

In a discussion on safety controls for haul truck driving, Dr Andree Röttig and Chris McElman, Modular Mining Systems, Inc., US, ask if excessive safety regimes may actually detract from, rather than promote, a safe working environment.

THE HAZARDS OF SAFETY



They know safety is an illusion and being obsessed with safety is a sickness" (*Deep Survival*, Laurence Gonzales).

The statement above contradicts many deep beliefs about mine safety. Few would consider the underlying reasons for the statement, let alone agree with it. The book from which this quote is taken is about survivors who hate boredom, adventurers who take "calculated risks". Through their experiences, they ultimately come to realise that trusting in the illusion that somebody is taking care of you can have dire consequences. The book captures how the survivors' conscious and subconscious thoughts control their behaviour and influence their perception of safety. Similarly, this article addresses how people (in this case, haul truck operators) often make decisions based on what they see, hear and perceive; on proposed alternatives; on what they have learned from prior experience; and on what tools they have at their disposal.

The profound principles behind the introductory quotation apply to our everyday lives and, of course, to the special conditions of mining. Although we do not need to think in the drastic terms of "live or die", when it comes to mining mishaps, any accident onsite is one too many.

But is there a point where the number of safety controls actually decreases security? Can excess precaution be hazardous? In looking to answer these questions, we begin with another one: what situations affect the operator's attention to, and perception of, safety?

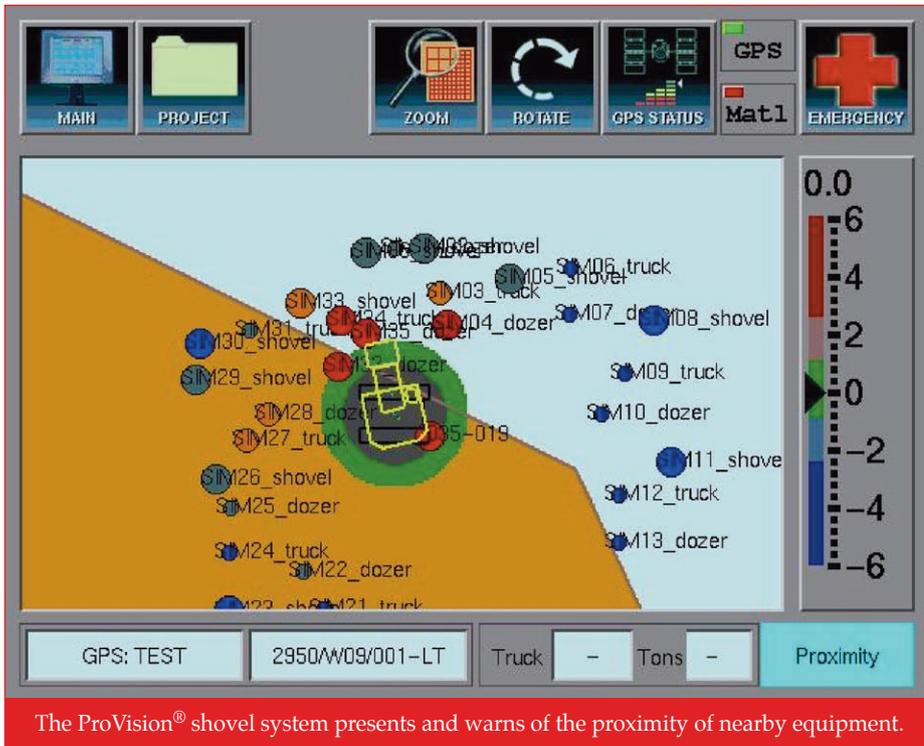
Demands of driving

Haul truck operation involves long stretches of boredom followed by critical periods of skilled focus. These paradoxical circumstances can place a surprisingly large strain on an operator's attention. Several environmental factors conspire to exacerbate this situation, such as limited visibility due

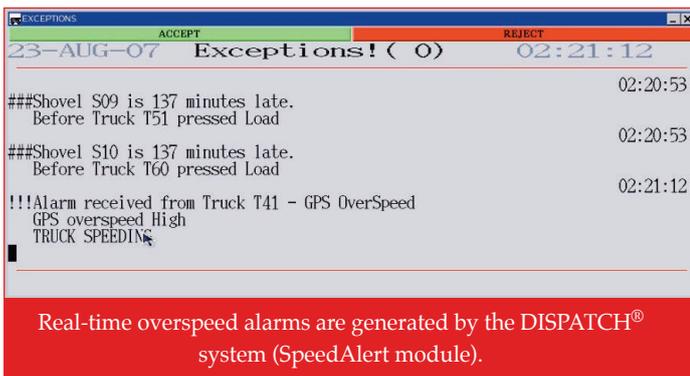
to dust or fog, long hours and combined work rosters, which affect operator awareness, and rapidly changing in-pit topography and road networks that catch drivers unawares.

Often, when the time comes for a haul truck operator to make a critical decision, he or she is caught off guard and must rely on reflex. These situations can result in "human error", and can have catastrophic results. In general, these so-called errors involve either inappropriate behaviour from the operator, diminished reaction time, poor situational awareness, or a combination of all three.

Although technology is no panacea, information tools in fleet management systems help proactively reduce or mitigate errors. However, a fail-safe system does not exist for people manually controlling haul trucks. Until driverless operations with autonomous equipment become commonplace, the traditional manual operation of mining equipment will



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emboldened, people tend to take more risks.

Hazardous habits

When reviewing accident reports, inappropriate behaviour stands out as a frequent contributor. Most of these accidents

continue to present risks caused directly by human operators.

Human factors and technology

Development of autonomous mining technology is in its infancy: a lot of room for improvement exists between the extremes of conventional unassisted operation and autonomous haul trucks. Although someday mining operations will be driverless, current safety systems are only as successful as their effect on the operator. Can a piece of technology completely and efficiently augment awareness without producing unsafe overconfidence?

People sometimes follow even the most inadequate machine instructions blindly. Operators often follow turn-by-turn navigations like commands, at times leaving the road on which they have been driving for months. Research has also shown that accidents increase with the introduction of more sophisticated automotive technology, such as air bags and anti-lock brakes. Falsely

happen in spite of the most sophisticated safety systems. Feeling a false sense of security, operators (consciously and unconsciously) take risks: they speed, enter forbidden areas and make blind turns, etc. Here, enforcement of proper procedures is one of the most effective ways to improve safety.

Successful integration of safety systems and enforcement procedures requires an awareness of context. Cameras, for instance, are great tools for enhancing visibility, but they need to be integrated selectively in order to function effectively. Requiring operators go through a pre-check procedure is one example of effective process enforcement: drivers must confirm visibility before the brakes are released. This is not disruptive; it effectively reminds operators to check their sight lines. However, these enforcements should not always occur. In this case the necessity depends on the context of the haul truck first being parked.

To further establish context, global positioning systems (GPS), machine health sensors and real-time information help determine the proper circumstances for visibility confirmation and similar safety measures. With context-centred pre-check procedures, sites can effectively diminish hazardous habits and reduce overconfidence. Of course, some safety systems - most notably those monitoring operator fatigue and alertness - need to operate at all times, regardless of the surrounding conditions.

Fatigue as a constant factor

A haul truck's braking system determines how quickly it can stop based on current speed but the operator must first recognise the danger and apply the brakes. This reaction time is always influenced by fatigue, much like the effects of alcohol and drugs. Simple reflex can be improved if decision inputs are provided in advance, effectively "pre-loading" an operator's attention. However, the definition of sufficient time can vary depending on an operator's relative alertness level.

Several solutions to monitor and manage operator fatigue have been introduced. These solutions may rely on circadian rhythms, eye movement or reaction time measurement. Integrating these with fleet management information - such as geographic position, time of day, vehicle type, and time in current activity - provides a rich background for analysing fatigue events.

If the analysis indicates an operator may be fatigued, this information can be relayed to the operator and any supervisory personnel in real-time. Based on recorded fatigue patterns, mines can empower their operators to battle exhaustion in advance. Care must still be taken, however, to ensure that, as a consequence of managing fatigue, operators are not distracted.

Distractions and unresponsiveness

Sufficient awareness of surrounding site conditions relies on a relevant, digestible presentation of the working environment. Proximity detection solutions (using RF signal strength, EMF field strength, radar or GPS) can warn an operator that another vehicle is in the vicinity before it comes into view. Providing early notification gives an operator a head start in deciding how to manoeuvre relative to another mobile unit. However, a proper safety system must intelligently filter these proximity alarm

events to improve the signal-to-noise ratio in alarm data. Excessive assistance messages and false alarms detract the operator's attention from other vital matters — a form of "safety sickness."

Operators often deal with these unnecessary alarms in unproductive, detrimental ways. For example, if a proximity alarm is triggered whenever two vehicles pass each other - something they must do all the time - the minor annoyance and excessive frequency may eventually condition an operator to consciously or unconsciously "disable" his or her reaction to the alarm.

A better approach is to trigger an alarm only when there is an imminent danger, providing the operator time to react. For instance, a proximity alarm should only be generated where an operator is unable to recognise the danger (e.g. in a blind curve). There are dozens of such situations that can improve productive safety measures, but they must be carefully examined on a

case-by-case basis. This again leads to the need for context.

GPS applications are especially effective in helping operators attain pre-emptive awareness. Along with fast wireless networks, current GPS applications give the position of all equipment in real-time relative to one another. This operator-centric "birds-eye-view" augments the situational information available to the naked eye. However, one shortcoming of GPS is that it is not 100% available. A proper solution requires multiple redundant sensors integrated with context available from fleet management systems.

Conclusion

Care must be taken not to condition haul truck operators towards undesired reaction patterns, whether such repeated actions consist of overconfidence in safety solutions or a lack of interest generated by information overload. Context-appropriate tools and information should be provided

to assist operators in their decision making.

We have seen how pre-emptive warnings are preferable to instantaneous alarms. Minimising false alarms will enhance the significance of true alarm events, whether or not operators are overconfident or apathetic.

Mines must also pay close attention to fatigue as a constant factor, as increased fatigue leads to increased reaction time. The longer it takes a haul truck operator to recognise a danger and react, the less time safety systems (such as brakes) have to achieve safe, desired results. Though operator fatigue can be mitigated by technology, regardless of context, fatigue management systems should work in conjunction with pre-emptive awareness in a sparing, responsible use of alarms.

Safety may be an illusion but a thoughtful application of technologies and processes that account for human factors will help make safety a reality. **WCL**