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# Case Study:

## Readi Reduces Fatigue Camera Alarms by 50% at Major Copper Mine

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FATIGUE SCIENCE

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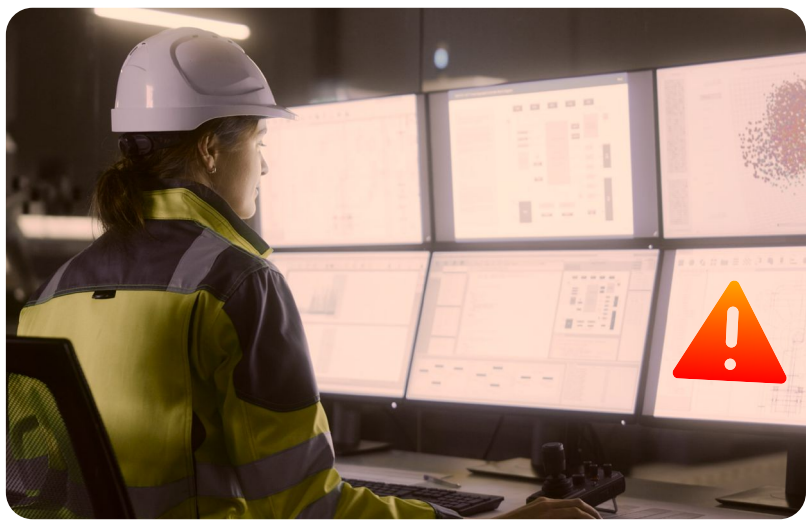
# 1. Executive Summary

Fatigue is a significant concern in the mining industry, affecting both safety and productivity. In recent years, mining firms who have relied on **reactive**, camera-based systems to detect operator fatigue have begun adopting **predictive** fatigue technology, such as Readi, to augment the safety and productivity outcomes they can achieve, while reducing disruption caused by those reactive systems.

In this white paper, we present a case study of a Central American mine that implemented Fatigue Science's Readi alongside their existing reactive camera-based system, Caterpillar DSS.

After Readi's successful deployment, the mine observed a substantial **50% reduction** in fatigue alarms generated by the Caterpillar DSS system.



Camera-based fatigue alarms often disrupt operations by requiring haul trucks to stop mid-haul cycle

The mine site concluded that its daily, proactive measures enabled by Readi's predictive technology were responsible for the reduction in fatigued operation of haul trucks and the corresponding reduction in camera-based fatigue alarms. These reductions **significantly benefitted both safety and operational continuity.**

Consequently, the mine recently expanded its commitment to Readi for site-wide use, deploying the technology to all operators and shift supervisors throughout the operation.

In-cab fatigue cameras act as a "last resort", detecting microsleeps as they happen

# 2. Background

## 2.1 Causes of Fatigue in Mining

Fatigue is a pervasive issue in the mining industry due to the nature of the job, which often involves long hours, shift work, and physically demanding tasks.

In a shift work context, there are several causes of fatigue, including:

- the **timing** of sleep opportunity
- inadequate **quantity** of sleep opportunity
- **under-utilized** sleep opportunity.

**Timing** refers to the fact that the human body is naturally programmed to sleep during the night and be awake during the day, so working during the night can disrupt the body's natural circadian rhythm and lead to fatigue. Predictability and consistency is also key here: changes from night work to day work and unexpected schedule changes are additional sources of circadian phase shifting, and ultimately, fatigue.

**Inadequate** sleep opportunity refers to not having enough time to sleep between shifts and related factors such as long commutes, family life, and more.

**Under-utilized** sleep opportunity refers to not being able to fall asleep or stay asleep during the time allotted for sleep, for reasons such as sleep health and poor sleep habits. An uncomfortable sleep environment (loud, bright, hot, etc.) can also contribute here. These factors can all contribute to fatigue in shift work contexts and can have negative impacts on worker safety and productivity.

Operator fatigue is responsible for 65% of haul truck accidents

## 2.2 Effects of Fatigue in Mining

Fatigue can have **significant consequences** for both safety and productivity, with research showing that fatigued workers on average exhibit **30% lower mental performance** on tasks like communication and decision-making, as well as **42% slower reaction time**, which affects tasks like braking a vehicle at the right moment.

Operationally, a study by Caterpillar Global Mining found that **65% of all haul truck accidents** could cite fatigue as a primary cause, while studies by Fatigue Science have found operators exhibit **3.2 lower dig rates** and **3.3% slower spot times**–key productivity impacts–when fatigued.

## 2.3 Comparing Approaches to Fatigue Management

There are two primary approaches to fatigue management in the mining industry: reactive and predictive.

**Reactive fatigue technologies**, such as camera-based systems like Caterpillar DSS, detect fatigue after it has occurred or just moments before a critical incident.

**Predictive fatigue technologies**, like Fatigue Science's Readi, enable a proactive approach to fatigue management by predicting fatigue hours before it occurs.

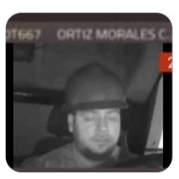
### REACTIVE TECH

Reactive fatigue technologies emerged in the early 2000s. Typically, they involve in-cab cameras that attempt to detect an operator falling asleep shortly before an accident is imminent (a “micro-sleep”).

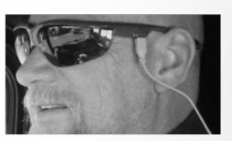
By raising alarms in these critical moments, reactive technologies act as a “**last resort**” and are intentionally disruptive to operations. Stopping a vehicle and shaking a driver’s seat, for instance, involves temporarily pausing short-term productivity in an attempt to avert catastrophe.

Cameras

PVT Tests



Seat Vibrators



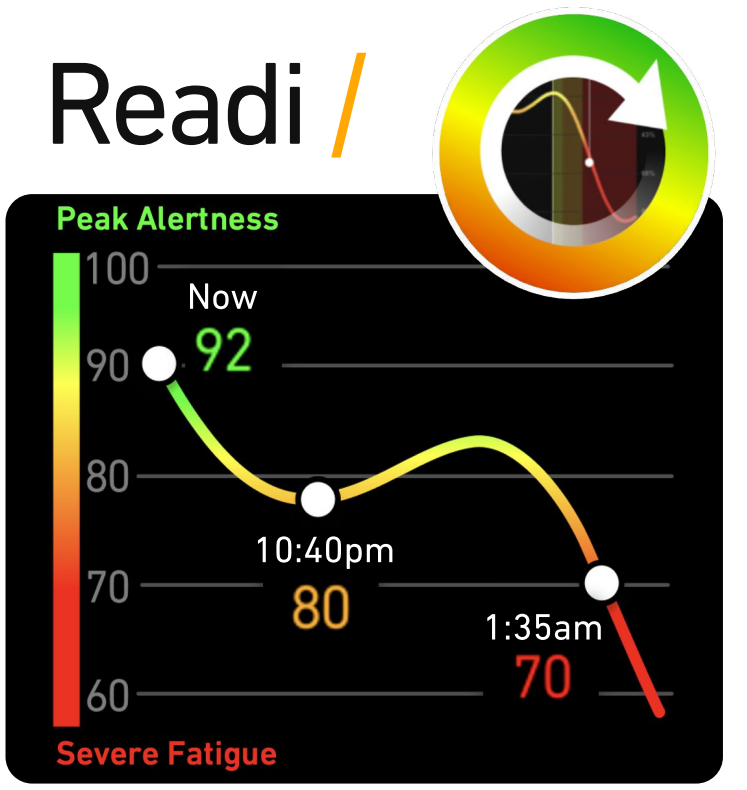
Glasses

Hats

### PREDICTIVE TECH

By contrast, predictive fatigue technologies act as a “**first resort**” – providing insights into which operators are likely to become fatigued and when. These insights are sent to shift supervisors at the start of each shift, allowing for targeted countermeasures, such as assigning additional rest breaks, and, in more extreme cases, re-assignment of critical tasks to less fatigued operators.

Readi, the pioneer of predictive fatigue technology, leverages **machine learning** and **biomathematical models** to provide accurate and personalized predictions of fatigue risk.



# 3. Case Study: Reduction in Camera Alarms

## 3.1 Use of Readi at Central American Copper Mine

A major Central American mine site producing copper and molybdenum implemented **Fatigue Science's Readi** alongside their existing **Caterpillar DSS system**, which is installed in their haul trucks. The mine site implemented Readi after experiencing **unacceptably high levels of alarms** from the camera-based system, which were disruptive to operations and costly in terms of lost productivity.

Importantly, the mine site found that both **"false" alarms** and **"true" alarms** from cameras were problematic. "False" alarms were problematic because they disrupted operations due to a faulty reading, while "true alarms" were also problematic because stopping a haul truck in the middle of its haul cycle is highly disruptive to operations–even when warranted.

Management decided to implement Readi in order to provide supervisors and dispatchers with advance knowledge into which operators were likely to become critically fatigued and when this fatigue would occur during the shift.

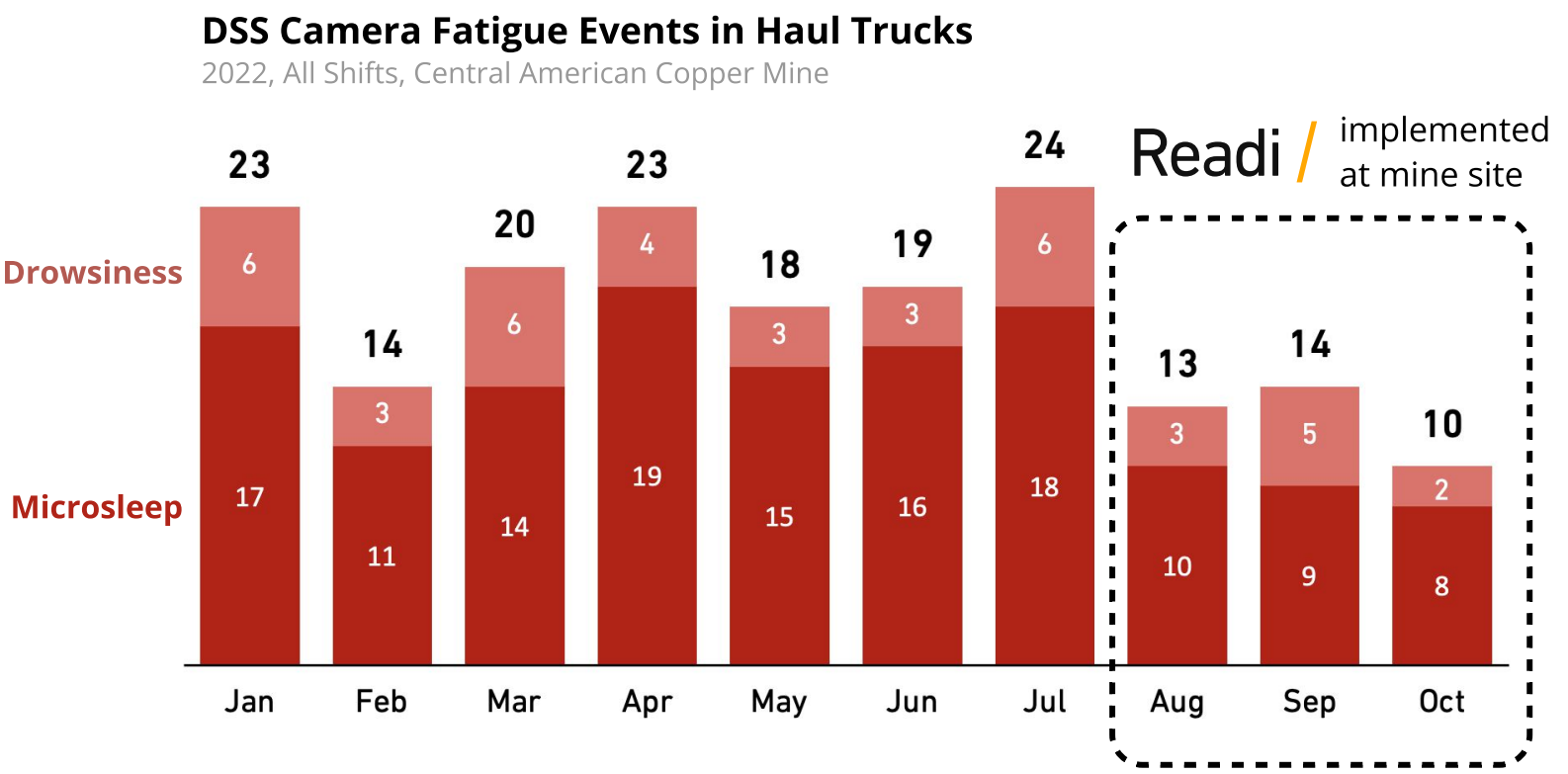
This foreknowledge would enable **proactive countermeasures** to prevent fatigue-related incidents, such as the **targeted assignment of additional rest breaks**, and **task re-assignment** in exceptionally critical cases.


### Proactive countermeasures

- Targeted assignment of rest breaks
- Task re-assignment in exceptionally critical cases

## 3.2 Results: Impact of Readi on Incidence of Camera Alarms

The implementation of Fatigue Science's Readi system at the Central American copper mine site led to a significant reduction in the number of DSS camera fatigue events.



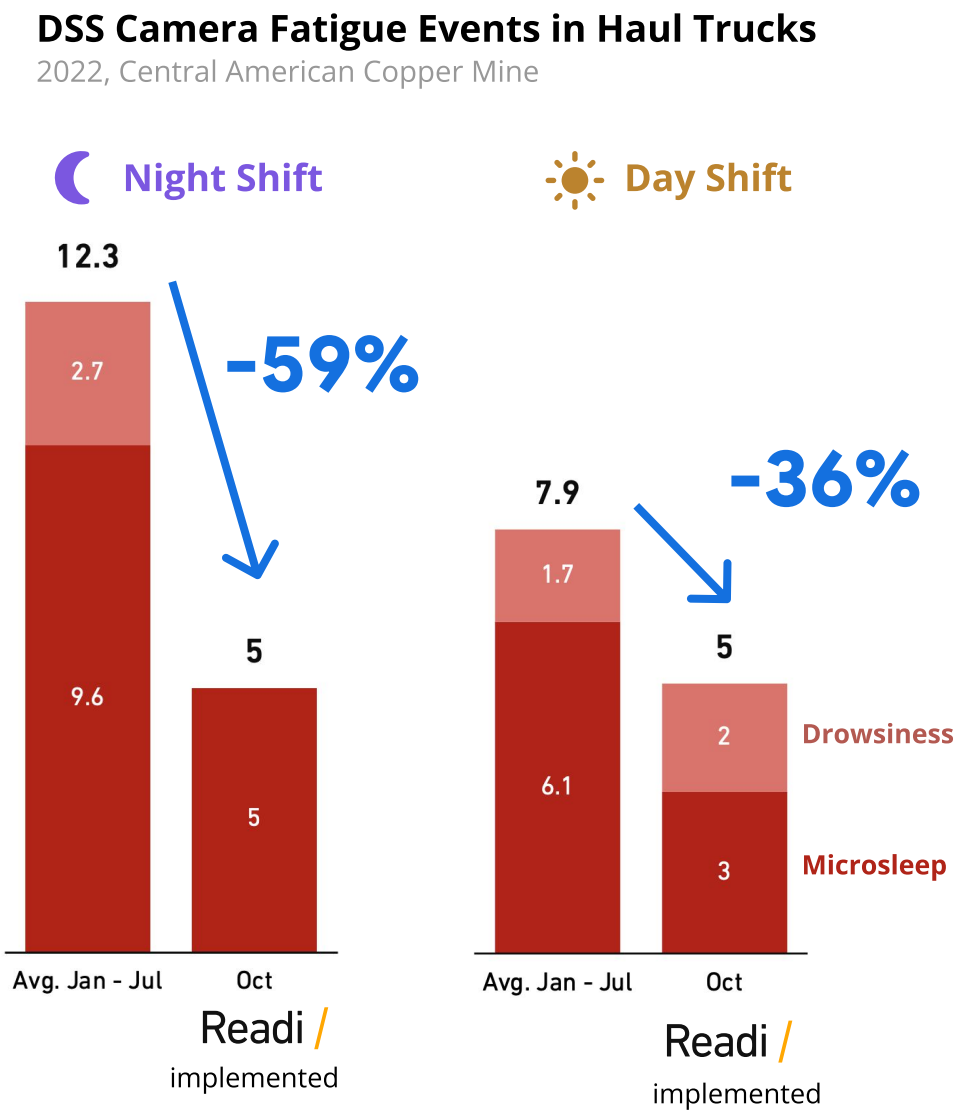

Before Readi was implemented, during the baseline period between January and July 2022, the mine site experienced an average of 20.1 DSS camera fatigue events per month. These events comprise both microsleeps, which are critical events where operators are caught on video dozing off while operating a vehicle, and drowsiness events, which are less severe but can still be considered leading indicators of fatigue.

Following the implementation of Readi, the mine site saw an immediate and sustained decrease in DSS camera fatigue events. By October 2023, the average rate of fatigue events had dropped to 10 per month, representing a **50% reduction.**

This decrease in fatigue events was observed across both night shifts and day shifts. During the night shift, fatigue events were reduced from an average of 12.3 per month in the baseline period to just 5 events in October, a remarkable **59% reduction.**

For the day shift, fatigue events declined from an average of 7.9 per month during the baseline period to 5 events in October, a **36% reduction.**

The reduction in alarms minimized disruption to operations and enhancing safety at the mine – **a rare "win-win"** in the industry. Consequently, the mine's management decided to expand its use of Readi site-wide to ensure the sustained improvement of safety and productivity throughout their operations.



# 4. Discussion

## 4.1 Synergy of Predictive and Reactive Technologies

The case study showcases the power of harmonizing predictive and reactive technologies in fatigue management within the mining sector. By capitalizing on their combined strengths, mining companies can devise a robust, efficient strategy that bolsters both safety and productivity.

The successful integration of Readi's predictive fatigue technology with the existing reactive Caterpillar DSS system led to a considerable reduction in fatigue events. This synergy highlights the complementary nature of these technologies, fostering a comprehensive fatigue management solution that proactively addresses and mitigates fatigue.

## 4.2 Embracing the Future of Fatigue Management in Mining

The success of Readi in this case study reflects the broader trend in mining toward adopting data-driven approaches, predictive analytics, and machine learning. The increasing adoption of predictive fatigue management technologies is driven by a renewed focus on proactive methods and a growing understanding of the limitations of reactive fatigue technologies alone.

Readi, as the pioneer of predictive fatigue management, is the industry leader in this space. Used at hundreds of industrial sites in some capacity, Readi recently achieved a milestone of securing 20 mine sites that have deployed it **site-wide across to all operators and supervisors across entire operations**. Industry experts acknowledge the growing adoption of predictive fatigue management as a new “best practice”, with the US National Safety Council recently awarding Readi its prestigious **2022 Green Cross Safety Innovation Award**.

As the industry progresses, mining firms that embrace predictive and reactive technologies will not only enhance their safety and productivity, but also secure a competitive edge in an increasingly technologically sophisticated landscape.

# 5. Conclusion & Next Steps

The case study presented in this white paper demonstrates the benefits of integrating predictive and reactive technologies in fatigue management, with the implementation of Fatigue Science's Readi alongside an existing reactive camera-based system leading to a **50% reduction in camera alarms** at a major Central American copper producer.

As the mining sector continues to evolve, the integration of predictive and reactive technologies will play a critical role in addressing fatigue and ensuring the safety and productivity of mining operations.

If you are interested in implementing predictive fatigue management technology at your mining operation, please contact us at Fatigue Science for more information.

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