

Optimising Safety Performance with the Brain in Mind

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Introduction

Mining is undoubtedly a risky industry in which to work. In recent times, we have heard of many serious incidents and fatalities concerning workers in frontline, operational roles at mines across Australia.

In March 2014, the Queensland Commissioner for Mine Safety and Health, Stewart Bell, released a statement in regards to fatalities in mining and reiterated the importance of taking action to maintain the safety and health of all workers, both employees and contractors. Bell suggested that a key priority for the year would be to ensure that all mines have a single health and safety management system (HSMS) encompassing all personnel and equipment on site. Key areas of focus under the HSMS included supervision methods, safe work practices for all employee and contractor work activities, competence of contractors, and ensuring equipment is fit for purpose. Interestingly, Bell said, "To avert further industry deaths, mine operators, mine management, supervisors and all mine workers and contractors alike, are reminded that they are working in an inherently hazardous industry that requires constant attention."¹

A range of questions need to be posed: Are humans fundamentally wired to be working in such complex and dangerous environments? Can we constantly attend to the hazards that surround us? If not, what is it that we need to know and how can we address these issues? Are sound HSMS's enough?

The evolution of a people focus in Workplace Health and Safety

The mining industry in Australia has invested greatly into the people aspects of health and safety in recent times. We have seen a considerable shift towards safety culture interventions, underpinned by research that has demonstrated the importance of these interventions. For example, recent research undertaken in Australia demonstrated that investment into greater protection for workers and engineering a safer work environment does not guarantee any improvement to safety performance in the absence of improvements to safety culture². In addition, James Reason³, a well-known expert in the field of safety culture, argues that the inherent limitations of safety systems are less critical if organisations can develop more robust safety cultures.

The importance of safety culture for the safety conscious organisation operating in a high risk environment cannot be underestimated. It is not enough to think that implementing safe work procedures and providing personal protective equipment is

enough in sustaining safety performance. When employees become accustomed to their work environment over time, they are inclined to become complacent and less likely to perceive danger and risk. Considering what employees believe, think is important, and the ways in which they go about their work, can provide some valuable insights into safety performance over time. However, we need to start taking some of these interventions one step further. It is not enough to consider the attitudes, beliefs, behaviours and actions of workers; we need to better understand the fundamental *ability* of the average worker to stay safe.

Understanding how our brain works...

The brain is a fascinating organ. It is highly complex, in fact, it could be argued that the human brain is the most complex entity known to man. Scientists have invested phenomenal effort into understanding the brain, and much of what we know has only been discovered in recent decades.

Over approximately the past 7 million years, the brain has tripled in size. As our technical and mechanical abilities took a giant leap forward, the brain developed to adapt to some of the changes that have occurred in our environment, e.g., cultural, linguistic, and dietary changes. However, in the last 10 to 20 thousand years, not much has changed.

In the 21st century, our environments are considerably more complex than they were back in the day of the cave man. They have vastly different types of physical threat, and more complex cognitive processing demands and multi-faceted social interactions. However, our brains really have not evolved to adapt to the highly technical and dangerous environments that workers in the mining industry operate in every day. Though our brains are essentially designed to ensure our survival for as long as possible, some of the functions of our brain may be counterintuitive to this process because of the ways in which we perceive dangers and threats. This effectively means that there are limitations in the performance of our brain that may result in failure to adequately identify and manage risks, and this may at times result in serious incidents.

According to experts, our brain uses approximately 20-25% of our body's energy⁴. Our brain is always looking to conserve energy and use resources in the most efficient way possible. We also have a very limited processing capacity, that is, there are very few things that we can consciously attend to at any one time. The brain conserves energy by operating on auto-pilot where practical, automating processes that do not require our conscious attention. So much of what we do in our day-to-day lives happens with very little effort. Examples include typing on a keyboard, riding a bike, or within mining many of the tasks associated with driving vehicles, operating machinery, drilling, lifting operations and so forth. We undertake these activities so often that the neural pathways become heavily reinforced, and the activities essentially hard-wired into our brains. The implications of this are that we pay less and less conscious attention to the tasks we do on a day to day basis, and this can result in risks to our health and safety.

How much information can we actually process?

Much research has been done to understand attention and working memory (the system that actively holds and works with information required to complete tasks). Back in the 1950s, Cognitive Psychologist George Miller developed a theory now known as Miller's Law. Essentially, Miller suggested that the amount of information that can be held in working memory at any one time is 7 plus or minus 2, i.e. between 5 and 9 units of information. This doesn't mean we can do between 5 and 9 things at one time, some tasks require a lot more of our resources – engaging in complex problem solving might require the use of all our units of working memory capacity. Because of the immense amount of data that we are exposed to in any given moment, Miller suggested that we can only consciously attend to approximately 0.3% of the stimuli in our environment at any one time.⁵ This means that we miss an overwhelming amount of information. Thus, it's not so simple to suggest that we need to pay more attention to the risks inherent in mining, risks are not always going to be easy to identify, and this phenomenon may cause many of the human errors that result in safety incidents on our worksites every day.

There are many implications of our severely limited information processing capacity. Our drive for increased productivity means that workers are increasingly feeling the pressure to work harder, do more with less, and juggle multiple complex tasks simultaneously. Yet, the concept of multi-tasking is a pure myth, at least we can attempt to do two tasks simultaneously, but we certainly wouldn't be undertaking either effectively. The brain handles tasks sequentially, switching backwards and forwards, or "togglng". The brain has the ability to switch between tasks quite quickly, but more quickly for some than others. The more complex the tasks, the more of our attentional resources are required, and the less effectively we can do two things at once.

Because of our extremely limited processing capacity, the way our brain attends to information is compromised. Many experiments have been conducted on a phenomenon known as "*inattentional blindness*", in which we miss important stimuli that appear right within our field of vision, but which we don't consciously attend to as our attentional resources are already being used up. Inattentional blindness can occur when we are overloaded, distracted, or we have directed the brain by giving it "instructions" to focus on particular items. To overcome the challenges associated with inattentional blindness, we need to find strategies to assist us in consciously focusing our attention on workplace factors that may be important, i.e. factors within our work environments that could pose potential risks to our health and safety.

Driving and operating machinery is one area in which inattentional blindness can have dire outcomes. We need to be as focused as possible when operating a vehicle, which means giving our full attention to what we are doing. There are many distractions that can impact our operating ability, such as mobile phones, passengers or workers, radios, even our own thought processes. Transport Canada's Ergonomics Division conducted a study to track the eye movement of drivers taking on a hands-free system versus those not. Drivers engaged in a conversation on hands-free had a significantly limited field of visual focus, used their peripheral vision less, checked their driving instruments less, and looked at traffic

signals less⁶. In this situation, it would be a lot easier to miss important information that could result in a vehicular incident.

Similar to inattentive blindness, there is another phenomenon referred to as “change blindness”. Because it is hard to process much of what happens in our environment every day, it is very difficult to detect changes that occur without additional cues to direct our attention towards items that may have changed⁷. Experiments with slowly changing images shown to participants in safety workshops demonstrate that when individuals are shown a picture of an image in which a change occurs slowly over a period of seconds, most individuals are not able to detect it as they tend to scan the scene, and do not have the capacity to simultaneously attend to all the details of the scene. This highlights the importance of stringent and appropriate planned maintenance activities in mining. Small and slow changes could occur on plant or equipment over a period of time, such as a bolt working loose, and because of the limitations of the human brain, these changes are mostly likely to go unnoticed by workers.

Individual operators in high risk environments, such as mining, are susceptible to the risks that change blindness presents. Recent research investigated whether or not teams are as susceptible as individuals in failing to identify critical changes in the work environment. What these researchers found was that teams with effective communication and good collaborative work practices were more likely to successfully identify changes in the workplace⁸.

Are you paying attention?

If we know then that our brain can process very little information at any one time, what is it that we do pay attention to? As mentioned, the brain is designed primarily to keep us alive. The brain screens out information that it doesn't see as being important to the task at hand. Over the years, many researchers have suggested that the brain has a hierarchy of prioritised areas for attention and focus. Generally speaking, anything that is perceived as dangerous will immediately capture our attention. For example, if a large explosion occurred, most people would think that was dangerous and their attention would be immediately captured. This would usually take priority over anything else that was happening at the time. In the absence of perceived dangers or threats, we attend to things that are important to our safety and existence, such as the needs of our family, our grumbling stomach, or the road when we are driving. Everything else after that point is of interest to us, including focusing on getting important tasks done at work or watching our favourite sporting team play a match on TV.

There is a series of stages involved in the way people process information. We experience our environment, we select what requires attention (whether consciously or subconsciously), we then process that information, and we work through a process of making sense of what we see. The challenge is that we are subjected to hundreds and hundreds of pieces of data every moment, and we do not have the cognitive capacity to process all of this information. Everybody's filter for information is different – it is based on our experiences and circumstances in life, our beliefs and value systems, our motivations etc.

The other important element to attention is the degree to which we are able to sustain it over time. Sometimes this is referred to as vigilance – our ability to maintain focused concentration over periods of time. In regards to vigilance, we are not all created equal. Some individuals have a naturally greater ability to sustain their attention than others. Vigilance is critical to many tasks in the mining industry. Take spotting for example. Spotters have a significant responsibility to help operators stay safe by continuing to scan the environment to identify any hazards or increase risks that may occur. Sometimes these activities can be undertaken over long periods of time, perhaps hours or for an entire shift.

Maintaining attention over time uses a high degree of our mental resources. Particularly in the context of safety, these tasks can, at times, also be stressful as the potential consequences of failing to detect risk can be catastrophic. For the average individual, our ability to remain vigilant decreases more rapidly than most would realise. In relatively complex tasks, we can sustain our attention for as little as 15 minutes before we start to experience the impacts of distraction, stress, fatigue and other factors that impact on our cognitive abilities⁹. However, when the task is particularly challenging or demanding, decrements in vigilance can occur as rapidly as within the first 5 minutes of commencing a task¹⁰.

Perception and risk awareness

The challenge of perceiving risk is that it involves both an element of our attention, as well as a belief that a task or situation is dangerous. When it comes to dangers in our workplace, we need to be able to notice the hazard (attend to it), perceive that there is an element of risk, and then take action to mitigate that risk. It is likely that for most workers in mining, they would have experienced their work environment as relatively dangerous. However, over time, our brain becomes accustomed to exposure to danger, and so we give less and less of our attention to noticing these factors in the workplace. This is often referred to as “habituation”.

In addition to habituation, our perception of risk can be altered by complacency. When we are continuously exposed to danger, the brain becomes progressively desensitised. We trick ourselves into thinking “that will never happen to me” and thus can underestimate the potential for harm to occur. Complacency alters our ability to effectively evaluate the hazards that are present in our work environment by downplaying the level of risk. In order to more effectively perceive the risks that exist, conscious attention is required to reflect on potential consequences of incidents occurring and the continued need to maintain a high level of vigilance and to follow health and safety procedures accordingly.

Making good decisions...

The ability to make integral decisions in the workplace can be the difference between staying safe and being involved in an incident. Workers are constantly required to assess their work environments for risk, and make decisions about the best course of action. Decision-making requires conscious attention and a large proportion of the brain’s available resources. We often find the task of making a decision or solving a complex problem quite taxing, and this experience of fatigue can continue to have an effect on our performance at work.

The quality and accuracy of our decision-making is influenced by many factors. Being overwhelmed with data to consider can make it difficult to cut through the noise and focus only on what is important. Furthermore, when workers experience high degrees of stress and pressure, the experience of a range of emotions can have an adverse impact on the decisions we make. For example, when we are experiencing looming deadlines or are feeling tired, we may make the evaluation that it's ok to cut corners or take shortcuts in completing tasks.

We learn from our mistakes and reflecting on incidents that we have experienced can provide us with information to later draw on when making decisions. Many organisations experience under-reporting of health and safety incidents; this occurs for many reasons, including perceived lack of management responsiveness to reports, fear of reprisals, loss of benefits, poor safety climate, and acceptance that incidents and injuries are just a part of the job. The issue with under-reporting is that employers and employees alike are cheated of opportunities to learn from near misses and incidents, and continue to improve practices and explore practical controls that could be implemented to prevent future incidents from occurring.

Key Recommendations

In better designing systems of work and health and safety practices, there are a range of recommendations that mining organisations could consider in further improving safety performance. These recommendations include, but are not limited to:

Educate and train workers on human factors

Employees need to understand human factors and the limitations of human performance. This will help to influence worker attitudes towards safety practices that are designed to control for these limitations, such as conducting risk assessments.

Focus on developing effective leaders

The value of effective leadership practice cannot be underestimated. Leaders play a critical role in mentoring workers onsite and influencing the culture of safety in an organisation. Leaders need to understand human factors, be able to discuss human factors with workers, and understand how to influence safe work behaviours and effectively manage worker performance.

Design risk assessments with consideration for the limitations of the brain

Risk assessment tools are seldom changed, allowing workers to fill them out with generic information and do so automatically without actually conducting a thorough assessment of risk. Risk assessment tools should be regularly changed, refreshed and/or updated, and in conjunction with this, workers should be educated on the importance of risk assessment tools as a way to consciously focus attention to overcome the limitations of human performance.

Accept that effective safety practices do take time

One of the challenges of engaging in safe work practices is that they are often perceived as a waste of time, or a hindrance to meet production requirements. To

more effectively engage in practices such as risk assessments, time needs to be dedicated and focused attention is required – this needs to be acknowledged.

Integrate psychosocial safety interventions into existing safety management practices

Psychosocial factors such as fatigue, stress and workplace bullying are significant health and safety issues in themselves, but these factors when present in the workplace can pose significant distractions and also result in cognitive performance deficits.

Address human factors in risk assessment practices

It is easy to fail to attend to the risks that we cannot physically see. Risk assessments should address human and psychosocial factors as much as physical factors.

Encouraging robust reporting practices

If organisations are to truly learn from incidents, including near misses, workers need to be encouraged to report openly and honestly. This is underpinned by the practices of leaders. Leaders must create an environment in which employees feel safe to speak up, demonstrate the value of reporting, and thoroughly follow through on reports by explaining what actions have been taken to respond to incidents, and why.

Plant, equipment and tasks are designed with consideration for human factors

It will never be possible to completely eliminate human error as long as we employ humans in our workplaces. Mining organisations should consider making use of technology to help engineer the work environment in a way that creates an automatic response to error, preventing serious incidents and injuries from occurring.

Undertake department cross-over observations and inspections

When we become highly accustomed to our work environment, it becomes more challenging to identify risks. Having individuals from other work areas conduct safety observations and inspections can result in a fresh set of eyes picking up things that might have otherwise been missed.

Double-team workers that are new to work environments with those that have been at site much longer

Similar to cross-overs, though new workers are often less experienced, they have a different perspective on the work environment and in collaboration with more experienced workers may more successfully identify hazards and risks.

Foster high performing teams

Teams that work together collaboratively and have strong communication practices are more likely to work in a way that supports the identification of risks and development of appropriate controls to mitigate those risks.

Examine approaches to rostering and task design

To counteract some of the limitations of the brain, employers should consider shift length, using job rotations where appropriate, and ensuring that workers are not required to stay on tasks for too long that require a high degree of mental effort.

Conclusion

Whilst it is well understood that the mining industry involves many risks, it is clear that humans are not well equipped to maintain attention over time and to identify the risks that are inherent in their work environments. In addressing these limitations, safety culture interventions need to be taken one step further and run in conjunction with greater education and awareness of the importance of safety practices such as risk assessments, incident reporting, investigations, effective communication, and the design and engineering of equipment and practices that take human factors into consideration. By continuing to develop and evolve interventions that attend to the people aspects of safety, and in combination with the systems and physical aspects of safety, the mining industry will be able to more effectively and holistically optimise safety performance and continue on the pathway to zero harm.

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