Empowering Miners to Eliminate Fatigue

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Introduction

Fatigue is routinely cited as a contributing factor in a high proportion of incidents, and represents an ever-present risk in a shift work environment. Over the decades a number of techniques and technologies have been developed to mitigate fatigue risk, the most prevalent of which is control of working hours to provide sufficient opportunity for sleep.

Within the technology spectrum, this paper focusses on the monitoring technologies, which are designed to provide a real-time assessment of sleep or sleep risk throughout the shift.

While various technologies have existed for some time, it is only in the last few years that the "adoption chasm" has been crossed. The mining industry is now seeing a worldwide uptake of real-time fatigue monitoring.

Monitoring Technology Selection

There exist a number of frameworks within which existing fatigue monitoring technologies may be categorised; the most common is to identify the primary measurement utilised, some example of which are:

- Electroencephalogram (EEG), or brain activity;
- Heart rate variability (HRV);
- Percentage of eye closure (PERCLOS); or
- Micro-corrections in steering angle.

Individual technologies, regardless of the primary measure, typically utilise proprietary algorithms to produce derivatives analogous to performance, vigilance, fatigue and/or the risk of unintended sleep. It is the nature of these derivatives that define the intended purpose of the tool as follows:

- To identify the occurrence of sleep with sufficient immediacy to permit the avoidance of further incident; or
- To estimate the risk of an unintended sleep with sufficient resolution to allow practical intervention prior to incident.

Understanding the purpose and capability of each technology, and identifying how that purpose aligns with business objectives, is critical in the selection process.

Another factor relevant to technology selection is the particular legislative environment with respect to individual privacy and data collection. Some jurisdictions do not allow video recording of employees without written consent. Others require that auditable processes be in place to ensure the timely deletion of related video data upon cessation of employment by the individual. Privacy laws can also impact the choice of wearable technology, depending on whether the primary measure is both capture/recorded and is biometric in nature.

The aforementioned selection criteria can also be assessed as part of a "desktop evaluation". More valuable insight can be gained by direct interaction with a specific tool or its customers.

It is common practice for vendors to provide the details of one or more reference sites. In person travel to or contact with reference sites is an invaluable source of information relevant to technology selection. Site visits should include interaction with stakeholders at all levels with the intent to validate vendor claims, to evaluate its ongoing support requirements and performance, and to assess overall stakeholder satisfaction.

The final step in technology assessment usually involves a small-scale trial. This can be valuable; however clear success criteria should be established beforehand. Also, it is the view of the authors that some typical motivations for small-scale trial are untestable in a small-scale trial, or at a minimum require some critical thought. Discussion of these motivations is covered in the following section.

Challenging the Trial Motivations
While each site has its particular motivations and desired outcomes, the most common questions being asked of the technology in a trial setting are as follows:

1. Accuracy – does it work?
2. Acceptance – does the workforce buy in to the initiative?
3. Data – Do we have a fatigue problem?
4. Results – Does we see it helping?
5. We're Different – Does it work with our equipment/site?

Each of these are addressed individually below.

With respect to accuracy, there is very little that can be done to assess this formally. One approach of merit is to engage the services of academics or qualified consultants to conduct a formal study. This, however, significantly impacts on the user experience which likely is also being assessed. As an alternative, sites often ask operators whether the technology measurements aligned with their own assessment. In cases where alignment is not observed, this is either due to technology inaccuracy, the result of negative bias on the part of the operators in opposition to the initiative, or is a truthful account of the operators though suffers from the inherent inaccuracy of self-assessment. Cases where alignment between the technology and self-assessment are achieved are not necessarily a good indicator of technology performance, as a result of the same self-assessment inaccuracy. Put simply, testing whether a technology performs accurately cannot be established in a small-scale trial setting. As such, sites willing to investigate technology performance should seek independent, scientific validation performed by reputable institutions.

Operator acceptance again suffers from a similar bias. Positive acceptance may indicate a favourable view of the tool, but also may be the result of:

- Perceived pressure to provide favourable feedback to management, which is more commonly observed for contract operators; or
- Laissez-faire attitudes toward safety programs.

Alternatively, negative feedback from operators may highlights genuine concerns with the tool, however may also represent a veiled protest to the initiative due to concerns of management oversight or fear of personal issues coming to light (e.g. health issues). Again and much like accuracy, operator acceptance is an important element however is difficult to accurately gauge in a small-scale trial. Establishing good rapport with participating operators and being genuinely open to honest discussion is necessary to fairly gauging acceptance.

Sites looking to establish the presence or severity of fatigue risk may be able to do so in a trial setting. That said, there are factors that are likely to result in the risk being poorly estimated. Firstly, operators participating in a trial that previously haven't been exposed to

fatigue monitoring technology may feel the need to change behaviour in order to ensure they are fit for duty during the trial. This of course has its benefits, however underestimates the quasi-steady-state, pre-existing risk. Also, if trial participation is on a voluntary basis, bias may exist in which operators volunteer. Finally, a more poignant concern is that some sites believe that revealing a low risk during trial negates the need for the technology. All shift workers are at risk, and a combination of the dynamic nature of fatigue risk and the confounding factors mentioned above means that a small-scale sample should never be used as a standalone measure of risk.

The question of "does this help" can rarely be answered in a short period of time. Any technology vendor that reveals a dramatic safety improvement in a time-frame of days or weeks is likely to be providing misleading information or is being purposefully selective. In-cab alarms and other interventions certainly do provide immediate benefit, however the true benefit in risk reduction is bulk behavioural change in conjunction with medical intervention where needed. Both of these take time, and therefore the "does this help" question should not be a factor for assessment in a trial setting; instead it can be answered from longstanding reference sites if available.

Finally, the position of "we're different" is valid in some cases, but largely irrelevant to the function of the technology. This question is pertinent if the working environment impacts on the primary measure of the tool or PPE requirements unique to the site or working environment. In such cases, a trial is valuable, and can be conducted on a very small scale with a short time frame to establish whether the technology is practicable.

Typical Operator Concerns

Over the past decade, the authors have gained insight into the nature of operator concerns with respect to monitoring technology introduction. While initial inquiries and surveys reveal a plethora of specific issues, closer investigation reveals the following five concerns as the underlying concern in most cases:

- **"You're tired, you're fired"** – essentially this concern is that the introduction of monitoring technology will lead to discipline or dismissal for those individuals that are identified as struggling to manage fatigue. This apprehension is rarely allayed with verbal reassurance, and is significantly heightened if previous initiatives or monitoring tools have been used in such a manner.
- **Big Brother** – operators are often opposed to excessive management oversite and 24/7 monitoring, again due to fears of misuse and abuse.
- **Privacy** – Unlike most technologies deployed on-site that monitor equipment, fatigue monitoring tools are designed to monitoring the individual. This raises obligations and more importantly concern with respect to individual privacy.
- **"Technology is unnecessary"** – A number of operators, particularly those with more shift-work experience, feel that they are and have always been able to manage their own fatigue. Sometimes referred to as a "Superhero complex", such an attitude is strongly opposed to anecdotal and empirical evidence, which overwhelmingly demonstrates that self-assessment of fatigue risk is poor in all individuals.
- **Silver Bullet** – This concern is linked with a notion that the business considers the technology a total, standalone solution to fatigue risk. It is often revealed in the statements like, "If they really cared about fatigue, they would….". No technology is a silver bullet, nor are any of them perfectly accurate. Monitoring technology is best used as part of a broader fatigue risk management framework.

Considerations for Queensland Coal Operations
Introducing fatigue monitoring technologies to daily operations is uniquely challenging in Queensland's legislative environment. Section 42 of the Coal Mining Safety and Health Act places requirements on how the introduction or changes to the assessment of personal fatigue are conducted. Specifically, the Act requires that the assessment must receive agreement from the majority of workers at the mine.

Although sometimes considered onerous, the requirements for consultation and majority consent may in fact be the key to more immediate safety benefits and the overall contribution to the health, wellbeing and lifestyle of QLD's mining community.

If a business intends to introduce a fatigue monitoring tool in a Queensland Coal operation, it will likely need to conduct a ballot. Given that the workforce are voting on the assessment and fitness provision, it is advisable to provide a non-compulsory trial for sufficient duration to allow the workforce to make an informed decision with respect to the technology.

Key Factors for Deployment Success
As a result of the abovementioned legislative requirements, workforce acceptance is the key factor in determining whether a technology may be deployed on-site. If and when a technology is adopted, it is the authors' experience that while always important, workforce acceptance is not the most critical element for long-term deployment success; instead, the key seems to be supervisor acceptance.

Supervisors play a critical role in mining operations, and also represent the first tier of safety leadership. If supportive of a technology initiative, supervisors have the ability to encourage adoption amongst resistant members of the workforce. Alternatively, supervisors not supportive of a technology can rapidly and irreversibly disrupt the initiative.

If policies associated with technology deployment include additional supervisor workload (e.g. face-to-face interactions with operators receiving fatigue alarms), it is important to recognize the need to find workload offsets. Alternatively, dedicated resources can be used to ensure supervisors do not become overworked.

Since behavioural change and risk reduction take time, the greatest workload is in the early days of a deployment, which is the time during which acceptance and adoption are most volatile. Deployment plans should factor this in, and should include sufficient quality engagement with supervisors to ensure success.

Learnings

The following represent some learnings on the part of the authors, based on first-hand observation of deployment successes and challenges with respect to multiple fatigue monitoring technologies. While somewhat obvious, there is a trend of failure to do the obvious, which is which each of these is detailed below:

- **Genuine consultation** – It is imperative that all stakeholders be genuinely engaged, including workforce representatives and relevant unions. Fatigue monitoring technologies provide incredible benefit if deployed well, however also give rise to concern and distrust.
- **"Trial" vs "Pilot"** – if a small-scale deployment is the starting point, how this stage is named changes stakeholder perception. The term "trial" is suitable if a business testing the tool; the term "pilot" is suitable if the business has decided on the tool and instead is testing their processes for effectiveness, practicality and scalability.

- **Data privacy** – This should be addressed upfront, and not in response to the expression of concern or filing of a complaint. It is also important to openly communicate what information is being stored, who has access to data, and what controls are in place.
- **Define success criteria** – if trialling a technology, this should not be an arbitrary, box-ticking exercise. It is important to establish measurable criteria, and ensure the trial scope will allow adequate assessment.
- **Communicate results, decision and rationale** – following a trial, a business decision is made. Often participating operators are left in the dark regarding what, if any, decision was made. Communicating the results and decision rationale is good practice, and will facilitate goodwill for future initiatives.
- **Fatigue training** – Technology is not a silver bullet. Pairing a technology deployment with fatigue training has the added benefit of demonstrating that the business is treating technology as such.
- **Put commitments in writing** – Given the primary potential concern amongst operators centres on discipline and dismissal, it is important that management communicate its position on this topic in writing.

Concluding Remarks

Fatigue Monitoring technologies have been established over the past decade or so, and a small number have emerged as established tool. All of these technologies offer benefit, and each differs in its core measurement and/or intended purpose. Regardless, the mining industry has available to it a range of tools with a proven history of adoption and success.

Selecting which technology is an important decision, but how the technology is tested and deployed is more critical to success. The trial phase can produce insight, but caution is required as confounding factors do exist.

Supervisor acceptance is critical to deployment success, and while always important, operator acceptance is most relevant in Queensland coal operations.

Engagement with the workforce is key, not only to allay concerns and garner buy-in, but because the engagement of stakeholders is necessary to achieve significant and sustained behavioural change and fatigue risk reduction.