cornell and Glynn, 2004).

1. Professor of Health and Safety in Mining and Director of the Minerals Industry Safety and Health Centre, Sustainable Minerals Institute, University of Queensland, Brisbane Qld 4072. Email: d.cliff@mishc.uq.edu.au

2. Research Assistant, The Minerals Industry Safety and Health Centre, Sustainable Minerals Institute, University of Queensland, Brisbane Qld 4072. Email: Kirsty.bailey@uqconnect.edu.au

IMPROVING SAFETY IMPROVES PRODUCTIVITY THROUGH REDUCED COSTS

This school of thought focuses on the direct, and indirect, costs of accidents and illness. The costs include not only the direct costs, but also the hidden costs, which can be up to 200 per cent of the direct costs (Oxenburgh, 1991). Thus it would be argued that reducing accidents and illness makes good financial, as well as ideological, sense.

Hidden costs include:

- overtime
- over employment (extra staffing)
- employee turnover
- lost production time
- additional management/supervision time of temporary replacement personnel
- reduced productivity from lower skills
- product damage
- plant damage
- reduced investment opportunities
- equipment downtime
- personal losses to those injured or ill (Oxenburgh, 1991).

Oxenburgh goes onto demonstrate the potential for the costs of injury and illness to directly affect profit. He gives an example of a Swedish car manufacturer where the overall cost of an employee is 2.66 times the direct wage cost, with absences adding 20 per cent to cost of employment over a year, and turnover adding 15 per cent. Better safety performance can reduce workers compensation insurance premium by up to 50 per cent or about two per cent of wages paid. He also demonstrates that mechanisms employed to reduce injury and illness can lead to increase in productivity.

It is not just time away from work that reduces productivity, but presenteeism – where one is at work but not functioning at full capacity – also reduces productivity. Williden, Schofield and Duncan (2012) showed that workers affected by stress and anxiety whilst still at work, have reduced productivity by over ten per cent. Presenteeism can multiply the real cost of an illness by up to four times (Geotzel *et al*, 2004). An indication of the size of the problem can be found in the statistics presented by Cooper and Dew (2008), which analysed UK health information and concluded that 46 per cent of all work-related illness lost-time days were due to stress, depression or anxiety – a total of 13.8 M days in 2006 - 2007. Overall, 175 M days are lost due to sickness and 70 M days due to mental health problems. This means that up to £1.6 B are lost each year in the UK due to work related mental illness and over £3 B on occupational sickness in total. They estimated that presenteeism costs 1.8 times the costs of absenteeism. Another way of identifying the significance of presenteeism is to note that in the UK, 22.3 per cent of all people in paid employment have some kind of mental health problem (including 6.9 per cent with an alcohol or drug dependency problem).

In reverse, von Thiele Schwarz and Hanson (2012) found that by encouraging 2.5 h/w of physical exercise during working hours, sickness absence costs were reduced by 22.2 per cent (in dental health workplaces studied). In comparison with a control population, reducing the working hours by 2.5 h/w only caused a reduction in sickness absence of 6.2 per cent.

As well as causing illness and lost productivity, work stress has also been shown to influence employee safety through a number of mechanisms. Masia and Pienaar (2011) found that work stress had an inverse relationship with safety compliance, as they did for job insecurity. In addition, several studies by Maiti and colleagues have suggested that job stress encourages employees to avoid safe work behaviours, thus increasing their likelihood of workplace injuries, and that job stress can indirectly lead to employees becoming less job-involved, which may also increase their likelihood of injury as greater job involvement is associated with better safety performance (Maiti, Chatterjee and Bangdiwala, 2004; Paul and Maiti, 2008). In the same studies, Maiti and colleagues also suggested associations between safe work behaviours and negatively personified individuals, suggesting that these individuals not only fail to avoid work injuries, but that they are also unable to extend safe work behaviours in their work; instead they engage in risk-taking behaviours, all of which makes them more susceptible to workplace injuries (Maiti *et al*, 2004; Paul and Maiti, 2008). This research indicates the potential need for organisations and employers to take a greater interest in the psychological health of their employees, beginning as early as the recruitment process, in

order to decrease the likelihood of job stress and negative personalities contributing to workplace injuries. However, further research is needed to strengthen the results of this limited research base.

Absenteeism is another employee-level issue affecting worker safety in hazardous industries such as mining. In their investigation of the consequences of absenteeism in relation to accidents, Goodman and Garber (1988) introduced the concept of familiarity to explain the safety impacts of absenteeism. In this study, the authors defined familiarity as 'the level of specific knowledge one has about the unique aspects of the work place' (Goodman and Garber, 1988). The central premise of this research was that, as a result of lack of familiarity, more hazardous conditions would occur, which in the absence of compensatory behaviours by a miner, would result in higher accident rates. Through this research, the authors concluded that the results supported the familiarity argument, promulgating the view that prior absence has the effect of increasing accidents, and that regular miners experience fewer accidents than replacement miners. In addition to this study, several others have reported findings that support absenteeism-accident links, with a consistent finding appearing to be that of high-accident rate mines having greater issues with absenteeism than low-accident mines (Peters, 1989).

IMPROVING SAFETY AND PRODUCTIVITY JOINTLY THROUGH IMPROVED WORK PRACTICES

Currently the mining industry is experiencing major skills shortages. This is exacerbated by high turnover rates. The Heart Beat report compiled by the Kinetic Group estimated that turnover was as high as 24.4 per cent, with 18 per cent of employees leaving the industry within the first year of employment (Barrett, 2012). This will only get worse given the expected growth rate of 14 per cent over the next three years (Barrett, 2012). Indeed some mines are having difficulty in recruiting staff, which is causing delays in commissioning production (Caruana, 2012).

This pressure to recruit can cause its own problems. Niessner reported that the mining industry is so busy recruiting people they don't take the time to stop and put a solid infrastructure in place to enable them to recruit more for the long-term. The industry needs to take raw recruits and equip them with appropriate skill sets to make them more effective and to want to have a career in mining (Niessner, 2012).

The costs of turnover are enormous, when indirect costs are factored in. Estimates vary depending on the nature of the job. Oxenburgh estimated the average turnover cost-estimate from case studies at 75 per cent of one year's wage (Oxenburgh, 1991). Mercer (2004) estimated the cost of turnover as being between 50 and 150 per cent of salary of a replaced worker.

Turnover costs include:

- decreased productivity
- lost investment in training and development
- loss of revenue for key sales or management executives
- administration set-up
- equipment purchase
- recruitment costs
- induction costs
- interview costs, including the costs of personnel conducting the interviews
- legal fees
- separation costs.

Reducing turnover can be related to improving job satisfaction – 80 per cent of the top 100 employers on the Fortune 500 list outperformed their peers on the Standard and Poors Index (Mercer, 2004). Job satisfaction has been found to be significantly related to total sickness absence duration. Other factors that were identified to correlate with sickness absence were: physical workload, mental workload, job autonomy and decision authority (Roelen *et al*, 2008).

Low job satisfaction can be related to a poor safety climate. A weak safety climate within an organisation may lead to employees feeling the need to take shortcuts with safety procedures (Brown, Willis and Prussia, 2000). A positive safety climate, characterised by an open door policy for hazard and accident reporting, a sincere concern for employee well-being and fairness in accident investigations, contributes to employees engaging in safer work practices. General organisational climate had a significant influence on safety climate, and that safety climate in turn was linked to

self-reported levels of compliance with safety procedures, as well as participation in safety-related activities within the workplace (Neal, Griffin and Hart, 2000). A number of researchers have also found evidence linking safety climate with a number of variables that have been linked to employee safety behaviours and compliance, including job satisfaction, psychological climate, organisational commitment, job stress and general well-being (Clarke, 2010; Paul and Maiti, 2008). Thus it is evident that current research supports safety-oriented job design and the development of organisational climates that emphasise safety first.

Job security is linked to turnover and productivity. It has been proposed that job insecurity impacts upon employee safety in a number of ways, interacting with multiple individual and organisational characteristics in often quite complex ways. First, as mentioned earlier, job insecurity has been linked to safety behaviours through the consequences of production pressure. Probst and Brubaker (2001) asserted that when an employee feels that their job may be in jeopardy, they may become driven to cut safety corners in order to focus more on performance and production quotas, as performance is, in some organisations, more valued and rewarded than safety compliance. Second, job security has been linked to employee psychological well-being and mental health, which in turn has been suggested to impact upon risk behaviour and safety compliance (Sverke, Hellegren and Näswall, 2002; Emberland and Rundmo, 2010).

The last factor to be discussed in relation to job insecurity, as well as to employee safety in its own right, is job satisfaction. Research has accumulated in recent years regarding the links between job satisfaction and safety at work, both through direct and indirect influences. Results of the study conducted by Probst and Brubaker (2001) suggested job security perceptions to be strongly related to job satisfaction and, in turn, that job satisfaction is a key predictor of safety motivation and knowledge. They also went on to find that job security can also be linked to meaningful safety outcome measures, such as safety motivation and reported compliance with safety policies, and found that injuries and accidents were predicted by safety motivation, and, to a lesser extent, by safety knowledge and compliance. Other studies have reached similar conclusions – Sverke, Hellegren and Näswall (2002) found concurring evidence in their meta-analysis that job insecurity was substantially related to job attitudes (including job satisfaction); Paul and Maiti (2008) found job dissatisfaction to have a significant positive association with work injury; and Masia and Pienaar (2011) found through their research that job satisfaction was a significant predictor of safety, despite finding evidence that it did not significantly correlate with safety compliance, contrary to other studies.

Fiedler *et al* (1984) demonstrated that working on productivity and safety cooperatively improved both. They implemented two schemes: organisational development (OD) and structured management training (SMT) to increase productivity and safety at two underground mines. Accidents and injuries are highly related to the quality of supervision and to organisational climate. Management intervention methods were used to improve the organisational climate and the quality of work life. They compared safety and production to similar mines where there was no intervention. OD groups worked on solving problems relating to pay, safety and productivity – vertical slice of workforce. SMT involved modules in leadership match, critical supervisory skills, training motivation and action planning – focuses on managers.

The results of the SMT intervention showed that productivity at the end of the study was seven per cent above industry average, having started at industry average. The number of accidents started out 220 per cent of industry average, reduced to 1.7 per cent above average at the end of the study (over three years). This correlated to a 280 per cent reduction in accident rate. The mine also achieved a reduction in mine safety and health administration (MSHA) citation rate (ten per cent of preintervention level).

The OD was a three-year intervention and included the introduction of a safety incentive scheme, using small rewards for 20 000 man hours accident free. Productivity data was not able to be assessed due to strike action at the mine. Safety record improved 51 per cent over the period of the study (from 23.5 per cent in 1978 to 11.4 per cent in 1981 and early 1982 indicated five per cent). The industry average stayed at 11 per cent. Absenteeism dropped – this contributes to better safety through safer working conditions by reducing fatigue caused by overtime work and the need for temporary replacements (prestudy 11 per cent to seven per cent). The MSHA citation rate dropped to 30 per cent of prestudy level.

Another study by Salminen and Saari (1995) found that from a survey of workers that had been involved in a serious accident, three of the top five measures to improve safety and productivity were common to both areas. These three measures were: improved equipment, more room to work and better housekeeping.

CONCLUSION

Whilst historically good safety and health performance has been seen as a cost to production, in fact many of the same measures that encourage productivity also encourage good safety and health performance. This extends to the indirect influences on safety and health that result from a stable and contented workforce. Stability drives low turnover, which is good for production. Happiness drives low mental illness issues, which reduces presenteeism and improves production.

Thus productivity and safety and health are not mutually exclusive and in a modern mine should be managed and promoted cooperatively.

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Occupational health and safety capability in mining – challenges and opportunities

P Pryor[1], A Hale[2], D Borys[3] and D Hudson[4]

ABSTRACT

Specialist occupational health and safety (OHS) advice is vital to safe operation in complex environments such as mining, oil and gas. However, the OHS function within the resources sector is facing a confluence of challenges not encountered since safety became recognised as a specialist function. Pressure on product pricing, changed business models, a reduction in OHS personnel and changes to OHS functional roles are contributing to a lack of clarity about the OHS role, which has led to a potential devaluation of the role with consequential detrimental effects on safety and health. In this environment, it is vital that organisations and OHS professionals themselves optimise OHS capability to ensure that they have the skills and knowledge to adapt to the changing environment and the confidence to lead OHS within their organisation into the future.

This paper addresses the outcomes of a project examining OHS capability conducted under the auspices of the International Council of Mining and Metals. The project examined position descriptions across all levels of the OHS function for 13 mining companies, analysed questionnaires completed by site, regional and corporate personnel and conducted interviews with managers. The results were mapped to the OHS Professional Global Capability Framework developed by the International Network of Safety and Health Practitioner Organizations. An OHS capability framework was developed for the mining industry addressing both practitioner and professional roles that included position profiles, roles, knowledge and skills statements together with a self-assessment tool and development pathways.

This paper explores the deficiencies in OHS capability identified through the analysis, the views of managers on the 'areas for improvement' and the response by OHS professionals. The OHS capability framework for the mining industry developed as an outcome of the project is presented, together with development strategies for organisations and OHS professionals.

INTRODUCTION

Following a decision by the International Council of Mining and Metals' (ICMM) Council of CEOs to undertake a project to redefine the role and development pathways for occupational health and safety (OHS) professionals, the ICMM OHS Forum agreed in 2014 to undertake a joint project with the International Network of Safety and Health Practitioner Organizations (INSHPO) to develop an OHS capability framework for the mining industry. This framework was to be developed based on the draft INSHPO *Occupational Health and Safety (OHS) Professional Capability Framework – A Global Framework for Practice* and informed by input from the mining industry. The focus of the project was full-time safety roles at the corporate, regional/commodity and site levels. The project comprised four phases:

1. Registrar, Australian OHS Education Accreditation Board, Melbourne Vic 3207. Email: registrar@ohseducationaccrediation.org.au
2. Professor Emeritus, Delft University of Technology, Netherlands and Director, HASTAM, Loughborough LE12 8PY, UK. Email: andrew.hale@hastam.co.uk
3. Adjunct Professor, RMIT University, Prairie du Chien WI 53821, USA. Email: davidmborys@gmail.com
4. Executive Director, American Society of Safety Engineers, Chicago IL 60068, USA. Email: dhudson@asse.org

1. current status
2. the vision
3. learning from others
4. the development of the framework.

The outcomes of the project were a detailed report on the findings from the data collection and consultation, together with the actual framework presented as six elements:

1. graphic overview
2. overview
3. developing OHS position descriptions (PDs)
4. activities, knowledge and skills
5. self-assessment tool
6. guide to professional development pathways.

This exploration of the current status of the OHS role in mining and definition of the vision for the OHS role by both managers and OHS professionals has iteratively informed the ongoing development of the INSHPO *Occupational Health and Safety (OHS) Professional Capability Framework – A Global Framework for Practice* and resulted in the development of online tools such as an OHS position description builder, a self-assessment tool and professional development plans. Thus, while the project was specific to the mining industry, the outcomes have also enhanced the capability framework for generalist OHS professionals working in all industries.

This paper begins by outlining the project, sources of data and data collection. It then presents the findings from the analysis, summarises the indicators of the need for change and outlines the vision for the OHS role. Finally, it presents the framework and provides some recommendations for implementation.

PROJECT OUTLINE AND DATA COLLECTION

This section outlines the sources of data and the data collection processes for each phase of the project.

Sources of data

The benchmark

The draft INSHPO *Occupational Health and Safety (OHS) Professional Capability Framework – A Global Framework for Practice* provided a benchmark for the analysis and a basis for the final framework. The intention in using the INSHPO framework as the benchmark was not to say that it set the desired standard, but rather to provide a structure for comparison.

The framework was developed by INSHPO through an international research project reviewing documentation relating to requirements for OHS professional practice set by national professional associations and certification bodies from the US, Canada, the UK, the EU, Australia and the Russian Federation. The draft framework document was subject to critical review through OHS professional bodies and at international conferences and presentations, including the XX World Congress on Safety and Health at Work 2014 in Frankfurt and the Seventh International Conference of the Working on Safety Network in Scotland.

The framework includes the descriptive position profiles, activity statements and knowledge and skill matrices required to carry out the roles of OHS Practitioner and OHS Professional.

Industry input

Industry input to the project came from four sources: PDs, questionnaires completed by OHS personnel and interviews with operations managers and senior OHS personnel.

Position descriptions

PDs for OHS roles at various levels were provided by 13 ICMM member organisations.

Questionnaires

A questionnaire based on one used in earlier studies by the report authors was adapted for the project. Two related questionnaires were provided: one to OHS Practitioners employed at site level and the other to OHS Professionals with broader remits in regional, commodity or corporate headquarters roles. The questionnaires comprised questions about the size of the company, the type and location of mining, the range of responsibilities, education and OHS training, whether and how frequently they were involved in a range of OHS tasks and interactions with a range of line, staff and external stakeholders. The questionnaires were distributed by ICMM to member companies, which then gave them to potential respondents as defined by the accompanying instructions. The number of returned and fully completed questionnaires totalled 93 at the site level and 50 at the regional/commodity and corporate level.

Manager interviews

ICMM forwarded invitations to participate and information on the project to a representative sample of 16 companies, inviting their senior managers to participate in an interview. From the 16 companies contacted, 13 senior managers (81 per cent) representing seven companies agreed to be interviewed. Interviews were skewed in favour of Canada with five of the 13 interviewees (38 per cent) drawn from this region. The interviews were also skewed by the fact that eight of the interviewees (61 per cent) worked for gold mining companies. All except one interviewee (a chief operating officer) were general managers at the operations level. These limitations should be taken into account when considering the interview findings.

Input by senior occupational health and safety professionals

The results of Phases 1 and 2 were presented at a workshop as part of the ICMM OHS Forum in London in October 2015. Forum participants provided comments and feedback. A small group of senior OHS professionals also provided feedback on the draft framework.

Phase 1 – current status

Phase 1 of the project was designed to clarify the current status of the OHS role in mining companies and had two components. The first component was an analysis of PDs to identify the company perception of the OHS role. The second involved questionnaires to determine the demographics of people currently in OHS positions and the activities and training/education routinely undertaken at the site and corporate/regional levels.

Position description analysis

The PDs were benchmarked against the INSHPO position profiles and activity, knowledge and skills statements to answer the question: what do current PDs indicate is required of the roles?

The INSHPO position profiles are at three levels for both the OHS Practitioner and the OHS Professional. Their development was informed by the Australian Qualification Framework, the European Qualification Framework and several frameworks from related professions. The INSHPO OHS Capability Framework describes the key activities for the OHS Professional and the OHS Practitioner across seven areas of activity. These are supported by six categories of knowledge and a range of 11 types of professional, technical and personal skills.

The mining PDs varied markedly in format, style and level of detail, both across and within organisations. Some PDs had clearly been developed to address the requirements of specific positions in detail, whereas others appeared to be derived from a 'cut and paste' template. The latter approach resulted in some inconsistencies or possibly inappropriate and unintended specifications, which, if applied in practice, could lead to some role ambiguity and confusion. Two such examples were:

1. Purpose of corporate OHS role: to contribute to competitive advantage and shareholder value. If listed as a priority, this may be a conflict of interest for the OHS Professional.
2. Communication and engagement requirement for site support role: to engage with senior management. The site support role involves engagement with workers, supervisors and line management, but would rarely involve encounters with senior management.

Questionnaire analysis

The questionnaires were designed to answer the following questions:

- What is the profile of people in OHS roles in the mining industry?
- What training and education have they undertaken?
- What are the focus and priorities for current activities and practice?

The objective was to uncover any anomalies or mismatches between the tasks carried out by OHS personnel and their competence, which might need to be addressed when making recommendations for a mining-wide framework of OHS professional capabilities.

Comparison of findings of analysis of position descriptions and questionnaires

A third component of the analysis of current status was a comparison of the outcomes of the PD and questionnaire findings to identify any:

- similarities or differences between PDs and questionnaire responses
- anomalies such as high levels of tasks central to the INSHPO framework but considered by respondents as 'not my job' or practitioner tasks being carried out at regional or corporate levels by professionals and vice versa.

The objective was to answer the following questions:

- Does current practice reflect the PDs and vice versa?
- Do the competency requirements match the level of the functions?

Phase 2 – the vision

Phase 2 was about identifying the ICMM vision for the OHS roles. This was achieved by asking a small sample of site general managers how satisfied they were with their OHS personnel, their views on where OHS personnel could do better together and what they thought was important in terms of knowledge and skills for the role.

This phase of the project was designed to answer the following questions:

- What do mining industry senior and operational managers see as the strengths and deficiencies in the current OHS functional roles and job performance?
- What do mining industry senior and operational managers need/want from OHS professionals in their area?

To answer these questions, senior managers from different countries, companies and commodities were invited to respond to the following two questions:

1. To what extent are you satisfied with the performance of the OHS full-time personnel at the global, regional/commodity and site levels of your organisation?
   - What do they do well?
   - What could they do better?
2. Ideally, what are the knowledge, skills and roles that you would expect those OHS personnel to have at the different levels of your organisation?

Senior managers were also asked to comment on the following two additional questions:

1. To what extent is mining industry experience important for OHS personnel?
2. To what extent are formal OHS qualifications important for OHS personnel?

With the permission of the interviewee, interviews were recorded, and the recorded interviews were used by the researcher/interviewer to analyse the results and identify themes.

Phase 3 – learning from others

Phase 3 was the exploration of what might be learned from the experiences of other industries and organisations that had already developed frameworks. The INSHPO working group collected and analysed frameworks from a wide range of industries, organisations and professional associations. In addition, INSHPO conducted a literature review to identify relevant research on frameworks. After analysing the various approaches to developing competency frameworks, INSHPO concluded that the best way to organise the framework was around job role profiles.

Development of the framework

The results of Phases 1 and 2 and feedback from the ICMM OHS Forum in October 2015 were then overlaid on the pre-existing version of the INSHPO Global Capability Framework to develop a framework that addressed the issues identified.

OUTCOMES FROM DATA ANALYSIS

This section presents the outcome of the data analysis for each stage of the project.

Current status

Position descriptions as a specification of role

A comparison of PDs with INSHPO position profile descriptors revealed close similarity between the mining senior corporate and corporate roles and the INSHPO OHS Professional Level 3 (the top level). Similarly, there was a good comparison between the mining regional roles and the INSHPO OHS Professional Level 2. At the senior site level, there was some overlap between the INSHPO profiles for OHS Professional Level 1 and OHS Practitioner Level 3, with the similarity being greatest with the Practitioner role. While in practice, the mining site support roles may operate across OHS Practitioner Level 1 and 2 profiles, the PDs reflected more of the Practitioner Level 1 role. Table 1 compares the summarised mining roles to the INSHPO profiles.

Mapping PDs to the INSHPO profiles revealed that some PDs were silent on parameters that might be considered important to the role, or the intention had to be derived by implication from other statements. Problem solving and, surprisingly, business and organisational skills were two areas that were often not addressed, whereas influence/leadership was usually well-addressed at all levels.

The knowledge requirements in the mining PDs showed a common gap at all levels in that none of them referred in any way to the need for a systematic and integrated body of knowledge or the need to be informed by leading edge thinking in OHS. Only one company's statement required actions to ensure currency of knowledge. Many descriptions required 'technical skills' or 'OHS and risk management skills' together with 'knowledge of legislation'. Others had a 'laundry list' of risk assessment techniques, OHS management systems, ISO standards, auditing, investigation, project management, quality and training.

For higher-level positions, the required qualifications and experience tended to reflect the INSHPO profile at the senior corporate, corporate and regional levels. However, at the regional and site level, OHS qualifications and experience were less in demand in favour of mining/technical qualifications and experience in mining or heavy industry.

The activity analysis for the PDs revealed a concentration of activities with a number of gaps at both corporate and site levels compared with activities considered 'core' in the INSHPO framework (Table 2). At the corporate and regional levels, there was an emphasis in the PDs on development and implementation of OHS management systems and associated planning processes; however, the promotion of a resilient safety culture was not overtly mentioned. Overall risk management processes

TABLE 1

Mapping of International Council of Mining and Metals (ICMM) professional profile to that developed by the International Network of Safety and Health Practitioner Organizations (INSHPO).

INSHPO professional level	ICMM professional profile
OHS Professional Level 3	Senior corporate Corporate
OHS Professional Level 2	Regional
OHS Professional Level 1	Senior site
OHS Practitioner Level 3	
OHS Practitioner Level 2	Site support
OHS Practitioner Level 1	

TABLE 2
Focus and gaps in activities required in position descriptions by the occupational health and safety (OHS) function.

	Major focus	Medium focus	Major gaps
Senior corporate	• Development of OHS Management System (MS)		• Advise on resourcing and priorities • Hazard identification and risk assessment • Monitoring controls • Monitoring performance and controls • OHS information management • Communication and consultation
Corporate	• Strategic and operational plans • Development of OHS MS	• Processes for monitoring performance • Audit processes • OHS knowledge and skill development • Understanding of responsibilities • Criteria for monitoring performance • Implementation of controls • Investigations	• Advise on resourcing and priorities • OHS in change management • Provide information to support risk assessment • Monitor controls • Communication and consultation
Regional	• Strategic and operational plans • Development of OHS MS • Risk assessment processes • Address identified issues • OHS knowledge and skills development • Understanding of responsibilities	• Processes for monitoring performance • Provide advice on compliance • Monitor controls • Address identified issues • OHS knowledge and skill development • Understanding of responsibilities • Manage team	• OHS in change management • Innovation
Senior site	• Audits • OHS knowledge and skills development and understanding of responsibilities • Provide information to supervisors and others • Use data to monitor performance • Strategic and operational plans	• Implement OHS MS • Investigate incidents • Risk assessment • Emergency preparedness • Monitor compliance • Develop OHS team	• Provide information to support risk assessment • Monitor effectiveness of risk management
Site support	• Provide information to supervisors and others • Conduct training • Use data to monitor performance	• Workplace inspections • Audits • Workplace monitoring • Personal protective equipment and fire equipment • Report non-conformities	• Risk management processes

received attention, but there was little specific emphasis on control and very few mentions of critical risks or critical controls. Other areas of attention were auditing, using data to monitor performance, transfer of knowledge and training. At the site level, the emphasis was on compliance and workplace monitoring through inspection and environmental monitoring, auditing (including of contractors), data collection and collation and training. Significant gaps occurred in the areas of organisational culture as well as certain areas of risk management, performance monitoring and knowledge management.

There was little or no reference to activities related to professional and ethical practice. This may be because they are considered the purview of membership of a professional body or are addressed in organisational codes of conduct. However, such requirements were only mentioned in the PDs that required/desired professional certification.

Questionnaires

The questionnaire analysis revealed two main findings potentially relating to issues of capability:

1. the demographics of OHS personnel indicated some issues related to OHS training of current personnel

2. the distribution of tasks carried out by site and corporate OHS personnel revealed a large overlap between practitioner/site personnel and management/corporate OHS personnel.

Demographics and training

The average age (46 for site personnel and 44 for corporate) and length of career in safety (11 and 14 years respectively) indicated a generally well-established OHS career path in the mining industry for OHS personnel. The average figures for general education of OHS personnel were also healthy, although there was still room for development (61 per cent of site personnel and 83 per cent of corporate personnel had a university qualification). When it comes to their OHS training, 29 per cent of site personnel and 48 per cent of corporate personnel had university qualifications in OHS, with the majority of the rest having vocational/technical training.

The analysis suggests that there are two cohorts of OHS personnel working in mining companies. One group transferred into OHS roles a relatively short time ago after a career in other functions in the company, sometimes entered from a low level of formal education and relied on mining experience to do their OHS tasks rather than formal training in OHS. The other group is more highly educated, younger and has more years in a safety function, which would appear to be more of a primary career choice.

Questions relating to formal OHS education or other training addressed a range of topics covering risk assessment, control and management. While the responses on average were respectable, with a median of 65 per cent for site personnel and 82 per cent for corporate personnel having followed courses in the specified subjects, there were some significant low-scoring topics for both site and corporate personnel, notably:

- design of monitoring systems for safety performance
- OHS information management
- contractor management
- change management
- consultation with employees (site personnel only).

Such results may indicate areas of capability that are undervalued in mining companies.

Activities

Both questionnaires asked whether the respondents performed a list of OHS tasks and, if so, how often. The wording of the activities was designed to differentiate between typical safety practitioner tasks expected to be found more frequently at the site level and professional safety management activities expected to be found more frequently at corporate levels. The analysis looked to see whether this expected dichotomy of the tasks actually occurred. In general, although there was a trend in this direction, there was clearly a large overlap in tasks between the two levels. Some examples are given as follows.

Corporate occupational health and safety personnel

Over 50 per cent of corporate OHS personnel considered that all of the practitioner tasks were part of their jobs and over 25 per cent said that they carried out those practitioner tasks more often than once a month. Such tasks included:

- visiting sites to observe safety behaviour
- advising on how to comply with detailed workplace safety regulations and company standards
- carrying out routine workplace safety inspections
- writing and updating workplace safety procedures
- monitoring workplace compliance of employees and contractors with safety procedures
- carrying out job safety analysis.

On the other hand, more than 20 per cent of corporate personnel said that the following professional tasks were not part of their job:

- organising periodic strategic management reviews of safety
- benchmarking company OHS performance against other relevant organisations
- designing a systematic OHS monitoring system (a topic they also had little training in)

- coordinating safety management audits
- advising on the cost-effectiveness of company risk controls
- approving the choice of (sub)contractors based on their safety capabilities.

Site occupational health and safety personnel

Over 70 per cent of site personnel claimed that 69 per cent of the professional-level tasks were part of their jobs. These included:

- developing methods to select and assess the adequacy of critical risk controls
- developing plans for safety improvements
- advising on design solutions to critical hazards.

On the other hand, more than 20 per cent of site personnel said that a range of the typically practitioner-level tasks were not part of their jobs, including:

- job safety analysis
- safety training of supervisors and operators
- writing and updating of safety procedures
- writing safety reports on safety statistics and trends.

Comparison of outcomes of analysis of position descriptions and questionnaire responses

The third analysis undertaken compared the results of the PD analysis with those from the questionnaire analysis to identify whether current practice reflected the PDs and vice versa. The findings identified a mismatch between the PD specification and the activities actually undertaken and between PDs and education/training received.

Activities listed in the PDs were generally addressed by activities reported in the questionnaires. However, much activity indicated in the questionnaires was not reflected in PD requirements. Table 3 lists the activities that registered the greatest discrepancy between the level of activity and the PDs.

There was a significant overlap of practitioner activities at the higher levels of the organisation identified from the questionnaire with activities that are not reflected in PDs. This led to issues concerning role clarity that were reinforced in the manager interviews.

A number of apparent anomalies occurred, with relatively high numbers of people indicating that an activity considered as 'core' in the INSHPO framework was 'not part of their job' (Table 4). It may be that in large mining companies, these activities are undertaken by people in designated positions. The important point is to know whether the role is addressed elsewhere within the organisation.

For site-level personnel, a relatively close correlation was found between the training received and the activities undertaken, but a relatively poor correlation between the requirements of the PD and their training. At the corporate/regional level, there was only a loose correlation between training received and activities undertaken and between training received and PD requirements.

TABLE 3

Differences between activity levels and position description requirements.

High/medium activity – low position description (PD) requirement	
Corporate/regional	**Site**
• Advise on occupational health and safety (OHS) culture • Engage to promote innovation • Change management and OHS • Provide advice on compliance • Advise on hazard and risk controls (including critical controls) • Monitor effectiveness of hazard and risk controls • Support and structure periodic management reviews	• Risk assessment/job safety analysis • Provide information on compliance • Monitor integrity of controls • Monitor contractor compliance
High PD requirement – medium activity	
	• Manage/participate in audits

TABLE 4
Activities important in the International Network of Safety and Health Practitioner Organizations (INSHPO) framework but relatively frequently registered as 'not my job'.

Corporate/regional		Site	
Activity	**Position description requirement**	**Activity**	**Position description requirement**
Implement processes for monitoring occupational health and safety (OHS) performance	High	Conduct emergency drills	Low
Manage/conduct OHS audits	High	Manage issue, etc, of personal protective equipment[a]	Medium
Support and structure periodic management reviews	Low	Conduct training	High
Analyse and evaluate information	Low	Use data management systems to collect OHS information	Low

a. This is seen as a supervisor's role in many mining companies.

Managers' perceptions

While the interviews with managers were part of clarifying the vision for OHS capability in mining, it is useful to summarise the views of managers about the current status in this section. The relevant questions put to managers were:

- How satisfied are you with the performance of your OHS personnel?
- What do you they do well?
- What could they do better?

While the number of managers interviewed was small (13) and skewed towards gold mining and North American locations, the outcomes were instructive. Overall, senior managers were divided as to how satisfied they were with the performance of their OHS personnel, although 'in reality, there is a range of performance'.

As a group, managers identified ten functions they considered that OHS personnel did well (Table 5), but they did not differentiate between site and corporate personnel. Response 'maintain the status quo', could be viewed in two ways. Firstly, it could be seen as a positive outcome in that OHS personnel were carrying out those functions that, as a minimum, they would be expected to perform to keep known risks under control. Alternatively, it could be seen as a negative in that OHS personnel were offering little in the way of improvement strategies beyond the status quo. This latter point was supported by one senior manager who said that simply maintaining the status quo limits innovative improvement opportunities.

TABLE 5
Managers' view of current status of the occupational health and safety function.

Currently do well		Could do better
• Strategic planning • Investigating accidents • Maintaining the status quo (ie risk assessments, auditing) • Raising awareness • Creating a safety culture • Marketing • Safety observations • Distributing information about incidents • Distributing information about legislation • Safety training	Corporate	• Rules: less focus on rules and paperwork, simplify rules and streamline standards. • Compliance: move away from 'pencil whipping enforcement' and interact more. • Role clarity: need to understand what is happening at site level but move away from execution role and stop trying to solve site problems. • Strategy: think strategically in a business context.
	Site	• Rules: reduce paperwork, stop writing long procedures. • Compliance: avoid being 'safety police'. • Deliverables: turn systems into deliverables.

Issues identified by managers as 'could do better' tended to relate to one or more of four activities for OHS professionals at the corporate level and three at the site level, with a focus on rules and compliance at both corporate and site levels being a concern. Role clarity was a recurring theme. Table 5 summarises the key activities that managers believe OHS personnel do well and the areas where OHS personnel at site and corporate levels could do better.

A NEED FOR CHANGE

Analysis of PDs, questionnaires completed by OHS personnel at site, regional and corporate levels and interviews with operational managers strongly indicate a need for change to optimise the capability of OHS personnel in mining. The key areas for change are:

- specification of the role in PDs
- role clarity
- knowledge and skills
- education and training
- qualifications.

The key deficiencies or mismatches identified through this analysis are summarised as follows.

PDs

- PDs often do not reflect core OHS functions or the knowledge and skills specific to the role.
- Activities carried out do not reflect the priority areas specified in PDs.

Role

- Emphasis is on compliance, rules and paper-based systems rather than innovation, adaptation, participation and dialogue.
- OHS personnel are seen as good at maintaining the status quo.
- A lack of clarity between site, regional and corporate roles.
- Those that progress from site to corporate roles are often not able to make the transition effectively.

Knowledge and skills

- No recognition of the need for a systematic body of knowledge.
- OHS personnel are not able to enunciate the science of OHS.
- A lack of soft skills.

Education/training/qualifications

- Variations/conflict in advice from OHS personnel leads to a lack of confidence in OHS personnel and the advice they provide.
- Mining experience is often preferred over OHS qualifications and experience, which has the potential to devalue the OHS role.
- Training/education does not reflect the tasks undertaken or PD priorities (especially at corporate levels).

THE VISION

Managers' perceptions

As part of defining the vision of a capable OHS practitioner and professional in the mining industry, managers were asked:

- Suppose you are recruiting a new OHS person at either site or corporate level. What knowledge and skills would you be looking for and how would you delineate the roles and tasks at site and corporate levels?

Role clarity again emerged as a major issue, with senior managers able to articulate and differentiate between the knowledge and skills they required at the site and corporate levels. At the corporate level, senior managers were looking for OHS personnel with leadership skills to be 'strategic thinkers', 'understand how people make decisions' and 'understand the business'. In contrast to

the business and strategy skills required at the corporate level, site-level OHS personnel required knowledge and skills in 'how to execute OHS systems'. In particular, site OHS personnel should 'support, mentor and guide line leadership'.

In keeping with these views on roles, the skill most desired by senior managers for OHS personnel at both site and corporate levels were people skills (often referred to as 'soft skills'). However, the nature of the required people skills was subtly different for site and corporate roles.

Governance was viewed as a key role at the corporate level as well as 'developing robust frameworks and advising people, tactically, on how to do that'. A caveat expressed by one senior manager was that corporate OHS personnel should 'let the concrete cure'. This sentiment harks back to the concern expressed by senior managers that the corporate level saturates the sites with new initiatives, which becomes frustrating and disenfranchising for those on site. It also detracts from the good intent of the initiative, which is not given time to be fully implemented before the next new initiative arrives.

Senior managers were divided on the importance of formal OHS qualifications and mining industry experience. While some senior managers believed that formal OHS qualifications were important, others felt that good interpersonal skills (soft skills) trumped formal OHS qualifications. These senior managers believed that someone with good interpersonal and leadership skills could develop their OHS knowledge 'in-house'.

Mining industry experience was deemed important by some senior managers, while others were open to recruiting OHS personnel from other high-hazard industries such as the chemical industry. This latter group felt that someone coming into the mining industry from the outside would bring fresh ideas on how to manage safety and improve performance.

Table 6 lists some key comments made by managers on the role and required knowledge and skills for corporate and site OHS roles. As this table lists comments made in interviews, it records the areas of concern likely to be uppermost on the managers' minds at the time and is not intended as a complete representation.

Occupational health and safety professionals

Feedback from senior OHS professionals in mining on the outcomes of the analysis of Phases 1 and 2 focused on the need for the OHS professional role to be centred on enabling rather than controlling. Four main themes emerged:

1. OHS maturity
2. change management
3. role clarity
4. qualifications.

OHS personnel need to understand the concept of OHS management and cultural maturity. The OHS capability framework for mining must take account of the varying demands on the OHS role with the various stages of OHS maturity in organisations and in sites within organisations.

OHS personnel at both site and corporate levels need to be skilled in bringing about change. This should be through a coaching approach rather than being directive, but this will depend on the maturity of the organisation/site.

While OHS personnel at the workshop agreed with managers on the need for role clarity between site and regional/corporate roles, they noted that the latter group had to go on-site as part of their role to enable them to understand and keep contact with site issues so that they could make strategic plans relevant to their needs. They commented that the extent of their involvement at the site depended on the skills of the site OHS personnel and line managers. They also introduced a second element in that there may be lack of clarity between the line management and the OHS function.

OHS professionals considered that OHS qualifications were often undervalued in mining. They believed that the knowledge and skills obtained through formal qualifications were essential in acting as a change agent and in being able to enunciate the 'science' and rationale for strategy.

A vision for the occupational health and safety function in mining

As with industry more generally, there are two distinct OHS functional roles required in mining: the OHS practitioner and the OHS professional (refer to INSHPO (2016) for a detailed description

TABLE 6
Managers' perceptions of role and required knowledge for corporate and site occupational health and safety roles.

Identified aspect of role	Corporate		Site	
	Roles/tasks	Knowledge/skills	Roles/tasks	Knowledge/skills
Governance	• Develop robust frameworks and advise people, tactically, on how to implement			
Strategy	• Communication and engagement across sites at strategic level • 'Let the concrete cure!'	• Strategic thinker • Able to turn theory into practice • Understand the business • Understand how people make decisions		
Culture	• Create a culture of safety	• Leadership skills		
Change	• Change expert			
Improve			• Identify opportunities, communication needs	
Mentor		• Emotional intelligence • Understand humans in a more holistic sense • Understand the fallibility of humans	• Support, mentor and guide line leadership	• Demonstrate interest in others • Personality important (ie effective communicators, work through others, enthusiastic, team player – soft skills)
Engage			• Involve people	
Motivate			• Motivate people to behave safely	
Rules			• Write procedures	
Compliance			• Perform task observations	
Systems	• Provide effective occupational health and safety (OHS) systems			• How to execute OHS system
Risk management				• Specific knowledge about risk, first aid, occupational health and hygiene • Risk management
Accountability			• Get things done • Follow-through (ie accountability)	
Other				• Software skills

of these roles and their distinguishing features). While two roles are clearly defined, there are gradations within each role. Both OHS practitioners and OHS professionals are required in mining, and both roles are to be valued.

The OHS professional is a key advisor, strategist and pilot of the organisation's leadership in integrating the management of OHS risk into sustainable business practice at all levels in the organisation. The OHS practitioner has the key role of implementing strategy at site levels, with an emphasis on compliance. The regional/commodity OHS role is a bridge between the corporate and site levels that oversees the implementation of corporate strategy and supports the site as required. The continuum of the roles does not imply that a person may be expected to move from implementer to bridge to pilot as these roles have a different educational foundation[5]. Table 7 presents this vision for the OHS function in mining.

5. When this project was undertaken, most mining companies had a 3-tiered structure: site, regional and corporate. With the change in economic conditions impacting on the mining industry many companies have re-structured to remove much of the regional/commodity functions. It is vital that the 'bridging' role of the regional OHS function is considered in any restructure of personnel.

TABLE 7
The 'vision' for the occupational health and safety (OHS) function in mining.

Organisational level	OHS role	Function and responsibility	Qualifications and experience
Corporate	OHS Professional	• Work as a 'pilot' and 'champion' with senior executives to develop a strategy and framework for managing OHS risks, critical controls and improving business. • Build relationships as a basis for influence, mentoring and providing strategic advice.	• Minimum of a bachelor's degree, preferably in OHS. • Experience working in high-hazard industries that may or may not include the mining and metals industry.
Regional	OHS Professional	• Work as a 'bridge' to oversee the implementation of corporate strategy and framework with an emphasis on critical controls. • Build relationships as a basis for influence with both site and senior management and mentor site OHS personnel, providing technical and practical advice to support implementation of effective OHS risk management and improved operational performance.	• Minimum of a bachelor's degree, preferably in OHS. • Experience working in high-hazard industries that may or may not include the mining and metals industry.
Site	OHS Practitioner	• Work as an 'implementer' of corporate strategy and framework focusing on critical controls. • Build relationships as a basis for influence, mentoring and providing technical advice to enable supervisors and managers to effectively manage OHS risks and improve operational performance.	• Minimum of a vocational qualification in OHS. • Ideally experienced with operations and risks specific to the mining industry.

THE FRAMEWORK

The framework will facilitate a shared understanding of the OHS function in the mining industry, promote a high standard of capability for those in OHS roles and enable the mining industry to clarify their expectations of OHS professionals and practitioners to perform at the corporate, regional/commodity and site levels. The framework has four components:

1. position profiles
2. activity statements
3. knowledge matrix
4. skills statements.

The scope of application of activities, knowledge and skills is different for the OHS practitioner compared with the OHS professional. The sphere of influence of the OHS practitioner will usually be site-based with a focus on middle management, supervisors and workers. The OHS professional's focus will be across the organisation, including site, divisional/regional and corporate. It may also include local, national or global roles engaging with personnel across the organisation, including senior management and external agencies such as regulators and industry bodies.

The framework can be used in:

- developing PDs for OHS roles and to provide a context for understanding how the OHS role can be defined
- in recruitment as a basis for evaluating qualifications of applicants and assessing job applicants as part of assessment tests or interview questions
- as a basis for performance appraisals
- to inform the development of internal training programs
- to identify areas for OHS professional development.

To support implementation, guidelines for use are included with each component of the framework and there is a self-assessment tool and guide to professional development pathways.

An overview of the framework is provided in Figure 1.

Position profiles

The capability framework describes the activities, knowledge and skills for OHS practitioners and OHS professionals. These roles occur within organisations, and the positions of OHS practitioner or OHS professional will have a range of parameters in addition to the OHS-specific components, such as their degree of autonomy and levels of problem solving. There are also gradations in the OHS practitioner and OHS professional positions that reflect the seniority of the position, the demands of the role and the structure of the organisation.

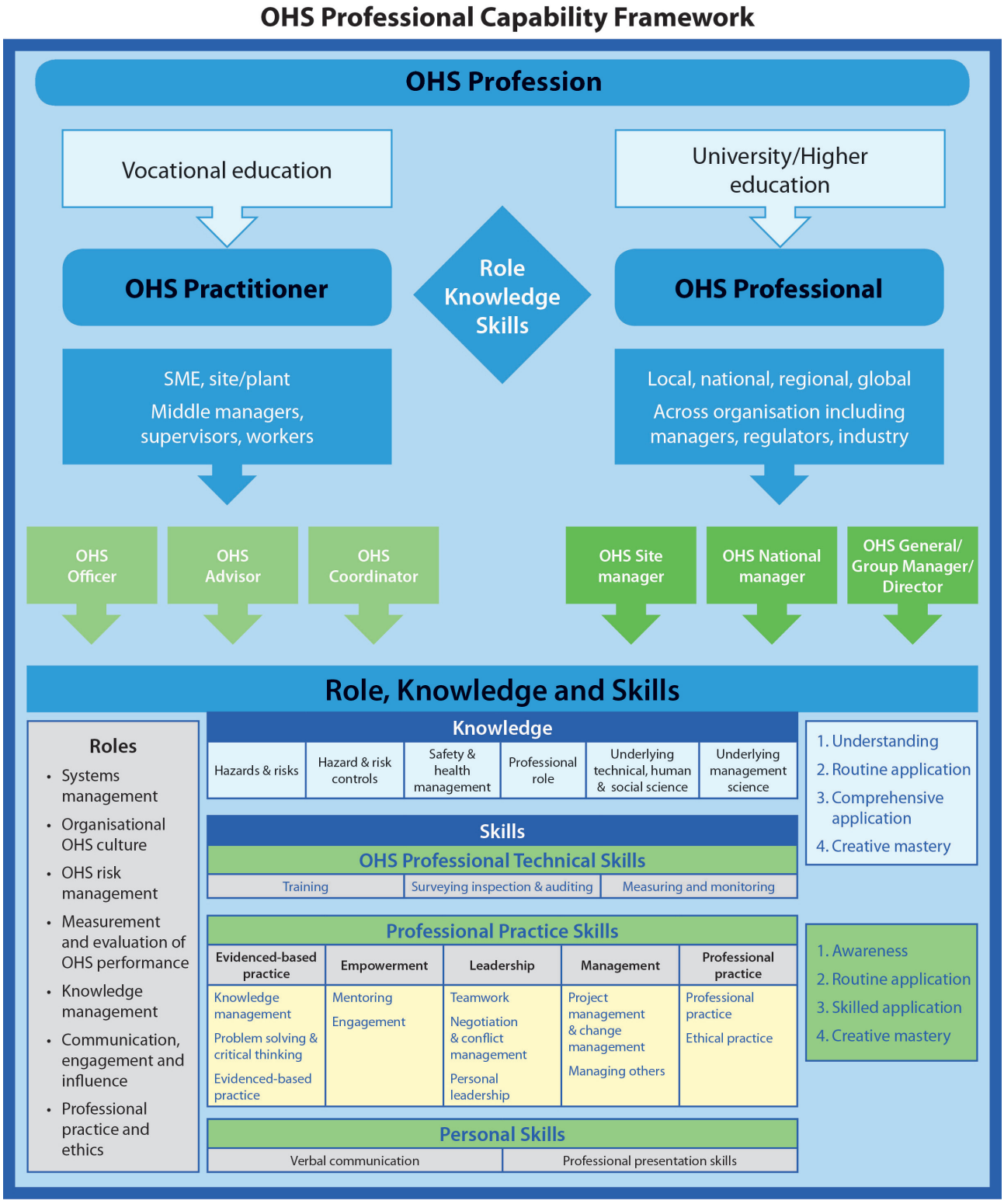

FIG 1 – The occupational health and safety (OHS) capability framework.

The position profiles may be seen as PDs. They do not address OHS aspects of the position in any detail, but they give an outline of the OHS professional and OHS practitioner roles at three levels for each role in terms of:

- position details
- professional parameters
- nature and complexity of knowledge and skills
- qualification and experience levels.

Subsequent to the completion of the project, INSHPO has utilised the generic version of the position profiles to develop an online PD builder that will also be of use to the mining industry.

Activities

The OHS capability framework defines the role of the OHS professional and the OHS practitioner in terms of OHS-related activities. These activities are described at two levels of detail:

1. dimensions – providing the scope of the distinguishing boundaries of the roles
2. domains – describing fields of activity within the dimensions.

Seven dimensions are used to outline the two roles:

1. systems management approach
2. organisational culture and its impact on OHS
3. OHS risk management processes
4. measurement and evaluation of OHS performance
5. knowledge management
6. communication, engagement and influence
7. professional and ethical practice.

The activity statements can be used in a number of contexts:

- as a mapping tool to confirm that key OHS activities are addressed by one or more OHS personnel in the organisation
- as a detailed OHS duty statement as part of a position description
- to create a shared understanding of the role by incumbents, line and senior managers and others
- to identify areas for role expansion and further development of an incumbent.

Knowledge

A conceptual framework and specific technical knowledge is essential for both the OHS professional and OHS practitioner. Such a knowledge base supports innovation, flexibility and openness to new and advancing thinking about OHS. It enables OHS personnel to develop and adapt their professional practice to changing demands of business and society as well as having the understanding to mentor and develop others. Such a knowledge base will be gained through a combination of formal education and experience. However, it is not expected that an OHS professional or OHS practitioner will gain the knowledge through education alone as continuous professional development (CPD) is considered requisite for professional practice.

The knowledge matrix of the framework is described in six areas. Each area has a number of categories with illustrative generic topics indicating the intended scope of the knowledge category. This is described at a high, generic level to allow flexibility in the way that it is applied to suit the legal and OHS context in individual countries.

The knowledge areas are:

- hazards and risks
- hazard and risk controls
- safety and health management
- professional role and functioning
- underlying technical and behavioural disciplines
- underlying management science.

The illustrative topics in the knowledge matrix are annotated at an indicative level to reflect the expected nature and complexity of the knowledge of the OHS professional and OHS practitioner.

The coding is centred on the four knowledge levels based on Blooms taxonomy (Anderson *et al*, 2001), which address the depth, breadth, maturity and integration of the knowledge. These knowledge levels are understanding, routine application, comprehensive application and creative mastery.

Skills

Personal and professional skills are vital attributes for effective practice as an OHS professional or practitioner. Such skills have been identified as a priority in recruitment and a key area of professional development for OHS personnel.

A Bloom-style taxonomy approach has also been used to describe skills in the framework, which are presented in three sections: personal skills, professional practice skills and professional technical skills.

As with the knowledge requirements, the skills have been annotated with a coding to indicate the expected skill level for the OHS professional and OHS practitioner. The coding is based on four skill levels: awareness, routine application, skilled application and creative mastery. The skill descriptions are structured to support self-assessment and peer or manager assessment. They may also provide a basis for training and development, either formal or informal.

Self-assessment tool

A self-assessment tool has been developed based on the activities, knowledge and skills. This tool may be used by individual OHS practitioners and professionals in:

- developing the application of their knowledge and skills in the workplace
- identifying gaps in knowledge and skills as a basis for identifying development pathways
- planning their CPD.

It may be used as part of organisational processes:

- to assess the adequacy of the OHS function
- as part of review processes underpinning the establishment or reorganisation of the OHS function
- as part of performance appraisal processes.

A process for conducting the self-assessment is described, with a key feature being discussion with and input by a supervisor/manager and/or a peer.

INSHPO has progressed the concept of self-assessment to create an online tool that is available to all OHS practitioners and professionals as part of their professional development planning.

Guide to professional development pathways

The guide to professional development pathways provides information to inform the professional development plan. Options for development will depend on the country of operation, the organisation and development objectives. The guide gives an overview of the pathway options and guidelines for selecting formal qualifications to develop knowledge and skills. It also lists competency statements as a basis for professional development through education, in-house or other training, mentoring or self-development. This guide complements the arrangements in well-resourced organisations that will have a range of options for their employees.

SUMMARY

An alliance was formed between ICMM and INSHPO to develop a capability framework for the OHS function within the mining industry. Benchmarking against the *INSHPO Occupational Health and Safety (OHS) Professional Capability Framework – A Global Framework for Practice*, analysis of PDs, questionnaires completed by OHS personnel at site, regional and corporate levels, interviews with operational managers and feedback from global OHS managers identified a need for change. This finding supported the original premise by the ICMM Council of CEOs that the role of OHS personnel in mining should be reviewed and redefined.

A vision for the OHS roles emerged where there were potentially three levels: site, regional and corporate.

The OHS practitioner operating at the site level should at least have vocational qualifications in OHS and some mining experience. They are an 'implementer' of corporate strategy focusing on critical controls. They engage and build relationships with workers, supervisors and line managers, providing OHS technical advice and mentoring to support effective OHS risk management and operational performance at the site.

At the regional level, the OHS professional should have university-level OHS qualifications and experience working in high-hazard industries. They build relationships with both site and senior management and OHS personnel to act as a 'bridge' between the two levels, providing mentoring, technical advice and practical support for the implementation of effective OHS risk management and operational performance.

The corporate OHS professional is the 'pilot' and 'champion' for OHS within the organisation. They should have university-level OHS qualifications, often at the Masters level, and experience in high-hazard industries. Their focus is the development of strategy and a framework for managing OHS risk and critical controls and integrating OHS into the overall business strategy. They inform, mentor and empower managers and others.

By providing position profiles, listing specific activities, outlining the required underpinning knowledge and the personal, professional and practice skills and providing advice on implementation, the OHS capability framework for mining provides a framework and road map for individuals and organisations to achieve this vision.

ACKNOWLEDGEMENTS

INSHPO has 14 member organisations across 11 countries and is a forum for international collaboration among OHS professional organisations to improve safety and health at work. INSHPO started from an appreciation that occupational safety and health issues and concerns are not limited by national borders. However, practicing OHS generalists and country-based professional bodies often lack the facility to influence policy makers on a global scale and establish effective, mutually supportive international networks and address concerns of common interest. The American Society of Safety Engineers currently acts as the secretariat for INSHPO.

ICMM is an international organisation dedicated to improving the social and environmental performance of the mining and metals industry, with membership comprising 23 mining and metals companies and 34 regional and commodities associations. Founded in 2001, it is the direct result of a multistakeholder initiative called the Mining, Minerals and Sustainable Development Project.

INSHPO thanks the Industrial Foundation for Accident Prevention, Australia, which provided funding for travel for the initial meeting with ICMM to explore the feasibility of the project and alliance.

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Functional safety impacts on study stages of major projects

M C Goode[1]

ABSTRACT

The use of electrical or electronic safety systems to protect personnel, and the engineering tasks associated with the design, manufacture and maintenance of these systems are referred to using the term 'functional safety'. In the past ten years, the use of such systems has transitioned from its traditional base, in oil and gas major hazard facilities, to being a part of most large mining and materials handling projects. In particular, functional safety is rapidly becoming a significant component of Australian iron ore projects, typically in the form of emergency stops, remote isolation, drive through interlock, robot cell entry or mobile machine anti-collision systems. While these types of systems have been in use in iron ore for a long time, functional safety standards (eg AS61508, AS62061, AS4024.1503) require more rigourous demonstration of the level of risk reduction provided by the systems.

The early engineering project development phases require a number of key decisions to be made around functional safety implementation. The decisions made at this point in a project will go on to dictate the required types of risk assessment and analysis, equipment selection, sizing of substations, and training and maintenance requirements for owners. For project teams that are unfamiliar with functional safety, or inexperienced in its application, an incorrect decision or failure to understand the requirements of the chosen standard can lead to a failure to meet contract requirements, as well as major cost and schedule overruns.

This paper examines the implications of functional safety on early engineering studies, focusing on the following questions: How does a designer or company determine what standard is best suited to their project? What key aspects of functional safety design need to be considered during project development? And finally, how can the impact of functional safety to the project be minimised?

INTRODUCTION

What is functional safety?

The use of electrical or electronic safety systems to protect personnel, and the engineering tasks associated with the design, manufacture and maintenance of these systems are referred to using the term 'functional safety'. Standards such as AS61508, AS61511, AS62061 and AS4024.1503 are typically applied to the design of such systems, and the application of these standards can present a steep learning curve to project teams.

The adoption of functional safety in the mining industry is being driven by two aspects; a changing regulatory and legislative environment, and changing safety attitudes in large businesses. Standards developers have been gradually moving away from prescriptive standards (in which a specific design is dictated by the standard), toward performance based standards (in which the designer must prove that their design is able to meet specific performance criteria) (Gruhn and Cheddie, 2006). This shift in the approach taken by standards has coincided with a greater focus on personnel safety by major mining companies, which are now starting to require compliance with functional safety standards on new projects.

The importance of early decisions

The final approval of a major project in the Australian iron ore industry is driven by the project development phases shown in Figure 1. The aim of these phases is to ensure that the proposed projects align with current business strategy as well as provide confidence in long-term asset viability (Wittig, 2014).

During the project development phases the first work on functional safety will begin, and it is at this point that the first key decisions are being made regarding functional safety approach. Paulson (1976) introduced the concept of the cost-influence curve, from which Figure 2 has been adapted. The curve shows the increasing cost of rework as the project proceeds, as well as the reduction in influence of the designer over project and ongoing life cycle costs. When compared to the error rectification cost for initial project stages, the cost in the construction phase is up to 26 times larger, in the testing/commissioning phase up to 177 times larger, and in the operations phase 1615 times larger (Stecklein *et al*, 2004).

The escalation in cost as the project proceeds is particularly relevant in iron ore when considering contracts for long lead items (eg mobile machines, car dumpers). In some cases, contracts for long lead items may be awarded prior to the completion of all project development phases to avoid

1. Principal Consultant, Black Ice Systems, Osborne Park WA 6017. Email: matt.goode@blackicesystems.com

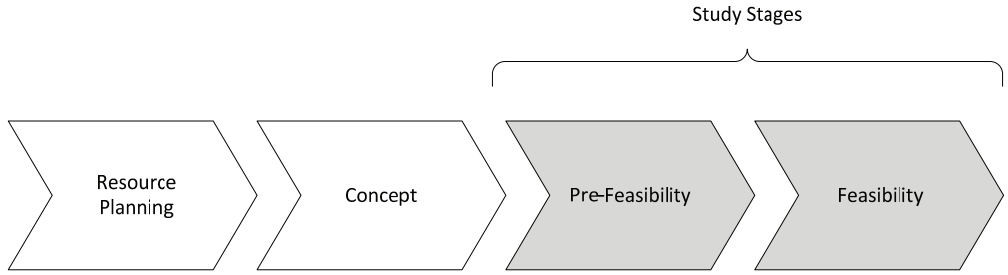

FIG 1 – Major project stages (Wittig, 2014).

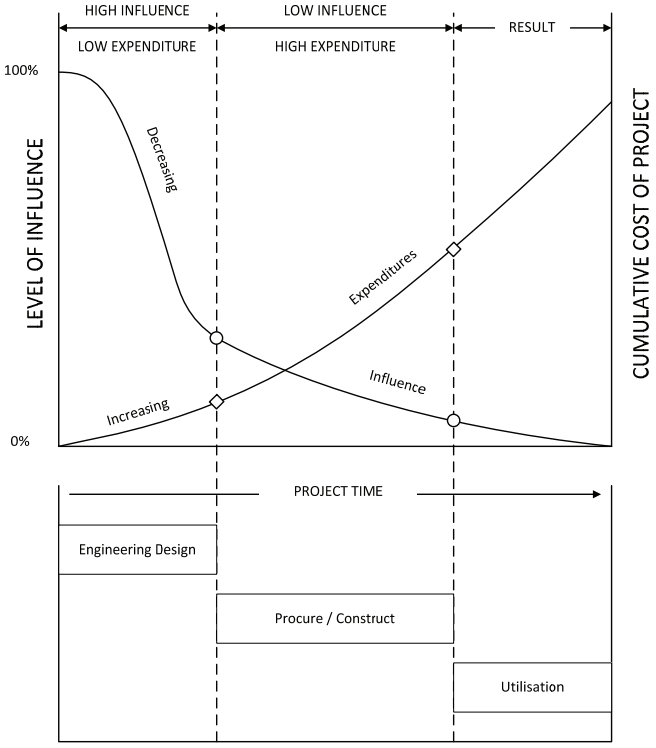

FIG 2 – Cost-influence curve (adapted from Paulson, 1976).

impacting the overall project schedule. Consequently, the contracts for these major equipment items will progress more rapidly through the influence/cost curve than the main project, requiring the key decisions to be made earlier in the project.

In addition to the cost implications, early decisions take on additional significance for functional safety as they begin to influence the maximum safety integrity level (SIL), a measure of risk reduction, that a given design can achieve. For example, a project team may select contactors and medium voltage circuit breakers during feasibility studies that are not suitable for use in safety functions (due to failure rate or other considerations). The total project cost of incorrect early equipment selection can be extremely large; a given safety function may require dual contactors, additional means of tripping or different components, which may mean that substations are not large enough. This can result in facility siting changes, rework of drawings and other significant knock-on effects.

KEY FUNCTIONAL SAFETY DECISIONS

At the earliest stage of a project, whether it be greenfield or brownfield, there are some key questions to be answered which set the tone for much of the subsequent work:

- What is the corporate risk criteria for safety systems?
- Which standard will be applied?
- Which parties will have responsibility for each section of the life cycle?

Brownfield sites must additionally consider how legacy systems and designs will be approached, however this is outside of the scope of this paper.

Corporate risk criteria

Corporate risk criteria often exist as a risk matrix, however to use many techniques for establishment of SIL targets these must be translated to detailed quantitative safety risk criteria. Specifically, for each type of consequence where safety systems would be required, a tolerable risk frequency needs to be specified. This information is additionally useful as it allows risk reduction effort to be focused in the most critical areas (Centre for Chemical Process Safety (CCPS), 2009).

For iron ore projects, which generally involve very large equipment and forces, the tolerable risk frequency must capture single and multiple fatality consequences. There are several sources in the literature (Frank and Jones, 2010; Frank, 2011; Shah and Moosemiller, 2012) which can provide context to assist decision-making when establishing corporate risk criteria.

Standard selection

Choosing an appropriate standard for an iron ore site can seem like a daunting task; the typical list to be considered includes:

- AS61508
- AS61511
- AS62061
- AS4024.1501
- AS4024.1503.

Equipment manufacturers can select any standard from the list above, although their choice may be limited by specific project requirements. However, for owners, we consider that AS61508 is the most logical choice, as only it provides a complete view of the requirements around functional safety management, auditing, operations and maintenance and decommissioning.

For some sites and projects, it may be required, or desirable, to use a mix of safety standards. This situation arises when a project is purchasing equipment or systems that are already built or certified to a given standard – which may include robotic sampling systems, isolation systems or other supplied packages. Mixing different standards may also be driven by competence considerations of vendors, for example, if a vendor has greater experience in implementing an alternative standard which is still acceptable to the owners.

In most cases the same functional safety management plan developing in line with AS61508 can be used when maintaining and managing systems developed using any of the other standards.

Safety integrity level determination method

Where AS61508, AS61511 or AS62061 are used for a project, there is an additional decision to be made regarding the SIL determination method. While AS62061 provides an option for use of a risk graph, each standard allows a range of different SIL selection techniques (AS61508.5, 2011). In many instances, the techniques which are quicker to execute will produce a higher SIL requirement, often with a higher overall cost for the function.

For projects in which there are many scenarios to be evaluated, or where the company is likely to evaluate scenarios across multiple projects in the future, a calibrated risk graph in line with corporate risk criteria is may offer the best approach. The various forms of calibrated risk graphs, such as proposed 'improved risk graphs' (Baybutt, 2007), require time and appropriate engagement at a corporate level to establish. Once calibrated risk graphs are approved for a company they can be used as a valuable screening method for safety functions, with further analysis performed using more refi ned methods, where required. It should be noted that simplifi ed analysis techniques such as the calibrated risk graph have received criticism as they are unable to account for multiple initiating events and corresponding mitigations (Baybutt, 2014). To account for these considerations, layer of protection analysis (LOPA) and related techniques are required.

More complex techniques, such as LOPA, allow credit to be taken for additional protection layers which may be present in a design, providing a means to demonstrate that a lower SIL is required. LOPA additionally supports analysis of scenarios in greater detail than risk graphs or risk matrices (Baybutt, 2014). LOPA must be applied with great care; a study reviewing the quality of LOPA assessments by the UK Health and Safety Executive (Chambers, Wilday and Turner, 2009), following the 2005 Buncefi eld disaster, identified mistakes and variations in quality within LOPAs performed by companies and consultants. This study reinforces that careful consideration is warranted when determining the individuals entrusted with performing these critical activities.

Responsibility for safety life cycle

Study teams may include representatives from groups including the owner/end user of the facility (collectively referred to as 'owner' throughout this paper), in house engineering team/contract engineering team (collectively referred to as 'engineer' throughout this paper), equipment suppliers, manufacturers and consultants. Responsibility for each stage of the life cycle must be assigned to one or more of these groups, and the responsibility must be clearly communicated to all stakeholders.

Allocating responsibility for these stages is a balance between maintaining the owner's and engineer's control, and allowing the vendors suffi cient freedom to produce an optimal design while managing costs. Given the safety life cycle in Figure 3, it is possible to approach handover between the owner and vendor in different ways.

Control

In cases where the engineer and owner complete more stages of the life cycle (this may include stages up to and including life cycle stage nine in Figure 3) it is possible for them to have more control over the fi nal design of the safety system. This control may be desired in cases where there are many vendors providing safety systems, and the owner desires consistency between selected SILs, risk assessment processes, or hardware and other equipment used.

The other consideration when performing more stages of the safety life cycle is that the owner implicitly assumes more responsibility for the design. If a system fails to perform due to inadequate requirement specification, the cost of rectification will generally fall on the engineer and owner as they performed stages 1 through 9.

Competence

When allocating responsibility for each stage of the safety life cycle, it is important to consider the competence of the individuals or groups involved. When more life cycle stages are performed by the vendor they must have a greater level of competence covering a broad range of skills and activities.

Critically, risk assessments must be led by competent individuals, and the quality must be suitable for proceeding with SIL selection (adequate detail, all significant consequences captured, all causes captured, enough detail to understand scenarios). The importance of this is demonstrated clearly by the BP Texas City refinery disaster where incomplete, poorly understood risk assessments, and poor competence in risk and hazard assessment were identified as being contributing factors (Chemical Safety Board (CSB), 2007).

Communication

Communication between stakeholders is critical throughout the project including the tender/award process. When managing a project that includes functional safety work, it is essential that any elements which include functional safety aspects be carefully structured. Major iron ore projects are comprised of many contracts, the following list provides examples of some of the contract roles which may include functional safety responsibilities:

- site electrical installation / commissioning
- control systems development / installation / commissioning
- design and construct packages (car dumpers, mobile machines)
- electrical design / installation / commissioning
- training development
- operation contracts (for own and operate facilities on-site)
- maintenance contracts.

Several of these contracts are likely to be tendered or awarded during the project development phases and it is important that the responsibilities involved are clearly communicated. Any parties involved in tendering or executing these contracts will need clear functional safety requirements, including standard selection and life cycle stage responsibility, to enable them to accurately assess scope, cost and schedule.

Another critical project initiation task is determining the order of precedence of the various documents and requirements. It is possible for confusion to arise through conflicts between requirements from project documents, project standards, and international or Australian Standards. One illustrative example that can create this issue is the use of a 'preferred equipment' list. A vendor may choose to cost a project based on adhering strictly to 'preferred equipment'. However, using a preferred equipment list may result in a safety function being unable to achieve the specified SIL. Consequently, confusion may exist as to the party responsible for the failure to meet the SIL; the vendor for failing to deliver a compliant design, or the preferred equipment list author(s) for failing to select equipment able to achieve the requirement.

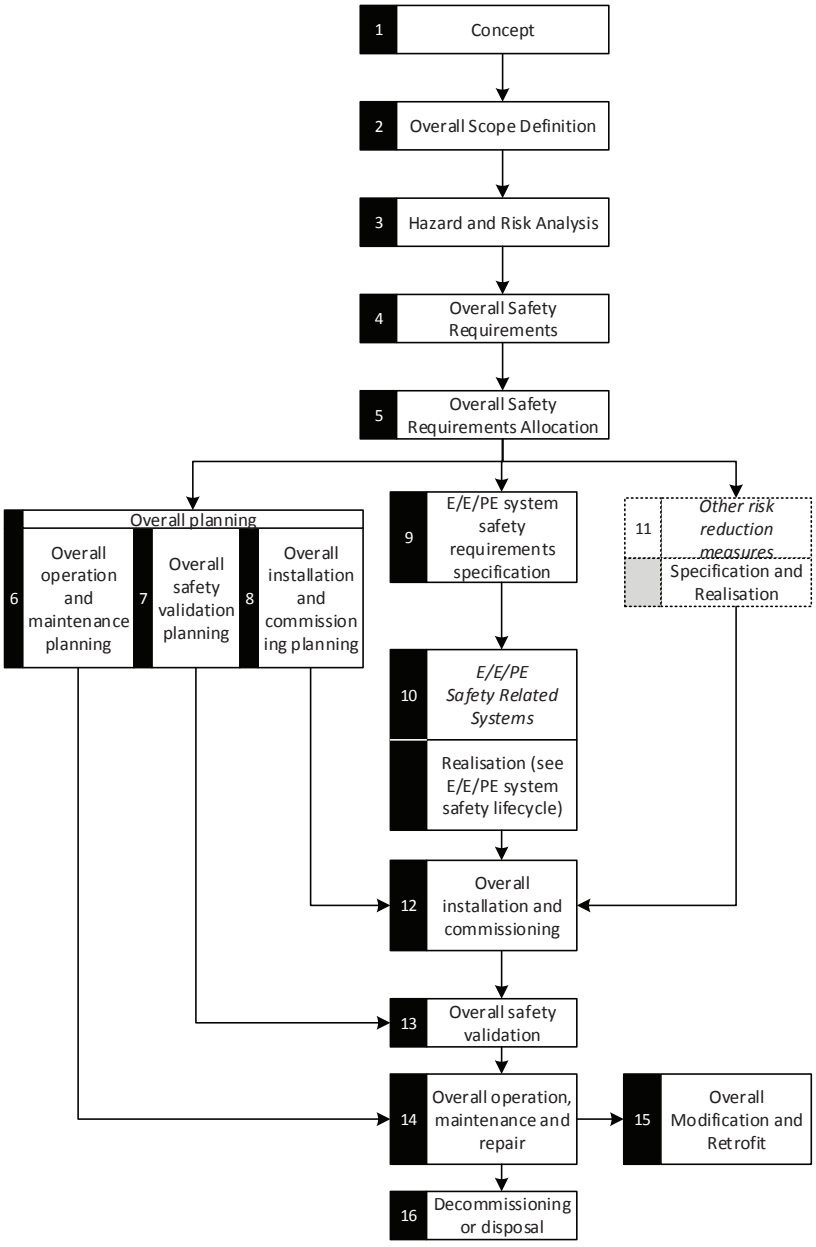

FIG 3 – Safety life cycle (adapted from AS61508.1, Standards Australia, 2011).

MINIMISING THE IMPACTS

For owners and engineers, the most effective approach to mitigating potential cost and schedule impacts is to commence project development with a complete functional safety management plan that details methods for engagement and communication with contractors, as well as any specific requirements to be enforced through the project life cycle. Establishing this plan and communicating it to vendors and other stakeholders provides an effective starting point for project execution with less opportunity for unexpected changes later in the project cycle, where they will have a greater cost to correct (Stecklein *et al*, 2004). Consideration should always be given to whether tenderers have the necessary competence to execute the life cycle stages which have been allocated to them. This process should consider the tenderer's previous history with functional safety, the complexity of the application, and the level of consequence of the hazard.

For vendors working on projects which include functional safety it is critical that they request the project standards, and functional safety approach prior to starting the project. In the absence of this information, documenting the selected approach to be followed will provide a clear basis for price and schedule. Having a documented plan will also act as a prompt for customers to ensure that they have supplied the information necessary for effective implementation of functional safety.

Safety in design

When implementing functional safety, the use of 'safety in design' is an essential part of managing the cost of a safety implementation. An effective safety in design program should identify key risks and address these in a manner consistent with the hierarchy of control as shown in Figure 4. This approach will minimise the number of safety functions required, allowing designers to focus on the areas where a safety function is the best method for reduction of risk.

As identified by Stecklein *et al* (2004) and Paulson (1976), addressing design challenges has a larger cost impact as the project progresses (Figure 2). When considering the role of safety in design versus functional safety, the impact can be more pronounced. For example, consider a plant which

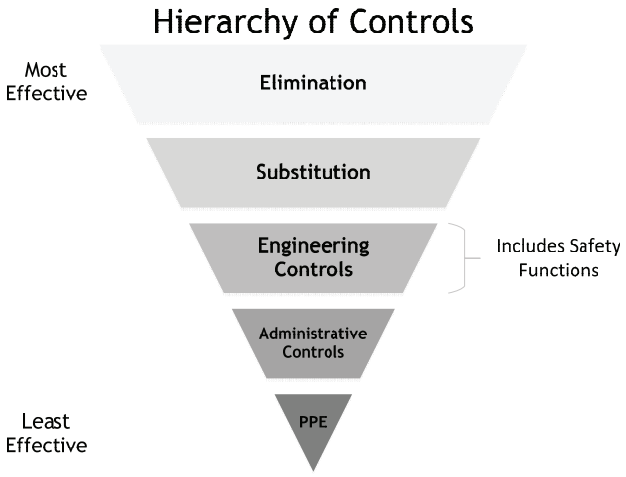

FIG 4 – Hierarchy of controls.

includes a conveyor crossing a roadway. A functional safety solution would involve the ongoing life cycle cost of safety functions to manage the risk to road users. Comparatively, routing of the road so that there is no crossing, if decided upon sufficiently early in the design process, may reduce the total life cycle cost while also providing a safer solution.

Functional safety can often be portrayed as prohibitively expensive, however in many cases the costs in question are due to a failure to implement a safety in design approach. To effectively implement a safety in design process it is essential the risk assessment portion of the project both commences as early as possible (including high level risk assessments on concepts, facility siting, and similar issues), and provides sufficient breadth and depth of hazard identification.

CONCLUSIONS

While the principles of functional safety are beneficial in developing safer sites, a careful approach is required to minimise the cost and schedule impacts of functional safety on the project. Many of the decisions which control these impacts are made in the early project studies, often prior to functional safety being considered. Making effective early decisions around risk assessments, and development of a functional safety management plan, make it possible to deliver a project with a lower cost while providing a safer work environment.

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Focusing on the critical few risks – ensuring control effectiveness through accountability

D L Head[1] and A M Masciangioli[2]

1.Principal Consultant, Riskcom Pty Ltd, Kew, 3101. Email: darren@riskcom.com.au
2.Director and Principal Consultant, Riskcom, Kew, Victoria, 3101.
Email: anthony@riskcom.com.au

ABSTRACT

Critical risks (associated with major hazards) can often be seen as a complex set of problems that seem to be unrelated and can result in boards, executives and senior managers being overwhelmed and exposed as the business struggles to address its issues across many competing risk priorities.

So how can we manage this?

Firstly, an organisation must identify and understand the critical risks that the business is exposed to. The concept of risk lends itself to the Pareto principle, which helps a business to focus on what matters. That is; 80% of a business' risk profile is related to 20% of its risks (i.e. the critical few). Given this, it is appropriate for a business to focus on the 'critical few' rather than the 'trivial many' and to drill down deep into the causal pathway of these 'critical few' to ensure that effective controls are implemented.

We must then understand the organisation's (including the boards', executive's and senior manager's) appetite for effectively managing these 'critical few' risks.

The appetite for managing these 'critical few' risks is a function of the organisation's culture driven by the strength of management to manage risk and we must understand what motivates (or demotivates) the board, executive, senior managers and employees to implement (or not) the relevant system requirements including activation of the critical controls when required.

The process of effectively managing critical risk is twofold:

1. Define the major hazards, assess the risks, develop the controls and implement them; and
2. Build accountability for these controls to codify effectiveness that is equivalent to accepted business accountabilities such as production, share market performance and profit. The safety performance of an organization must become an 'On Time Running Factor' (OTRF) and have a consequence for failure.

When management and boards are truly held to account for the effectiveness of these controls, then organisations have an opportunity to develop a culture that will enable a business to effectively mitigate and manage its risk profile and optimise its business performance and consequently "optimise value".

INTRODUCTION

"To prevent fatal and catastrophic events from occurring – the critical controls must be clearly defined and understood, with clarity as to who is responsible for implementation. A critical control management approach is an effective way of achieving this, by focusing risk-management on those controls that are most critical for health and safety". International Council on Mining and Metals "Critical Control Management",

The Australian Iron Ore industry is one of Australia's largest export earners and the world's largest exporter of iron ore (by some margin). Unquestionably an industry of both national and global significance.

For many years now, the mining industry and in particular the Iron Ore industry has invested tens of millions of dollars into safety and whilst there have been significant improvements to the safety performance, fatalities are still occurring.

Why is this so?

To prevent fatal or other catastrophic events such as tailings dam failures from occurring – the major hazards of a business must be understood, the necessary critical controls must be clearly defined and implemented and there must be clarity as to who is *accountable* for effective implementation and monitoring.

A critical control management (CCM) approach is an effective way of achieving this, by focusing risk management on those controls that are most critical for health and safety.

There is very little that could be considered new or unknown with respect to hazards associated with the mining industry. In Australia, mining hazards have been formally identified, documented and communicated throughout the industry for over 25 years now. Western Mining Corporation first developed the so-called 'Major Hazard Management Standards' in the 1990s following years of fatalities and frustration with the safety performance of the company. Many of these hazards have been identified and prescribed in a number of State mining legislations as well as in the National Mine Safety Framework.

So, for us today, there are few excuses for the occurrence of serious incidents in our industry.

This paper builds on practices and ideas published by the ICMM and based on the significant work of Jim Joy and the ICMM as the authors believe that their documented methodology is elegant, simple and effective (see Figure 1 below).

Our challenge is to build on their work. In this paper, we explore the significance of accountability (Step 6 in Figures 1 & 2 below) as we believe that if a company has an ineffective accountability process, Step 6 becomes the weakest link in what is otherwise a strong chain of control.

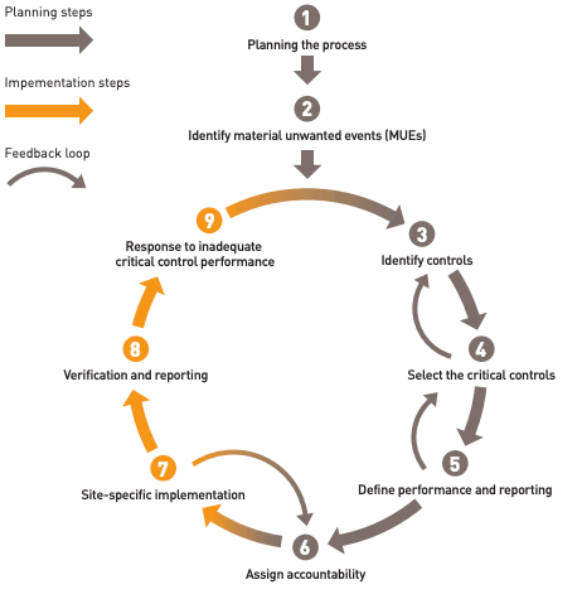

Figure 1: ICMM Critical Control Management Process from the ICMM Health and Safety Critical Control Management Good Practice Guide

In order to make the next 'leap' in safety performance, we believe that the accountability link must be called out and addressed by our industry no matter how uncomfortable and unpleasant.

It is our contention that despite all of the technical knowledge developed about hazards, the significant advancements made with comprehensive risk management techniques, extensive safety management systems, the changes to legislative frameworks and the extensive use of safety themes such as 'zero harm' by companies, there remains one reason that above all else explains why we continue to injure if not kill our workers; it is the result of a lack of accountability for effective critical safety controls.

	STEP	TARGET OUTCOME
Planning steps	1	A plan that describes the scope of the project, including what needs to be done, by whom and the timescales.
	2	Identify MUEs that need to be managed.
	3	Identify controls for MUEs, both existing controls and possible new controls. Prepare a bowtie diagram.
	4	Identify the critical controls for the MUE.
	5	Define the critical controls' objectives, performance requirements and how performance is verified in practice.
	6	A list of the owners for each MUE, critical control and verification activity. A verification and reporting plan is required to verify and report on the health of each control.
Implementation	7	Defined MUE verification and reporting plans, and an implementation strategy based on site-specific requirements.
	8	Implement verification activities and report on the process. Define and report on the status of each critical control.
	9	Critical control and MUE owners are aware of critical control performance. If critical controls are underperforming or following an incident, investigate and take action to improve performance or remove critical status from controls.

Figure 2: ICMM critical control management steps and target outcomes from the ICMM Health and Safety Critical Control Management Good Practice Guide

Critical risk, Critical Control, Major Hazards and Critical Unwanted Events (CUEs)

For the purposes of this paper, a critical risk is the risk associated with a major hazard. A major hazard is something that has the potential to cause harm to people, the environment or the business and has the reasonable potential to result in a fatality or multiple fatalities if people are exposed to the hazard. A CUE is an event caused by exposure of a person or people to a major hazard.

A critical control is crucial to preventing and/or mitigating a CUE caused by exposure to a major hazard. For a control to be considered 'critical', it must have the ability to prevent the hazard impacting a person and when it is effective, would reduce the risk to as low as reasonably practicable.

Table 1: Definitions of key terms

Key Term	Definition
Major Hazard	Something that has the potential to cause harm to people, the environment or the business and that has the reasonable potential to result in a fatality or multiple fatalities.
Critical Risk	Is the risk estimated for exposure to a major hazard.
Critical Control	A control that prevents, as low as reasonably practicable, exposure of people and/or mitigates the consequence of exposure to a major hazard.
Critical Unwanted Event	An event caused by exposure of people to a major hazard.

Hazard Identification and Risk Assessment

We will not deliberate the details of the process of hazard identification here other than to provide a brief outline. The reader is referred to the ICMM's 'Health and Safety Critical Management good practice guide'.

Once the decision has been made to adopt the process of critical risk management on a site, the organisation needs to identify those hazards that can be reasonably expected to result in a CUE. Figure 4 below illustrates the separation of the major hazards from the many others that businesses face.

The site hazard register would be reviewed initially by a team of appropriately skilled and knowledgeable people who have the experience to determine whether certain hazards could

reasonably be expected to give rise to a CUE. For example, the site may utilise concentrated sulphuric acid within a processing operation. The volume of sulphuric acid on site maybe greater than 50,000 litres. If this acid comes in to contact with an employee's skin or the vapours inhaled, serious burns are almost certain to occur. With sufficient burning of the body, it is reasonable to expect that death of the person is likely to occur. In this example, the unplanned exposure of a worker's skin or vital organs to concentrated sulphuric acid (as a liquid or a vapor) would be considered a 'CUE' and hence critical controls are required to:

- be implemented to reduce the event occurring to as low as reasonably practicable; and
- effectively mitigate the consequences if the event were to occur.

There is no need to go into detail here about the appropriate risk assessment tools that would be appropriate for this assessment but suffice to say that it would be reasonable to expect that the assessment would be undertaken to determine the various causal pathways and contributing factors, potential escalation pathways and the existence of mitigating controls should the event occur. Importantly, it is expected that the effectiveness of the current controls would be assessed, and it would also be reasonable to expect that an organisation would have a process in place to document the effective controls that need to be in place to prevent this event.

Assessing the Controls and Selecting the Critical Few

A risk assessment will have defined many contributing factors in a relatively complex causal pathway for a CUE. Given that the aim of critical risk management is to ensure control effectiveness of major hazards, a business must decide which of the controls constitute the critical ones.

A critical control is essentially the one (or ones) that with them, the event would not have occurred or at least, the likelihood and consequences would have been significantly reduced e.g. reducing the consequence from a fatality to a lost time injury. For example, in our plant with sulphuric acid, non-destructive testing of the tank integrity would be considered a critical control in protecting workers from coming in to contact with sulphuric acid.

The importance in being able to identify specific critical controls is that someone can be made accountable for verifying the effectiveness of the controls. This is very different from being responsible for the whole plant. Accountability cannot be delegated but we will come back to this point later.

On Time Running Factor (OTRF) or the 3 Ps (Production, Profit & Share Market Performance)

Despite company claims and statements like 'safety is the number priority' and 'our goal is zero harm', workers often tell a different story. It is common that workers distrust corporate safety slogans as they see a different reality of what the 'real' priorities and goals of business are. They see the behaviours and actions of management, they hear the comments and they understand the priorities.

They know that production outcomes like tonnes out of the gate are crucial; they know that machine down time does not pay the bills; they understand what is 'really' important to management and it is not necessarily safety. Productivity and down time are the factors that meet the definition of 'on time running' and this can give rise to the 'production-safety paradox' where there is an imbalance of priorities – a priority of production over safety.

Hopkins (2004) discussed the concept of 'on time running' (the OTR factor) with respect to the NSW railways. The organisational need and pre-occupation with achieving 'on time running' together with an individual's understanding of the importance of "on time running" can often contribute to the failure of many OHS systems leading to loss or injury. Business outcomes are achieved at the expense of safety.

The OTR factor (the OTRF) defines the primary business drivers or purpose of the organisation that most employees would relate to and understand. Whether this is the number of tonnes of iron ore railed in 24 hours or the number of trains arriving at and leaving the station on time for the railways.

Figure 2 Schematic diagram illustrating the separation of the critical few from the many other hazards

Helping achieve production goals for an individual, i.e. achieving the OTRF, helps to define who that person is (at least in the workplace) and how they are perceived by their supervisors, peers and workers. The effect of the OTRF on an individual may also help determine an individual's status within the company which may be largely determined by their input to achieving production goals. That said, we can begin to appreciate the motivating force of the OTRF on an individual's behaviour within an organization and this may even provide insight as to why individuals sometimes break the most logical and basic lifesaving safety rules.

If the achievement of production goals (or the OTRF) is important to people, then businesses can benefit by understanding this and use this important factor as an opportunity to positively motivate safety performance. The knowledge of the OTRF is a powerful tool for organisations to use to motivate employees to succeed as are consequences of failing to meet production goals.

Through experience, it often seems that safety procedures and safety law are seen as 'discretionary' by many management teams particularly when lined up against the business need to achieve the OTRF. This gives rise to the production-safety paradox.

Now, no-one is going to admit this, but we have no doubt that many management teams faced with a situation that has the potential to directly negatively impact the three Ps will often defer to a position that protects the OTRF. They complete a mental risk assessment of the situation and decide that if the likelihood of a negative outcome appears to be minimal, then in the interests of the business (i.e. OTRF) it is worth proceeding with an activity without necessarily understanding the risk.

This is not a formal process, there is no evidence of it occurring, in fact there may be hard evidence of a far more cautionary approach, but the reality is that a decision is made to maximise the potential to achieve the OTRF even if the risk of injury is unacceptable.

This behaviour is not restricted to management teams. For example, there have been many underground workers struck and killed by falling rock when venturing out into unsupported ground.

These are often highly skilled and experienced operators that are well trained and aware of procedures. However, it appears that if in the individuals' experience, the worst-case negative consequence is unlikely to occur when compared with the best-case positive consequence (i.e. get production going again) which is far more likely to occur, then a person is likely to take the risk even if it is with their own life. Positive feedback, being seen as a 'winner' by your colleagues and feeling a sense of pride and achievement because of the appreciation and respect received from your boss for getting the job done can be a powerful and heady drug that motivates people.

Managing this drug is the responsibility of management and someone must be held to account.

Making Critical Control an OTR Factor

Often, the expectation of a business is that the HSE Manager and department will ensure the effectiveness of the safety management system and its controls. The irony (but correctly) here is that it is rare that the HSE manager or the department has the delegated authority to make decisions to manage safety in the production environment. This is because many safety controls or initiatives can invariably adversely impact on production and cash flow which are the responsibility of a production manager.

Typically, decisions impacting production and cash flow (i.e. the OTRF) are generally set aside for managers that are responsible for these outcomes and for a mine, includes; the Mining Manager, the Processing Manager, the Maintenance Manager and the General Manager. This is reasonable as these people are also responsible for those workers actively engaged in operating plant and equipment to achieve the production and cash flow targets.

It follows then that because these people are responsible for production, they must also be directly accountable for the safety of these workers and this includes the systems that are provided as part of ensuring a safe place of work.

A general safety responsibility will be included within a manager's position description, but it will likely be missing the explicit accountability for ensuring that specific safe systems of work are implemented and effective. Too often safety is merely included within the responsibilities of a role and will be padded with statements like:

> *"providing the ongoing integration of work health and safety principles into work practices and the ongoing commitment of resources with effective consultation and communication between all workers".*

Safety maybe also be 'measured' for managers by the use of lagging indicators such as LTIFR or more progressive organisations may utilise leading indicators such as the number of inspections completed, meetings attended, or corrective actions implemented.

To assist in achieving these outcomes, the organisation will normally have support areas including Human Resources and HSE to assist managers to achieve these expectations. There will be training opportunities, procedures and policies developed, equipment will be designed, purchased and maintained to both carry out a task and the environment may be modified to make it more productive and safer for the employee.

We argue that specific aspects of safety (that is the critical controls) need to be made an accountability and applied to a single person. The accountabilities must be 'smart' (specific, measurable, achievable, realistic and time bound) with respect to safety and they must carry equal weight when assessing an individual's performance as do other business metrics used as KPIs.

Assigning Accountability for the Critical Few

"Investigations, after the fact, typically show that controls for known risks were not effectively *implemented. Often as a result of dense and complex safety management systems and hazard management plans or procedures that prove to be difficult to implement or lack clarity as to which controls are most important". From the ICMM Health and Safety Critical Control Management Good Practice Guide.*

We have previously discussed the importance of the OTRF in driving not only the behaviour of management teams but also employees. We should add that we see nothing wrong in having an

obsession with achieving the OTRF, after all, organisations exist to make money and that is an honourable outcome for without it, we would not need to employ people.

However, we argue that the concept of the OTRF must be expanded to include critical control effectiveness (CCE). CCE must become a factor that is considered when employees or managers alike are confronted with a decision that will impact the 3 Ps. Everyone in an organisation must understand that the consequence for not ensuring effective critical risk controls can be the loss of job.

The more senior that you are, the more serious the consequence.

History tells us that the improvements that have been made in safety over the past 30 years has helped to reduce the number of fatalities, but we have not eliminated them within our industry. Our industry cannot keep doing what we have been doing and expect a different outcome. We must do something different.

We believe that the 'something different' is to assign personal accountability for the successful implementation and availability of a range of critical risk controls to an individual. This person will be personally responsible and accountable for ensuring specified site critical controls are maintained and will be available and effective when required.

How an organisation chooses to measure an individual's performance in this area is their choice. What should not be left to choose is the direct linkage of a significant percentage of a person's remuneration and ultimately their position to the effectiveness of the controls. Their role will be at risk in terms of the maintained effectiveness of these critical controls.

Measurement of Critical Control Effectiveness

The measurement of CCE should be assessed by a third-party audit (bi-annually) and internally bi-annually (that is the controls will be audited every three months).

The outcome of the third-party CCE audits is to use the results to measure the accountable person's safety performance. We do not believe that the use of measures such as LTIFR or number of workplace inspections alone are appropriate to measure a manager's safety performance because whilst manager positions have influence over these criteria, they do not have absolute control (although these are still useful in appropriate situations). By having someone who is accountable for completing a verification of a specific critical control provides a measure of their commitment to ensuring that these systems are effective.

It is essential that the results of the CCE audits carry equivalent weight for an individual's performance assessment with traditional production or financial based metrics such as: tonnes mined, tonnes shipped or revenue. This is different from many performance systems that the authors have experienced over the years where safety performance is based on a random LTIFR result (or similar) and usually accounts for less than 10% of the performance assessment and may be as low as 5%. In some cases that have been witnessed, safety performance may not be included at all and we see managers being financially rewarded for what is essentially poor safety performance. This may be seen by other employees and serves to underline their belief that safety is really not important to the business, thereby reinforcing the 'production-safety paradox'.

When an organisation holds people directly accountable with significant and certain negative consequences for non-performance, then it is likely that people will do what is expected.

This is not to be seen as a draconian rule enforced through corporal punishment, but it is aimed at clearly setting the organisational expectation for safety performance and making it crystal clear that failure will not be tolerated and simply dismissed as a result of unforeseen circumstances and written off in a paragraph within the annual report.

The process must be implemented in a fair and just manner, but equally enforced in a fair and just manner so that the organisation and its workers trust and accept the consequences. After all, senior people in organisations have lost their role for arguably far less significant incidents such as extra marital affairs or causing a loss of corporate public image. Hardly comparable to the loss of human life.

CONCLUSION

To adopt a process such as we have suggested here requires a significant commitment from the board and the executive. It is a bold decision as often their performance is primarily measured by financial criteria. Ironically and in contrast to the millions of dollars invested in safety, this process that we suggest does not require investment of massive financial capital to be successful, but it does require significant investment of leadership, authenticity and commitment.

Having an organisation focus primarily on the effectiveness of the critical few controls rather than the entire safety management system, we offer organisations an opportunity to change and improve their approach to safety and to begin a transformation of the organisations safety culture from first principles.

As we began this paper, we stated that an organisations appetite for risk is a function of their culture driven by the strength of the management team.

The idea of holding individual managers accountable for quantified safety outcomes and implementing consequences that include loss of job for non-achievement will require a level of corporate bravery and commitment not often seen.

But until we take safety as seriously as we take production, profit and share market performance with consequences equal to what we see metered out for corporate failure, then it is unlikely that we will ever achieve the aspirational outcome of zero harm and certainly we will not eliminate fatalities.

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