20th November 2020

SEEING MACHINES LIMITED

SUBMISSION TO THE NATIONAL TRANSPORT COMMISSION (NTC) IN RESPONSE TO THE HVNL REVIEW: REGULATORY IMPACT STATEMENT

Seeing Machines is pleased to provide a view on the Heavy Vehicle National Law (HVNL) Review Regulation Impact Statement (RIS). Seeing Machines is an industry leader in Driver Monitoring Systems (DMS) for driver fatigue and distraction within the transport industry and a long-standing advocate for the uptake of safety technologies. We are delighted that the review of the HVNL is considering encouraging the uptake of fatigue and distraction monitoring technologies and other technologies that are known to save lives on our roads.

The following submission contains a response to options within the RIS that fall within Seeing Machines' scope as a fatigue and distraction technology service provider and in our experience in supporting customers in Australia and globally for over five years.

The response enclosed is focused on three elements from the RIS:

- Technology and Data
    - Option 6.1: Develop an overarching framework for the use of technology and data & establish a technology and data certifier under the HVNL.
- Fatigue
    - Option 8.1: Proposed changes to the Tier 1 Hours of Service.
    - Option 8.2: Revision of Tier 2 and tier 3 fatigue management framework.

In this submission we state that there is ample evidence for the safety case to support the widespread introduction of fatigue and distraction monitoring technologies. We also recognise from the NHVL's own programs that the operators derive great value from Seeing Machines' technology and that it is widely accepted. Finally, we believe there is sufficient evidence available to support initiatives that would grant operators more scheduling flexibility if they are to adopt these technologies.

T +61 6103 4700
80 Mildura Street, Fyshwick ACT 2609, Australia
seeingmachines.com

seeingmachines

TECHNOLOGY AND DATA

Option 6.1: Establish an overarching technology and data certifier under the HVNL

We have responded to Questions 6.1, 6.3 and 6.4 based on Seeing Machines' scope and experience as a technology service provider.

Question 6.1: Is there value in an over-arching data framework and, if so, to what levels of data assurance requirements should it apply?

There are significant challenges to developing an overarching data framework for fatigue and distraction monitoring technologies. Before an overarching data framework can be considered, the data that will be contributing to that framework must first be evaluated and assessed for accuracy and quality to ensure any insights obtained from the data are of value. Furthermore, if the National Heavy Vehicle Regulator (NHVR) is to encourage the use of fatigue and distraction monitoring technologies and consider their use within tier 2 and tier 3 fatigue management frameworks, some level of data quality assurance should be considered. Fatigue and distraction monitoring technologies vary in their monitoring approaches, effectiveness, and evidence of efficacy. This presents significant challenges both for assessing device performance in a technology agnostic manner and for standardising data from different technologies into an overarching framework. Only technologies that have met an acceptable standard of performance should be considered and encouraged by the NHVR. Globally, the challenge of rating DMS is being tackled by multiple policy groups, such as the European New Car Assessment Program (Euro NCAP). Any standards set by the regulators should consider what is recognised as the gold-standard for road safety systems globally. Regulators should continue to consult and collaborate with technology providers and heavy vehicle operators to ensure technologies are of appropriate quality and meet the needs and expectations of the industry.

Question 6.3: In relation to option 6.1, do the chapter 7 data handling privacy provisions provide enough clarity? Should they be expanded to cover more, wound back, or be removed from the law?

Third party technology providers should have agreements in place with their fleet customers that address many aspects of data privacy and consumer law. While we believe the regulator has a responsibility to ensure some standard of quality for technologies they are encouraging or mandating within the HVNL guidelines, any data assurance and management should consider the protections already in place. Any compliance or auditing requirements for technology manufacturers should only be considered if it is demonstrated that this is a value-add for the industry and can be supported with a practical implementation strategy.

Question 6.4: In relation to option 6.1, what specific technologies would industry be expected to bring forward under this option and what would the implications be for safety and productivity?

DMS that manage the risks of fatigue and distraction in real-time have been in use within Australian and global fleets for over five years. Seeing Machines supports the inclusion of DMS into this option, with implications for safety and productivity discussed here.

Driver fatigue is a key safety risk on Australian roads, contributing to ~20% of all motor vehicle crashes.[1] Fatigue is of particular importance in the heavy vehicle industry as the leading cause of truck driver fatalities, with 34.8% of truck driver deaths resulting from driver fatigue.[2] Driver distraction is another leading cause of truck driver fatalities and is becoming increasingly more prevalent in Australian truck drivers, with distraction and inattention accidents more than doubling from 2017 to 2019.[2] DMS is being deployed at an increasing rate worldwide to address the high risk that both distraction and fatigue pose to drivers.[3]

DMS that target driver fatigue (Fatigue monitoring technologies; FMTs) vary in both the methods used for detecting fatigue and in the evidence base underpinning efficacy.[4,5] FMTs that monitor drivers' eye movements are the most prevalent type and evaluate fatigue by examining the duration,[6,7] speed[6,8] and/or frequency[9] of eye closures. There is substantial evidence that ocular measures (such as those above) reliably predict fatigue and driving performance.[4,5] However, while the evidence for ocular measures as markers of fatigue is strong, many commercial FMTs have little or no scientific evidence or validation, with a recent report from the UK's Transport Research Laboratory finding that Seeing Machines' Guardian system was the only FMT validated within an occupational driving setting.[5] Seeing Machines Ltd. is an industry leader in the field of fatigue and distraction monitoring and has consistently demonstrated the strength of its technology through rigorous scientific validation. Seeing Machines' technology includes a driver-facing camera that can be wired into a car or truck cabin and utilises facial feature recognition to detect driver blink and glance behaviours.

The efficacy of Seeing Machines' technology for monitoring driver fatigue has been demonstrated on multiple occasions across a range of driving contexts. Scientific research has demonstrated its efficacy for monitoring fatigue under naturalistic conditions, with ocular measures predicting both microsleeps and lane departures.[10] The efficacy of this technology in operational fleets is evidenced by validation studies that have been subjected to international scientific peer-review, and has been used to provide critical insight into the impacts of shift start times on fatigue[11] and by leading experts in driver fatigue to investigate shift schedules in commercial truck drivers for the NTC.[12] These studies not only demonstrate that Seeing Machines technology is feasible for use in naturalistic conditions in trucks, but that it is also consistent with gold standard measures of drowsiness under these conditions.[12]

The safety impacts of Seeing Machines' technology are best demonstrated through analysis of safety outcomes in operational fleets. Research conducted in truck fleets in both South Africa[13] and Australia[14] demonstrated a 90-95% reduction in fatigue events when drivers

received in-cab alerts and direct driver feedback. Guardian consists of a two-step feedback system following the detection of driver fatigue or distraction. Firstly, there is a real-time in-cab alert (e.g., delivered through audio and physical vibration) that is designed to immediately notify the driver. Secondly, a Seeing Machines analyst contacts the fleet operator (e.g., via a nominated phone number). The second step only occurs for more severe events and following a video review of the event by a trained analyst to screen out acceptable driving behaviour. The Australian study showed that relative to a baseline condition (where no in-cab alerts were given to drivers who showed signs of fatigue), providing in-cab driver alerts alone resulted in a 66% reduction in fatigue events. Furthermore, the additional step of providing feedback to the fleet operators enabled a 95% reduction in fatigue events.[14]

In addition to monitoring fatigue, Seeing Machines technology can also detect when a driver becomes distracted.[8,9] While the RIS has clearly considered the potential safety benefits that fatigue management devices offer, there appears to be less consideration to the potential impact that distraction monitoring devices have on driver safety, despite distraction being a leading cause of accident and fatality amongst truck drivers.[4] Furthermore, research shows that there is an interaction effect between fatigue and distraction, with drivers becoming more distractible and inattentive with increasing fatigue.[8,10] Regulators should also consider encouraging the uptake of distraction monitoring technologies to address this risk, particularly given fatigue monitoring technologies are increasingly incorporating distraction monitoring into their technologies.

The widespread adoption of Seeing Machines' Guardian technology across Australia and worldwide is a testament to the benefit of Guardian technology to both drivers and fleet operators, with over 5 billion kilometres of road travelled by vehicles fitted with Guardian devices. Guardian technology is the industry leader in fatigue and distraction technology within Australia, with Guardian users telling the NHVR that they considered it the *"industry standard"* for fatigue and distraction monitoring technology.[15]

FATIGUE

Option 8.1: Making standard hours less complex

Option 8.1(b), *Reclassifying time using a "rest reference"*, is the option Seeing Machines recommends for changing the current tier 1 hours of service (HOS). We believe this offers some significant improvements over the current HOS. Importantly, by linking work hours to rest times, as opposed to an arbitrary 24-hour period, option 8.1(b) aligns better with scientific evidence regarding driving after extended periods of wakefulness. Furthermore, by making a distinction between on-duty time and driving time, this allows more flexibility for drivers while also limiting fatigue resulting from extended time-on-task effects. While option 8.1(b) is an improvement upon the current standard work hours, there are still significant fatigue-related gaps within the HOS framework, such as no consideration of time-of-day effects on fatigue. FMTs could act as a safeguard against some of the gaps within the HOS which are discussed further below. Regulators should consider incentivising the uptake of fatigue monitoring technologies for operators working under the standard tier 1 framework, in order to reduce risk factors that cannot be adequately addressed with changes to the HOS regulations alone.

Option 8.2: Revision to Tier 2 and Tier 3 of fatigue management framework

In order to investigate how fatigue monitoring devices could support safety under the proposed three-tier fatigue management framework, Seeing Machines analysed data collected from the Advanced Safe Truck Concept (ASTC) project. The ASTC project was a three-year research collaboration between Seeing Machines, Ron Finemore Transport, Monash University Accident Research Centre, and Volvo Trucks Australia. This research included data captured in controlled driving simulator conditions as well as on-road naturalistic conditions (operational driving). The present analysis utilises on-road naturalistic data, where trucks were instrumented with an automotive grade DMS camera. We collected data from 120 drivers (10 trucks) with the following analysis including data from 415 total shifts. While the data has been collected utilising Seeing Machines technology, we have analysed the data using scientifically validated ocular metrics that are utilised across multiple fatigue monitoring systems to provide insight that is technology agnostic. For this reason, ocular measures were examined as continuous signals, as opposed to binary classifications (i.e., drowsy/not drowsy) as is typically seen in FMTs. This is because different FMT devices utilise different cut-off values for the ocular measures they employ. Blinks were assessed for blink duration,[7,16] the opening and closing amplitude velocity ratio (AVR),[6,8] and the percentage of time spent with eyes closed (PERCLOS).[8,9] Drowsiness is marked by slower and longer-lasting eye closures, and is therefore associated with an increase in AVR, blink duration and PERCLOS values. These indicators of drowsiness were assessed across the entire duration of each drive to identify patterns of driver drowsiness. Results from opening AVR are included to demonstrate the pattern seen in drowsiness. Further information on the analysis and results may be requested from Seeing Machines.

Recommendation A: Seeing Machines data supports the use of fatigue management technologies for operators requesting extended driving schedules under the Tier 2 and 3 fatigue frameworks.

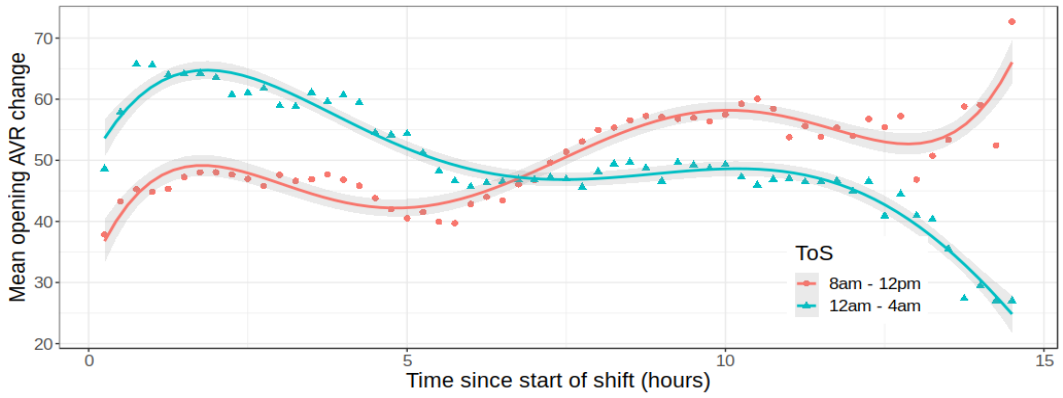
Option 8.2 proposes that operators who request schedules for driving longer than 14 hours under the Tier 2 or 3 fatigue management frameworks may be encouraged or required to use fatigue monitoring technology to protect drivers operating under these schedules. ASTC data was collected under, and limited to, the current HOS and Basic Fatigue Management (BFM) hours. While the study is constrained within the existing HOS, the analyses demonstrate the complexity of fatigue progression, with fatigue varying as a result of multiple factors beyond just the duration of the drive. This highlights the utility of DMS for the assessment and management of fatigue in real-time.

We have examined drives approaching the maximum HOS to identify drivers at particular risk of fatigue approaching 14 hours. Shift durations were estimated from dispatch times and ignition end times, with breaks estimated from short breaks in ignition start and end times during shifts. To examine the influence of time into shift and shift start time on fatigue, longer shifts (8-15 hours duration) were examined and grouped by start time. For shifts starting in the morning (8 AM - 12 PM), ocular measure trends indicate that drivers became increasingly drowsy as they approached the maximum HOS (see Figure 1). As an isolated result this supports the Tier 1 HOS assumption that drowsiness increases with shift duration and suggests that fatigue monitoring technologies be utilised for operators requesting schedules longer than 14 hours.

Importantly however, the results also indicate that drowsiness does not always increase across a shift, with shift start time impacting the pattern of drowsiness progression. Drivers who started their shift between the hours of 12 AM - 4 AM became progressively more alert towards the end of their shift, likely resulting from the impact of their circadian phase promoting alertness (see Figure 1). The current HOS could be unnecessarily restricting many drivers who are sufficiently alert, even as they approach the maximum shift duration. Overall, this indicates that managing fatigue risk cannot be achieved following a rule that equates time driving with risk.

The key takeaway is this. In some circumstances a driver may be fit to drive beyond 14 hours, and fatigue monitoring technologies can support driver safety when working extended hours by monitoring and detecting drivers who are at risk of fatigue. In other circumstances, this technology can provide an additional layer of protection for drivers who are fatigued due to reasons beyond how long they have been driving.

Figure 1. Opening AVR progresses differently across the duration of the shift depending on shift start time, with shifts starting in the morning (8am - 12pm, red line) showing an increase in drowsiness across the shift, whilst night shifts (12am - 4am, blue line) reach peak drowsiness in the first few hours of the shift.



Recommendation B. The value of fatigue management technologies extends beyond protecting workers driving longer durations and FMTs should be encouraged and incentivised across the entire industry.

Protecting drivers irrespective of circumstances

While fatigue management technologies can support extended shifts, drivers also risk fatigue when working within the prescribed HOS. Fatigue is dynamic, with many environmental and individual factors contributing to its development, and it is infeasible to reflect all factors within the HOS. Fatigue management devices circumvent this through assessing fatigue and microsleep risk on a case-by-case basis at the individual driver level. The Tier 1 HOS are focused on fatigue risk resulting from extended time awake, with little consideration for other fatigue risk factors. Shiferaw et al. (2019)[11] analysed fatigue event data collected from Seeing Machines' Guardian during operational driving to examine the impact of shift start times and time of day on fatigue. Shift start times had a significant impact on the average time into shift of the first fatigue event (see Figure 2a), with shifts starting between 12 PM - 6 PM having the earliest average fatigue onset of 435 minutes. In addition to the impact of shift start time, there was a strong time of day influence on fatigue risk, with Guardian fatigue events occurring more frequently during the night time (6 PM - 6 AM, see Figure 2b).[11] Under the proposed three tier fatigue framework, fatigue management devices are only encouraged for operators seeking longer driving schedules. However, drivers are clearly still at risk of fatigue when operating within the HOS, particularly during the night. In fact, depending on the time of day, some drivers may be most susceptible to fatigue at a time which the HOS framework would intuitively suggest fatigue is at its lowest risk (i.e., at the beginning of their shift). The NHVR should consider incentivising the use of fatigue management technologies beyond operators seeking longer schedules.

Figure 2a Kaplan-Meier survival curve demonstrating time into shift until the first fatigue event. Figure from Shiferaw et al. (2019).[11]

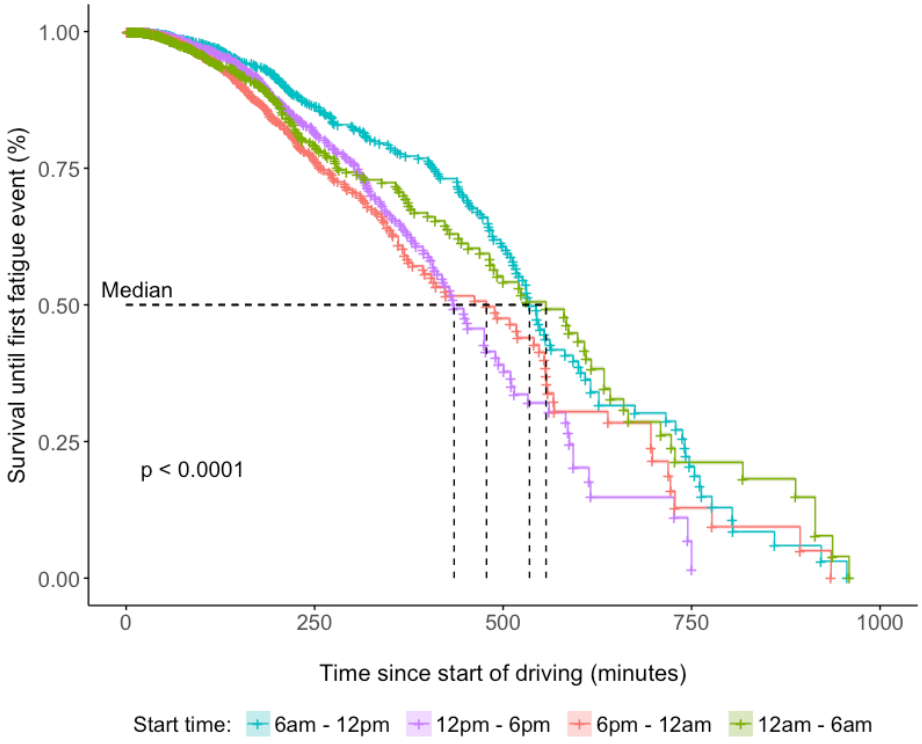
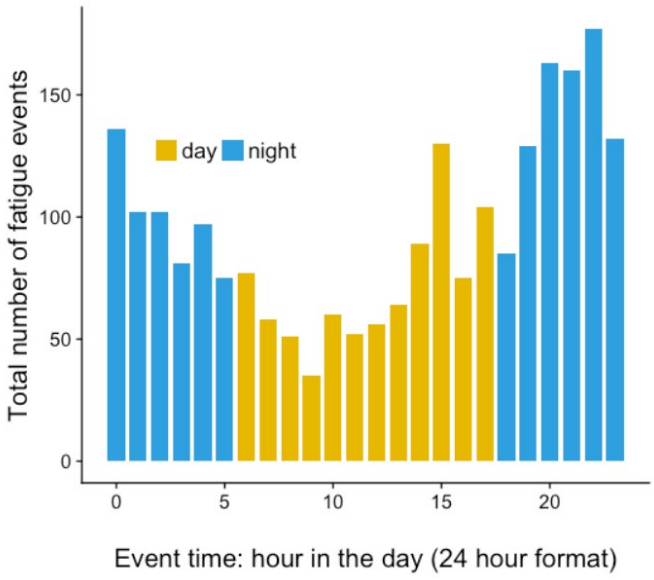


Figure 2b. Guardian Fatigue event occurrence across 24 hours. Figure from Shiferaw et al. (2019).[11]



Empowering fleet operators with data

As well as protecting individual drivers in real-time, fatigue monitoring devices can provide data that empowers operators to systematically manage fatigue on a larger scale. For example, the data can be used to create custom fleet risk profiles, identify common high-risk routes, times, and shift schedules or to enable personalised driver coaching and safety training. This feedback not only supports drivers when working longer schedules but also builds a safety conscious culture among drivers operating within the standard Tier 1 HOS. However, without any incentives encouraging the uptake of fatigue and distraction monitoring within the Tier 1 framework, operators may be discouraged from implementing driver monitoring systems.

Benefits to the industry as a whole

Widespread adoption of FMT has the potential to offer significant safety and productivity gains to the heavy vehicle industry as a whole. In addition to the lamentable personal cost of truck driver fatalities, there is a significant economic cost of fatigue-related road trauma every year. The Bureau of Infrastructure, Transport and Regional Economics (BITRE) estimates the economic costs of road crashes as approximately $2.4 million for each fatality, $3.8 million for a person suffering profound disability or impairment and $214,000 per injury requiring hospitalisation.[17] Reducing fatigue-related road trauma amounts to a substantive economic benefit to Australia. For small to medium tier trucking companies however, the cost of a high-quality, reliable and evidence based FMT could act as a barrier to uptake. The majority of trucking companies within Australia in 2019 were small businesses, with over 97% having less than 20 employees.[18] To make a real impact on driver safety it is crucial to encourage uptake of FMTs within these smaller operators. The Australian government and the NHVR should consider incentivising FMT uptake by subsidising some of the costs of FMT installation and maintenance to reduce the cost barriers within these smaller enterprises.

FINAL REMARKS

Seeing Machines has been a leader in driver monitoring technology for managing driver safety in the transport sector for over a decade and we are delighted that the NTC is considering changes to the NHVL that reflect the safety benefit of fatigue management technology. Encouraging the uptake of FMTs through flexibility in work hours could be instrumental in their uptake by heavy vehicle operators and would be an excellent first step towards achieving our shared goal of zero fatigue fatalities in the transport sector. However, we challenge the regulators to dream bigger and broaden their scope for encouraging and incentivising driver monitoring systems by:

- Supporting the uptake of FMTs beyond those requesting extended hours of operation, especially for businesses operating at high-risk hours in the early morning.
- Removing cost barriers for small and medium sized operations by subsidising FMTs
- Encouraging distraction monitoring technology in addition to FMTs, as distraction is also a behaviour that places drivers at high risk of crashes.

Australia has been a global leader in road safety, and we believe that supporting the uptake of driver monitoring systems in the national transport sector would place Australia at the forefront of advancing road safety.

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