Submission
No 18

INQUIRY INTO PRESSURES ON HEAVY VEHICLE DRIVERS AND THEIR IMPACT IN NEW SOUTH WALES

Organisation: Seeing Machines Ltd.

Date Received: 18 September 2023

Seeing Machines Response to the Inquiry into the pressures on heavy vehicle drivers and their impact in New South Wales

15 September 2023

Report Authors:
Mike Lenné, J.T. Griffin, & Kyle Wilson

For further information about this response please contact:
Dr Mike Lenné
Chief Science & Innovation Officer

Summary

- In-vehicle technology is available today to relieve pressures on heavy vehicle drivers by aligning prescribed driving hours with objective real-time assessments of driver fatigue

- The technology, camera-based driver monitoring systems (DMS) are fully mature and currently deployed in light vehicles and trucks around the world as both aftermarket and OEM-installed products

- The efficacy of this technology in operational fleets is evidenced by validation studies that have been subjected to international scientific peer-review

- There is an increasing global mandate for DMS, led by the European Commission's statement that all new vehicles sold in Europe from 2024 must have new technologies including Driver Drowsiness and Attention Warning (DDAW)

Background

Seeing Machines is pleased to provide a view regarding the Inquiry into the pressures on heavy vehicle drivers and their impact in New South Wales. 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. Because of our industry expertise, we have a unique perspective to offer regarding DMS technology. Our camera-based DMS technology has been in development for over 20 years. The technology was initially deployed in heavy mining trucks to monitor driver/operator fatigue while working long shifts. Seeing Machines is now managing fatigue and distraction in heavy on-road truck fleets in more than 35 countries and over 50,000 commercial vehicles worldwide. Through our Guardian Fleet monitoring program, Seeing Machines receives real-time video and alerts which are used to alert the fleet operator and to also continuously improve our technology.

Heavy vehicle drivers often work long hours and can suffer from fatigue. Current prescribed driving hours are not always aligned with levels of fatigue experienced by drivers, and can inadvertently increase fatigue and the pressure experienced by drivers.

The following submission contains a response to a particular element within the Terms of Reference (TOR) that falls 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 seven years.

(d) the capability for new and emerging technologies to assist in reducing pressures for heavy vehicle drivers and effect driver practice and observance of regulatory obligations, such as through training, implementing safety measures and fatigue management

In this submission we state that there is ample evidence that driver monitoring technology can support operator safety and thereby reduce pressures that heavy vehicle drivers face. We demonstrate that existing DMS products have validated capabilities to detect driver impairment arising from fatigue.

Managing fatigue with DMS

Driver fatigue is a key safety risk on Australian roads, contributing to ~20% of all motor vehicle crashes[1]. Fatigue is a particular concern in the heavy vehicle industry as it is the leading cause of truck driver fatalities, with 60% of truck driver deaths resulting from driver fatigue[2].

DMS that target driver fatigue (Fatigue Distraction Detection Technologies; FDDT) vary in both the methods used for detecting fatigue and in the evidence base underpinning efficacy[3,4]. FDDT that monitor drivers' eye movements are the most prevalent type and evaluate fatigue by examining the duration[5], speed[6], and/or frequency[7] of eye closures. There is substantial evidence that ocular measures (such as those above) reliably predict fatigue and driving performance[3,4].

Seeing Machines' Guardian technology includes a driver-facing camera that is fitted into a car or truck cabin and uses sophisticated face- and eye-tracking algorithms to measure drivers' head position, eye gaze, and eye closure. Several scientific studies, including a report from UK's Transport Research Laboratory[4], support the validity of Guardian in an occupational driving setting.

---

[1] Transport for NSW (2017). *Fatigued and distracted driver trauma trends*. Available from: https://roadsafety.transport.nsw.gov.au/downloads/trauma-trends-fatigued-distracted-driving.pdf
[2] NTI NTARC (2021). *Major Accident Investigation 2021 Report*. National Transport Insurance. Available from: https://www.nti.com.au/getmedia/aa1a1adf-d573-49ed-a8aa-16c81b2b8813/NTI-NTARC-Report-2021.pdf
[3] Dawson D., Searle, A. K., & Paterson, J. L. Look before you (s)leep: Evaluating the use of fatigue detection technologies within a fatigue risk management system for the road transport industry. *Sleep Med Rev, 18*, 141–52.
[4] Pyta, V., Gupta, B., Stuttard, N., Kinnear, N., & Helman, S (2020). *Assisting the update of INDG382: Vehicle technologies* (No. PPR968).
[5] Anderson, C., Chang, A. M., Sullivan, J. P., Ronda, J. M., & Czeisler, C. A. (2013). Assessment of drowsiness based on ocular parameters detected by infrared reflectance oculography. *Journal of Clinical Sleep Medicine, 9*(9), 907-920.
[6] Caffier, P. P., Erdmann, U., & Ullsperger, P. (2003). Experimental evaluation of eye-blink parameters as a drowsiness measure. *European journal of applied physiology, 89*, 319-325.
[7] Ftouni, S., Rahman, S. A., Crowley, K. E., Anderson, C., Rajaratnam, S. M., & Lockley, S. W. (2013). Temporal dynamics of ocular indicators of sleepiness across sleep restriction. *Journal of biological rhythms, 28*(6), 412-424.

The efficacy of DMS is supported by scientific research

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[8]. 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[9] and by leading experts in driver fatigue to investigate shift schedules in commercial truck drivers for the National Transport Commission[10]. These studies not only demonstrate that Seeing Machines technology is feasible for use in real-world conditions in trucks, but that it is consistent with gold standard measures of drowsiness under these conditions[10].

The safety impacts of Seeing Machines' technology are best demonstrated through analyses of safety outcomes in operational fleets. Research conducted in truck fleets in both South Africa[11] and Australia[12] demonstrated a 90-95% reduction in fatigue events when drivers received in-cab alerts. 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 operator to screen out any false positives. The Australian study was done with Monash University Accident Research Centre (MUARC) and involved data from an Australian fleet between 2011-2015. It 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[12].

[8] Mulhall, M. D., Cori, J., Sletten, T. L., Kuo, J., Lenné, M. G., Magee, M., ... & Howard, M. E. (2020). A pre-drive ocular assessment predicts alertness and driving impairment: a naturalistic driving study in shift workers. *Accident Analysis & Prevention, 135*, 105386.
[9] Shiferaw, B. A., Cori, J., Downey, L. A., Kuo, J., Lenne, M., Soleimanloo, S. S., ... & Howard, M. E. (2019, January). Fatigue among heavy vehicle drivers: the impact of shift-start times and time of day. In *41st Australasian Transport Research Forum (ATRF),* Canberra, ACT, Australia.
[10] Cori, J. M., Downey, L. A., Sletten, T. L., Beatty, C. J., Shiferaw, B. A., Soleimanloo, S. S., ... & National Transport Commission Heavy Vehicle Driver Project Team. (2021). The impact of 7-hour and 11-hour rest breaks between shifts on heavy vehicle truck drivers' sleep, alertness and naturalistic driving performance. *Accident Analysis & Prevention, 159*, 106224.
[11] Lenné, M. G., & Fitzharris, M. (2016). Real-time feedback reduces the incidence of fatigue events in heavy vehicle fleets. In *Proceedings of the 23rd ITS World Congress*, Melbourne, Australia.
[12] Fitzharris, M., Liu, S., Stephens, A. N., & Lenné, M. G. (2017). The relative importance of real-time in-cab and external feedback in managing fatigue in real-world commercial transport operations. *Traffic injury prevention, 18*, S71-S78.

With appropriate regulation, DMS can relieve drivers of a great pressure - to drive while drowsy

Fatigue is dynamic, with many environmental and individual factors contributing to its development. There are significant fatigue-related gaps within the current regulatory approach to managing driver fatigue. For example, the Tier 1 Hours of Service (HOS) regulations are focused on fatigue risk resulting from extended time awake, with little consideration for other fatigue risk factors.

An HOS framework needs to account for well-known scientific influences on driver fatigue that include the time of day a shift commences, and the duration of that shift by time of day. FDDT circumvent this through assessing fatigue and microsleep risk on a case-by-case basis at the individual driver level.

Fatigue progression across a shift

To examine the influence of time into shift and shift start time on fatigue, analyses were conducted on real-world driving data collected in an operational setting during a three-year research collaboration between Seeing Machines, Ron Finemore Transport, MUARC, and Volvo Trucks Australia. Data from 120 professional drivers (10 trucks) was analysed across a total of 415 shifts. Longer shifts (8-15 hours duration) were grouped by start time and examined.

The velocity of drivers' eyelid movements (Amplitude Velocity Ratio; AVR) is recognised as a strong predictor of drowsiness[7,13], with higher ratios associated with drowsiness. This objective measure of drowsiness was assessed across the entire duration of each drive. There was an increase from 12 AM - 2 AM, followed by a decline into the early afternoon and an increase from that point onwards[14]. As Figure 1 shows, 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. However, drivers who started their shift between the hours of 12 AM - 4 AM were initially drowsier but became progressively more alert towards the end of their shift. These results indicate that drowsiness does not always increase across a shift, with shift start time having a significant impact on how drowsiness develops. This could be explained by circadian phase effects, which have a strong influence on alertness over the 24-hour period[15,16].

---

[13] Johns, M. W., Tucker, A., Chapman, R., Crowley, K., & Michael, N. (2007). Monitoring eye and eyelid movements by infrared reflectance oculography to measure drowsiness in drivers. *Somnologie, 11*(4).
[14] Shiferaw, B. A., Kuo, J., Lenné, M., Fitzharris, M., Horberry, T., Mulvihill, C., … & Truche, C. (2021). Time of day influence on real-time detection of drowsiness and predicted sleepiness. *Driver Distraction and Inattention (DDI)*, Lyon, France.
[15] Kaduk, S. I., Roberts, A. P., & Stanton, N. A. (2021). The circadian effect on psychophysiological driver state monitoring. *Theoretical Issues in Ergonomics Science, 22*(5), 619-649.
[16] Zhang, H., Yan, X., Wu, C., & Qiu, T. Z. (2014). Effect of circadian rhythms and driving duration on fatigue level and driving performance of professional drivers. *Transportation research record, 2402*, 19-27.

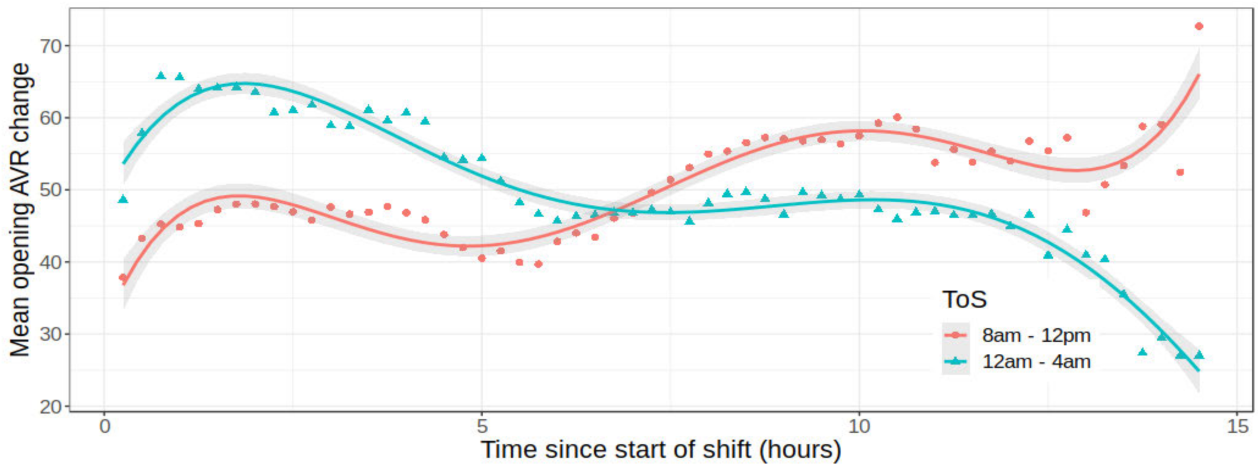

Figure 1. Eyelid opening AVR progresses differently across the duration of the shift depending on shift start time. Shifts starting in the morning (8 AM - 12 PM; red line) show an increase in drowsiness across the shift, while night shifts (12 AM - 4 AM; blue line) reach peak drowsiness in the first few hours of the shift before decreasing.

A key takeaway here is that managing fatigue risk cannot be achieved by simply equating time spent driving with risk. Fatigue monitoring technologies provide an additional layer of protection for drivers who are fatigued due to reasons beyond how long they have been driving. Conversely, in other circumstances a driver may be fit to drive beyond 14 hours, and this technology can support driver safety when working extended hours by monitoring and detecting drivers who are at risk of fatigue.

Time into shift before first fatigue event

Shiferaw et al.[9] 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 (~ 7.5 hours).

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 nighttime (between 6 PM and 6 AM; see Figure 2b).

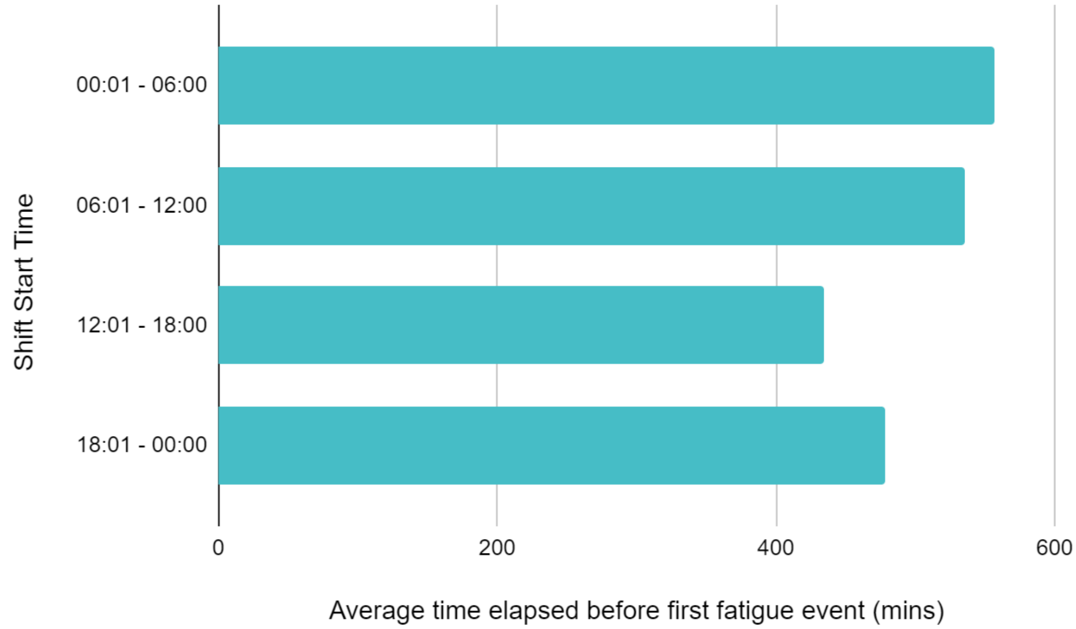

Figure 2a. Average time elapsed before drivers experienced first fatigue event in a shift. The difference between shift start times is statistically significant, $p < .001$.

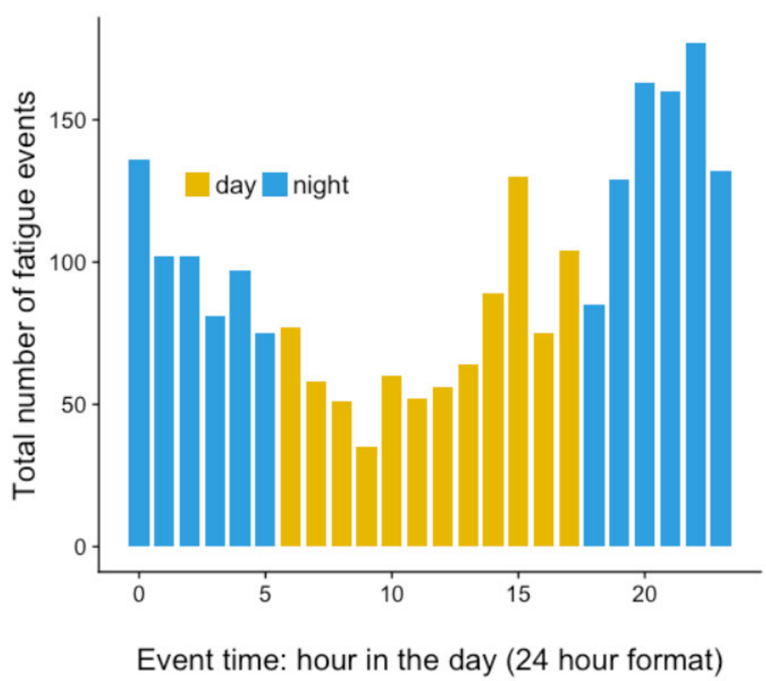

Figure 2b. Fatigue event occurrence across 24 hours demonstrating time of day effects.

These findings demonstrate the complexity of fatigue progression, with fatigue varying as a result of multiple factors beyond simply the duration of the drive. It has been proposed that FDDT may only be required 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 above findings highlight the value of FDDT regardless of whether long schedules are being used.

Global regulation is recognising the safety case for DMS

There is an increasing global mandate for DMS, led by the European Commission's General Safety Regulation (GSR) that all new passenger vehicles sold in Europe from 2024 must have new technologies including Driver Drowsiness and Attention Warning (DDAW). DMS technology is clearly gaining momentum as Seeing Machines OEM solutions now have over 1 million units on the road with 52,000 Guardian aftermarket connections.

This is supported by European NCAP programs that have this year begun to award points for DMS. Starting January 1st, 2023, EuroNCAP will only award full points to passenger vehicles that use DMS for distraction and drowsiness detection. Significant work has been accomplished in determining performance metrics for drowsiness and distraction. A paper published in *Frontiers in Neuroergonomics*, lays out several potential performance metrics and considerations for utilising DMS technology[17].

In April, EuroNCAP announced that it would expand this rating to commercial vehicles through the innovative Truck Safe City and Highway rating scheme. According to the EuroNCAP Safer Trucks report[18], "*There appear to be strong benefits from linking to fleet management systems that allow drivers struggling with fatigue to be identified and helped with softer interventions rather than just in-cab warning*." EuroNCAP is investigating DMS technology with the intention to require DMS for commercial vehicles as soon as 2027.

The United States is considering a similar approach to Europe. The Infrastructure Investment and Jobs Act, which authorises the U.S. transportation system including vehicle safety, was signed into law in late 2021 and contains significant provisions related to DMS. Specifically, the Department of Transportation (DOT) is required to complete advanced studies on DMS with a further requirement to begin a rulemaking if the technology is determined to save lives. This research is both timely and expected to result in new federal motor vehicle safety standards. These systems are growing in popularity, and this reinforces the efficacy of DMS at supporting driver safety.

[17] Fredriksson, R., Lenné, M. G., van Montfort, S., & Grover, C. (2021). European NCAP program developments to address driver distraction, drowsiness and sudden sickness. *Frontiers in Neuroergonomics, 2,* 786674.
[18] European NCAP (2023). *Safer Trucks: On the road to Vision Zero – 2023 and beyond*. Available from: https://cdn.euroncap.com/media/77173/2304-euro-ncap_safer-trucks_on-the-road-to-vision-zero.pdf

Final Remarks

Seeing Machines applauds the efforts of Portfolio Committee No. 6 - Transport and the Arts in establishing the inquiry into the pressures on heavy vehicle drivers and their impact in New South Wales.

The purpose of our response is to show that proven technology exists today that can reduce pressures on heavy vehicle drivers through detecting and managing fatigue in real-time.

Our response can be summarised as follows:

- **Fatigue is highly prevalent in the heavy vehicle industry**
- **There are many factors that promote the occurrence of fatigue - a main one being scheduling as dictated by current regulations**
- **There are approaches to managing risk today. Camera-based DMS have validated capability to objectively detect fatigue levels in real-time**
- **We advocate for a regulatory framework that relieves pressure on drivers by aligning driving time with their actual fatigue levels - which can be achieved with FDDT. This would be a great step forward for Australia.**
- **Camera-based driver monitoring systems are a fully mature technology and already used by trucking fleets around the world to protect drivers**

Australia has been a global leader in road safety, and we believe that supporting the uptake of DMS will place New South Wales and Australia at the forefront of advancing road safety.