

EVALUATION OF THE SEEING MACHINES GUARDIAN GEN 2 DRIVER FATIGUE AND DISTRACTION MONITORING SYSTEM IN INTERIOR BRITISH COLUMBIA LOG-HAULING OPERATIONS

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ABSTRACT:

As part of FPInnovations’ and BC Forest Safety Council’s ongoing evaluation of fatigue management technology, Seeing Machines’ Guardian Gen 2, an eye-tracking–based driver assistance system that monitors driver fatigue and distraction, was evaluated in Interior B.C. log-hauling operations. In addition, driver fatigue scores based on a wristband technology, Readiband, were correlated with the drivers’ reported scores to verify the fatigue level in the participating fleets. The study findings, participants’ feedback, and onboard device performance are summarized in this report.

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INTRODUCTION

Driver fatigue increases the risk of motor vehicle accidents (Bioulac et al., 2017); the Kee & Tramrin (2010) study suggests driver's reaction time increases by up to 18 percent. The consequences of a fatigue-related incident could result in serious injury, damage to property, or loss of life (Dawson & Bowe, 2019). Therefore, a driver's fatigue level should be considered when determining fitness for duty. Seeing Machines' Guardian technology is a fatigue monitoring system that alerts the driver if it detects fatigue, thereby reducing the risk of fatigue related incidents. Seeing Machines' Guardian technology uses an eye-tracking-based technology that tracks drivers' eyes and head movement to detect drowsiness and microsleeps (NTC, 2016).

In 2018, FPIInnovations and the BC Forest Safety Council (BCFSC) evaluated the first-generation Guardian system in Coastal B.C. log-hauling operations (Shetty & Kohorst, 2019). The evaluation of the system found the technology useful in identifying high-risk behaviours such as distracted driving. However, there was low prevalence of fatigue-related events such as microsleeps and drowsiness. The correlation between the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) score that is based on a wristband technology and the Karolinska Sleepiness Scale (KSS) that is based on the drivers' reported scores was found to be low.

In order to determine acceptability of the technology, drivers were surveyed at the end of the study. Drivers rated the technology favourably; however, they found the system was too sensitive for the log-hauling environment, due to false-positive alerts from distraction events. The feedback from the 2018 study was provided to the system manufacturer.

In March 2019, Seeing Machines released the 'Guardian Gen 2' system (Figure 1). Upgrades from the first-generation system included consolidation of the forward-facing camera and infra-red illuminator, reduction in the number of antennas, and improved algorithms. One of the recommendations from the 2018 study was to assess application of the technology within B.C. Interior log hauling operations, where differences in operating conditions could potentially impact fatigue risk. These differences are specifically because operating hours are generally longer in the Interior, when compared to B.C. Coastal operations. In addition, differences in operating conditions, specifically during the time prior to spring break-up, require drivers to operate a nightshift. Given the operational specificity, a second study was initiated in 2019 within B.C. Interior operations, in partnership with Tolko Industries.



Figure 1. First generation (left) and second generation (right) versions of the Seeing Machines Guardian technology.

OBJECTIVES

The objectives of this study were to:

- Evaluate the use of Seeing Machines' Guardian Gen 2 technology in B.C. Interior log-hauling operations; including its overall performance, effectiveness, acceptance, and usability
- Continue to evaluate whether there is a correlation between the SAFTE score and fatigue events or the KSS

METHODOLOGY

Study Method

The study took place in Interior B.C. Tolko operations. Eight drivers from six log hauling fleets participated. Seeing Machines provided training for the technicians that installed the units. The project facilitators supported the fleets during the installation and training period to ensure that drivers and fleet managers understood the technology. Figure 2 illustrates potential driver distraction elements and the placement of Seeing Machines' components.



Figure 2. Distraction elements within the cab (left) and Seeing Machines' device components (right).

The study consisted of a baseline establishment stage followed by an active fatigue management stage.

Baseline stage: Due to early implementation of night shift, the baseline period (when the system's alerts are turned off) was reduced to two weeks instead of three weeks. The period was shortened to optimize data collection during the night shift. This reduction should not have a significant impact on the study results, due to the consistency with the active fatigue management stage. Fatigue and distraction data were collected from six drivers using Readiband (wristband-based driver alertness monitoring device) and Seeing Machines' units. During the baseline stage in-cab alerts were disabled; however, the system did capture the fatigue and distraction events and send emails to fleet managers for verified fatigue events.

Active fatigue management stage: Monitoring of the same group of drivers continued to the end of hauling operations (in most cases an additional two weeks). In-cab audio and seat vibration alerts were activated for events identified by the system as 'fatigue detection'. System-detected distraction events only initiated an in-cab audio alert.

One of the trucks was not in service during the active fatigue management period¹. Two units were affected by system errors related to GPS and camera misalignment for the entire study. Therefore, data collection was limited to five trucks for the duration of the active fatigue management portion of the study. In addition to data collected through Seeing Machines, Readibands and daily sleep journals were provided to drivers to support project objectives and data requirements. Drivers completed daily sleep and activity journals, which were used to validate sleep periods, collect KSS data, record breaks, track medication/caffeine use, and document shift schedules for each driver. In addition, drivers recorded any fatigue prevention measures or countermeasures used, such as shortening shift duration, adjusting start times, taking a power nap, or drinking caffeine. The KSS is a subjective score that was used to assess the drivers' sleepiness state at the start and end of the shift; drivers rated this score and recorded it in their sleep journal. Table 1 shows the KSS from 1 to 9. A lower number indicates a higher level of alertness; a higher number indicates increased fatigue. In this study, the names of the drivers were kept confidential. Fleet managers had access to all the Seeing Machines' recorded events via a manager dashboard;² and, at their discretion, were able to use it to act when distraction or fatigue incidents were reported by the Seeing Machines system.

Table 1. The Karolinska Sleepiness Scale (KSS)

KSS	Description
1	Extremely alert
2	Very alert
3	Alert
4	Rather alert
5	Neither alert nor sleepy
6	Some sign of sleepiness
7	Sleepy, but no effort to stay awake
8	Sleepy, some effort to stay awake
9	Very sleepy, great effort to stay awake

The manager dashboard was available to fleet managers throughout the project. Table 2 shows the monitoring parameters during the baseline stage and the active fatigue management stage.

Table 2. Variation of the parameters during the baseline establishment stage and active fatigue management stage

Parameters	Baseline establishment stage	Active fatigue management stage
Number of trucks in which Seeing Machines were installed	8 ^a	8
Number of drivers on active trucks	6	5
Onboard alerts	No	Yes
Sleep and fatigue data collected	Yes	Yes
Seeing Machines' manager dashboard active	Yes	Yes
Readiband app. fatigue monitoring	Yes	Yes
Duration	2 weeks ^b (February 26 to March 11)	2 weeks (March 12 to March 26)

^a One truck was not in service after the baseline period. One truck had a GPS issue and one truck had a camera misaligned for most of the study period

^b less in some cases

¹ Although the out-of-service truck's baseline data were included in the study

² Tolko staff had no access to the dashboard, videos, or any personally identifiable information about the drivers

Monitoring Conditions

The parameters for creating an event record (record of fatigue, distraction, and other events) are presented in Table 3. Prolonged eye blinks were classified as drowsiness; very long eye closure and small eyelid openings were classified as microsleeps. Yawning generally occurs when a person is under stress and is tired (Karlson et al. 2011). Frequent yawning is one of the symptoms of driver fatigue (Tiffet 2010 and Sparrow et.al. 2019) and an important cue for the presence of driver fatigue, as found in Mohanty et. Al. 2009 and Abtahi et.al. 2011 studies; thus, these were categorized as fatigue-related events in this report. There is evidence of excessive yawning as a sign of fatigue. Jie et.al (2018) study suggests yawning as an important sign of fatigue and that fatigue monitoring systems should not ignore yawning events.

Table 3. Trigger conditions for recording events

Event	Duration (seconds) longer than:	Vehicle speed (km/h) greater than:	
		Current study	2018 study
Fatigue events (either drowsiness ^a or microsleep ^b state)	1.5	10	24
Distraction events indicated by head movement, such as glancing away or glancing down	4	40	30
Distraction events indicated by eye movement, such as attention off the road	1.5	10	30
Restricted behaviour events, such as cell phone use	Classified regardless of duration	Classified regardless of speed	
Obstructed view of driver facing camera	600	10	

^a A state of quiet wakefulness that typically occurs before sleep onset (AASM, 2001)

^b An episode lasting up to 30 seconds during which external stimuli are not perceived (AASM, 2001)

Drivers were alerted as soon as the system detected a fatigue or distraction event. Alerts within the cab were audio alerts for distraction type of events and audio alerts along with seat vibration for fatigue events. When the system detects an event, a few seconds of video from both the forward facing and rear facing cameras along with other telemetry data are sent to Guardian Centre for review. This occurs live if the unit is within cell coverage or is sent when the truck gets within cell coverage. Seeing Machines staff review event records, reclassify events based on a qualitative assessment, and alert the fleet manager through email when the event is verified as fatigue.

Events “eyes off the road but not closed for more than 1.5 seconds” were reclassified as distracted driving as these events were not fatigue events. Seeing Machines classified yawning events as false positives. Even though these events triggered alerts to the drivers they did not trigger alerts to fleet managers, as only safety critical events were reported.

Readiband sleep and fatigue data were collected to further determine the correlation between subjective fatigue levels and predictive fatigue levels. Figure 3 presents SAFTE thresholds correlated to blood alcohol content (BAC). A SAFTE score of 70 is considered equivalent to 22 h awake and 0.08 BAC (legal limit in Canada); a score of 77 is

considered equivalent to 17 h awake and 0.05 BAC (legal limit in British Columbia). Therefore, a score of 77 or lower is considered as fatigue impaired based on this equivalency.



Figure 3. Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) threshold (BAC: blood alcohol content) (Image source Fatigue Science – All rights reserved).

Evaluation Process

As part of the evaluation process, the following criteria were evaluated that would help the industry in making informed decision on the implementation of this technology within their fleets:

- Ease of installation
- Required training and ease of use
- Driver acceptance
- Performance and reliability
- Level of support from the technology provider

The comparison of baseline and active fatigue management periods and correlation of the subjective and objective scores for level of fatigue in the field assisted in evaluating the Seeing Machine Gen 2's performance and reliability.

RESULTS AND DISCUSSION

Seeing Machines Operational Performance and Effectiveness

Table 4 summarizes fatigue-related events for both the baseline and active fatigue management stages. During the baseline stage there were in 15 drowsiness events, 1 microsleep event, and 226 yawning events. Fewer

fatigue-related events were observed during the active fatigue management stage than what was observed during baseline stage.

Table 4. Total number of fatigue-related events

Type	Baseline stage	Active fatigue management stage	Difference
Drowsiness	15	4	11
Microsleep	1	0	1
Yawning	226	52	174

The progression of driver fatigue events during a same trip in the baseline period is presented in Appendix A. It was observed that there were yawning occurrences before drowsy or microsleep events. Yawning, as an early sign of fatigue, is still a subject of research. Although Thompson (2014) had studied the link between yawning, fatigue, and cortisol levels, concrete scientific evidence linking all three elements has not been found.

The microsleep event occurred on a highway, although at low speed. In the case of drowsiness, several events occurred on the same trip during the baseline period. There were a couple of instances where drowsiness events occurred on gravel roads in curvy sections of the road just before the trucks turned onto the highway. Having real-time alerts to the dispatcher for fatigue-related events to respond if the driver fails to act will be important in mitigating the risks.

Figure 4 shows the duration of fatigue-related events during the baseline and active fatigue management stages. The mean for drowsiness duration was 2.6 s and 1.9 s (with the standard deviation of 0.8 s and 0.006 s) for baseline and active fatigue management periods respectively. In the case of yawning, the mean duration for baseline and active fatigue management periods were 1.92 s and 1.78 s respectively. This translates into a reduction in duration of 0.64 s (25%) in drowsiness events and 0.14 s (7%) in yawning events between the baseline and active fatigue management periods. This difference in duration may be attributed to the Seeing Machines system alerting the drivers that a fatigue event had occurred; however, for conclusive findings, the system should be monitored for long term.

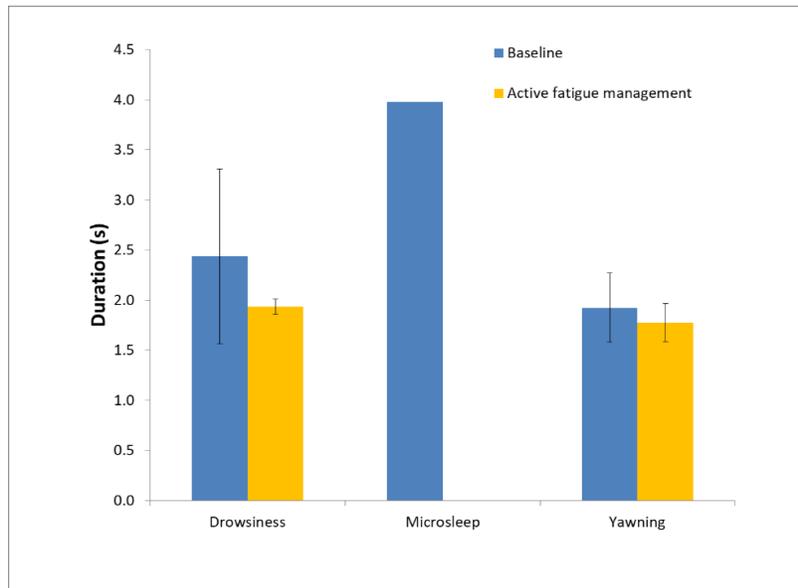


Figure 4. Duration of fatigue-related events (inclusive of the 1.5 s threshold): baseline vs. active fatigue management stages.

The number of distraction events by distraction type during the baseline and active fatigue management stages is presented in Table 5. The number of distraction events was considerably lower when compared to the previous study, which may be attributed to several variables; such as shorter study period, on duty hours, operating conditions, improvement in technology/system, etc. Overall, there was a 19% reduction in distraction events between the baseline and active fatigue management stages. Again, this reduction may be attributed to intervention of Seeing Machines system; however, this need to be confirmed with the long-term study. Some restricted behaviours such as cell phone use were observed in this study.

Table 5. Distraction-related events

Type	Baseline stage	Active fatigue management stage	Difference
Other distraction events (e.g., cell phone use, smoking, eating, reaching around within cab, nail biting)	2	2	0
Glance down (instrument panel, cell phone viewing) (obstructed view)	1	1	0
Glance away, left (mirror check)	2	0	2
Glance away, right up (communication radio)	11	0	11
Overall	16	3	13

The longer the duration of an “eyes off the road” event, the higher the likelihood of incidents. Liang et al. (2012) and Simons-Morton et al. (2014) showed that the likelihood of a crash and near-crash event is:

- 3.8 times higher for a duration greater than 2 s “eyes off the road” event during all secondary tasks (tasks subordinate to driving activity, such as eating and drinking, reaching for objects in the vehicle, adjusting the radio and other equipment on the steering wheel or centre console, and operating devices such as the window control, seat belt, or sun visor), and

- 5.5 times higher for a duration greater than 2 s during secondary task engagement (use of a cell phone—i.e., talking, dialling, and texting while driving—which is illegal in B.C.).

Figure 5 shows the duration for “eyes off the road” distraction events. Significant reduction in the duration for these events (especially for glance down and other events) was observed between the baseline and active fatigue management stages.

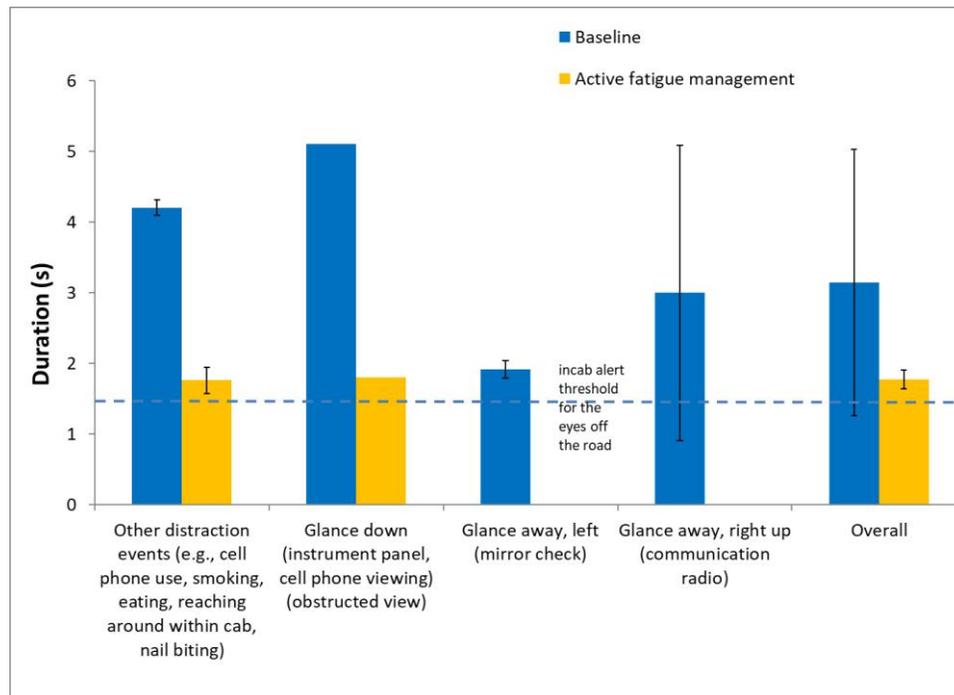


Figure 5. Duration of distraction events (inclusive of the 1.5 s threshold) for the baseline and active fatigue management stages.

When an event was detected drivers received real-time alerts, whereas managers were alerted after Seeing Machines staff verified the events. Table 6 shows the reclassification of false positive alerts during the active fatigue management stage. Seeing Machines staff reclassified the fifty-nine events as four true fatigue events, three distracted driving events and fifty-two yawning events. The two recorded distraction events were also reclassified as acceptable driving.

Table 6. Reclassification of false positive and true alerts during the active fatigue management stage

Truck no.	Fatigue alert (audio and vibration)			Distraction alert (audio only)	
	True	False positive reclassified as		True	False positive reclassified (Acceptable Driving)
		Distraction	Yawning		
1	1	0	4	0	1
2	1	0	0	0	0
4	2	0	0	0	0
5	0	1	48	0	1
6	0	2	0	0	0
Total	4	3	52	0	2

Seeing Machines Acceptance and Usability

Drivers' Acceptance

A driver survey was distributed at the end of the study to solicit feedback on system operation and its effectiveness as a tool for managing fatigue and distraction. The driver survey form used in the study is presented in Appendix B. Four drivers completed the survey and Table 7 summarizes their feedback. The drivers indicated that they found the system moderately effective in managing fatigue and distraction and rated the Seeing Machines technology moderate to very effective. One-quarter of the drivers felt the system infringes on their privacy if made mandatory, half of the drivers felt that the technology helped them change their driving habits, while three-quarters of the drivers also felt that the technology improved overall safety. All drivers who participated in the survey would recommend the Seeing Machines Guardian Gen 2 technology. Overall, the driver acceptance was better than in the previous study.

Table 7. Drivers' feedback

Category	Average feedback	Compared to 2018 study ^a
1. Effectiveness in managing distraction	Moderately effective	
2. Effectiveness in managing fatigue	Moderately effective	
3. Technology rating	Moderate to very effective	No change
4. Privacy infringement	25% felt their privacy was infringed upon if made mandatory	
5. Distraction	25% of the drivers thought device alerts were distracting during first week of active fatigue management period	
6. Feedback adequate	75% of the drivers found the feedback was adequate	
7. Change in driving habit	50% of the drivers indicated that the technology helped change their driving habit	
8. Incident avoidance	No incident avoidance	No change
9. Break encouragement	No break encouragement	No change
10. Improved safety	75% of the drivers felt that the technology improved safety	
11. Recommend	All drivers who participated in the survey would recommend Seeing Machines	

^a Upward arrow represents improved score and downward arrow represents reduction in score

Fleet Managers' Acceptance

Feedback was also solicited from the six fleet managers, four of which responded. The survey form is presented in Appendix C. Results are presented in Table 8. The managers found deployment, training, and use to be easy, and system performance and reliability to be moderate. The managers liked the concept and 75% of them were in favour of implementing this technology. Deployment and performance issues caused the fleet managers to rank the Gen 2 a bit lower than the average scores of the previous study.

Table 8. Fleet managers' feedback

Category	Average feedback	Compared to 2018 study ^a
1. Ease of deployment and maintenance	Easy	
2. Training required	Very minimal	No change
3. Ease of use	Moderately easy	
4. System performance and reliability	Somewhat reliable	
5. Ease of data management	Moderately easy	No change
6. Level of tech provider's support	Moderate support	
7. Safety improvement	Moderate impact	No change
8. Technology rating	Moderately liked	
9. Satisfaction level	Moderately satisfied	
10. Corrective action taken	Yes	No change
11. Resistance from driver	Some due to privacy concerns	No change
12. Implement technology	75% of the fleet is in favour of implementing this technology	
13. Comments	1) Support should notify customer when unit is not working, 2) Liked the idea but drivers didn't like the forward-facing camera 3) The data were surprising; thus, the device was highly beneficial for safety-oriented company	

^a Upward arrow represents improved score and downward arrow represents reduction in score

Correlation Between the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) Score and Karolinska Sleepiness Scale (KSS) Score

The correlation between the SAFTE score and KSS subjective score was conducted to verify the fatigue level of the participating drivers. Figure 6 presents the frequency distribution of the SAFTE scores during the shift based on four drivers' data and shows that 72% of data is within the alertness range, while 28% is within the fatigue range.

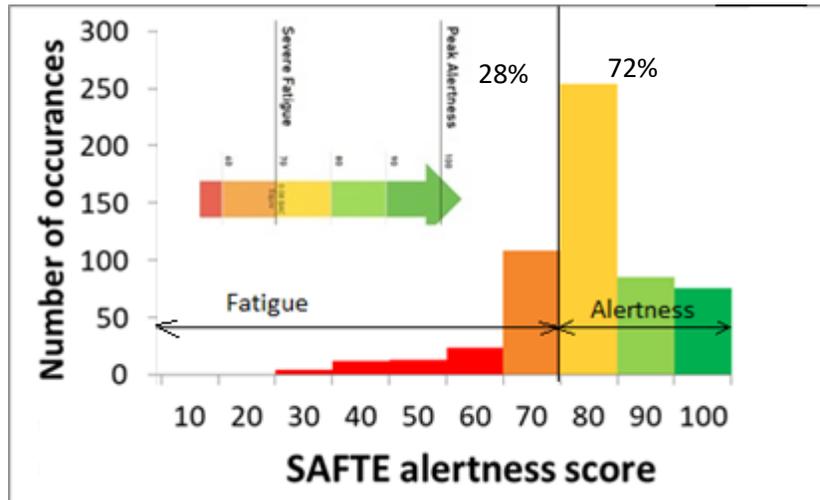


Figure 6. SAFTE score's frequency distribution during shift.

The SAFTE alertness score is an objective alertness scale with a range from 0 to 100 (measured by the Readiband). The SAFTE alertness scores are hourly averages. A SAFTE score below 70 indicates there is an increased risk of fatigue impairment; a score above 80 indicates peak alertness. KSS is a subjective sleepiness 9-point Likert-type scale; a KSS score above 7 indicates a sleepy state. Figure 7 shows the lower quartile of SAFTE scores is in a zone of high fatigue risk while the upper quartile of KSS is the zone of sleepy state. There were more than ten reported instances where the driver's fatigue state at the beginning of the shift was high based on KSS and Readiband reporting.

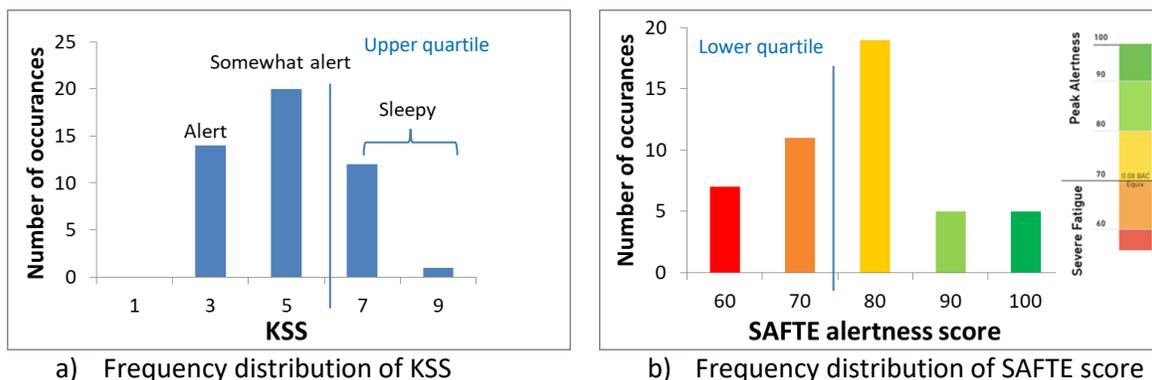


Figure 7. Frequency distribution of KSS and SAFTE scores while taking into account the scores only during the start of the shift and the end of the shift period.

The correlation between these two scales was examined with 78 observations and the correlation did not show a statistically significant trend. As the SAFTE's alertness scores dropped below 70, the alertness scores were in the sleepy zone of the KSS scale. However, due to variability in score correlation, it is possible for the driver to be

fatigue impaired at higher alertness scores. The drivers in this study reported being more fatigued than the drivers in the 2018 study.

The study results indicated that driver alertness decreased as the work week progressed. Recovery was achieved and alertness level increased with increased sleep over the weekend. Figure 8 shows the decreasing trend in SAFTE alertness scores for the participating fleets as the week progressed. A similar trend was observed in the earlier study. The data indicates that, on average, the drivers in this study were operating at a higher chance of fatigue/impaired state for 20% of the week/operating hours.

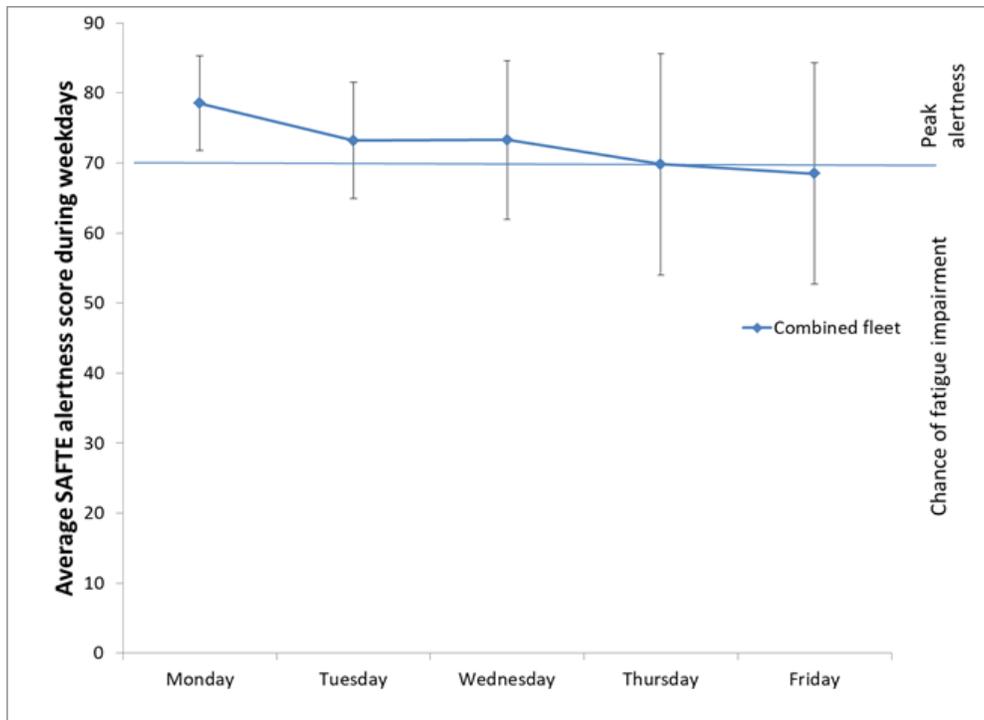


Figure 8. Average Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) alertness score during weekdays.

The KSS score showed a similar trend in sleepiness levels (Figure 9) based on the subjective feedback. Drivers self-reported that they were less alert at the end of the shift towards the end of the week.

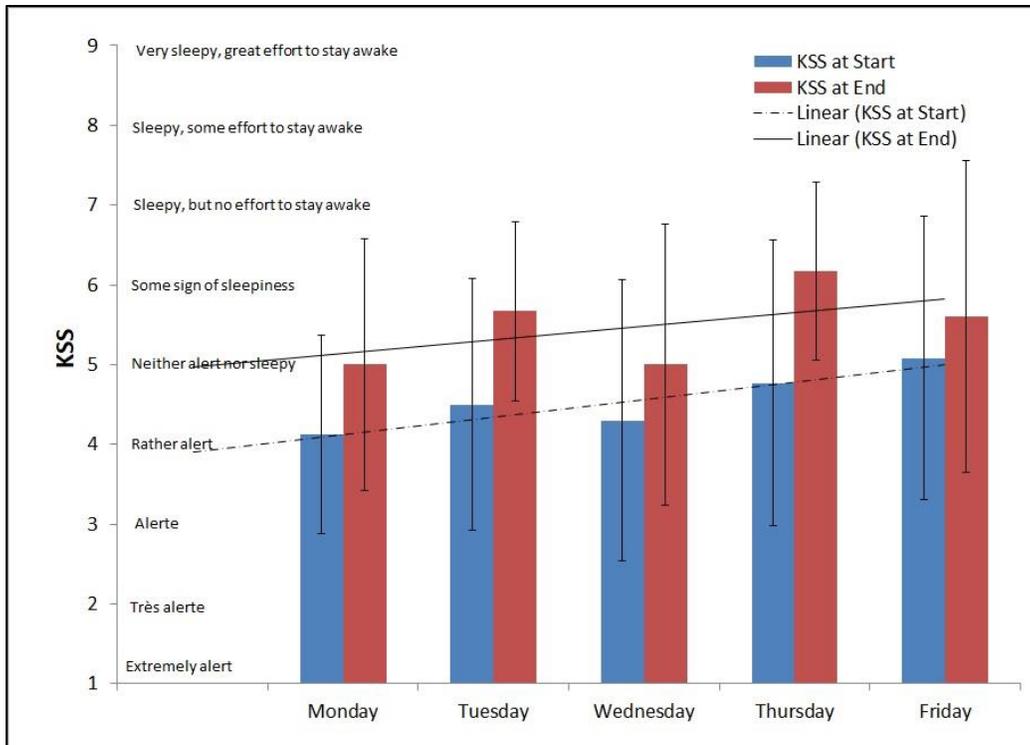


Figure 9. Comparison of the Karolinska Sleepiness Scale (KSS) at the start and end of shift throughout the week during the baseline and active fatigue management stages.

The average sleep duration for drivers was 6.0 h, with a minimum duration of 3.5 h and a maximum duration of 10.3 h. Some drivers indicated that they stretched, took caffeine, and exposed themselves to sunlight to help manage fatigue. None of the drivers reported napping as a countermeasure.

CONCLUSION

During the study period, the Seeing Machines Guardian Gen 2 system identified several quantifiable fatigue events during night shift operations. The system also identified distraction events. Some restricted behaviours (such as cell phone use while driving) were also observed.

Some improvement was observed between the baseline and active fatigue management stages. The reduction of drowsiness duration of 0.64 s and yawning duration of 0.14 s were observed during the active fatigue management stage. Reduction in these durations is likely due to in-cab alerts. Some drivers reported very favourably about the system, and some had privacy concerns. Overall, most drivers accepted the system. Drivers' acceptance could be further improved by reducing the frequency of false positive alerts, addressing their privacy concerns, and improving system reliability based on the feedback received. Technical issues with the non-working units affected fleet manager scores. However, 75% of fleet managers were in favour of implementing this technology into their fleets.

The correlation between the SAFTE alertness score and KSS did not show a statistically significant trend. In this study, the upper quartile of the KSS data and lower quartile of the SAFTE data showed higher level of fatigue impairment compared to the previous study.

The Seeing Machines' Guardian Gen 2 system is a promising technology for reducing fatigue and distraction-related incidents, thereby improving safety. However, although the system has been improved from the previous study, the number of false-positive fatigue alerts still needs to be addressed.

KEY POINTS

The key points from this study are as follows:

- The technology was found to be useful in identifying and alerting the driver during a fatigue or distraction event.
- Reduction in duration of “eyes off the road” due to drowsiness or distractions can be achieved with the use of this technology.
- The progression of the events (from yawning to drowsiness) that were observed in this study indicates that if real-time alerts were sent to the dispatcher, this could mitigate the risk if the driver does not take action.
- There were fewer distraction alerts in this study than in the previous study, which may be attributed to several variables; such as shorter study period, on duty hours, operating conditions, improvement in technology/system etc.
- Some restricted behaviours, such as cell phone use while driving, were observed in this study.
- For the drivers and fleet managers that replied to the survey, the following are some of their key points:
 - Drivers rated the technology favourably and all of them would recommend this technology;
 - Half of drivers reported their driving habits changed as result of this technology; and
 - 75% of the fleet managers were in favour of implementing this technology in their fleet.
- Technical issues may have been a result of the software upgrade mid-project or system support, which includes software and hardware.
- Three fleets (including drivers) requested access to the road-facing-camera recorded video footage to assist with incident investigations.

NEXT STEPS

The suggested next steps are as follows:

- Improve antenna and camera orientation, and over-the-air (OTA) firmware upgrades to alleviating technical issues.
- Continue working with Seeing Machines to reduce false positives.
- Collaborate with Seeing Machines to improve system reliability, enhanced support, and for further system tweaking.
- Continue discussions with industry, fleet owners, and drivers to determine parameters for alert settings.
- Due to the short study period, it is recommended to study the effectiveness of Seeing Machines' Guardian Gen 2 technology over a longer period.
- Continue to develop strategies that reduce the risk of fatigue- and distraction-related incidents. This type of technology is a component of a program but is not the complete solution in managing fatigue and distraction. Some of the recommendations from Australia's fatigue management guidelines for developing and implementing a fatigue-management policy in forestry (Dawson & Bowe, 2019) and from the North America Fatigue Management Program's guidelines (Thiffault, 2011) could potentially be utilized to develop best practices for fatigue management.

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APPENDIX A. SEEING MACHINES' RECORDED FATIGUE EVENTS BY DRIVER AND ROAD TYPE

Driver	Day (Time of day)	Fatigue-related events (closure duration, travel speed)								
		Off-highway				Highway				
1	Day 1 (8-9 a.m.)					Yawning (3 times)	Drowsiness (1.59 s, 62 km/h) Followed by yawning once	Drowsiness (1.67 s, 52 km/h)	Drowsiness (2.68 s, 47 km/h) Followed by yawning twice	Drowsiness (2.31 s, 42 km/h)
2	Day 2 (7-8 p.m.)				Yawning (1 time)	Yawning (6 times)	Micro sleep (3.98, 31 km/h)			
2	Day 3 (4-6 a.m.)	Yawning (5 times)	Drowsiness (3.04 s, 33 km/h)	Drowsiness (2.85 s, 32 km/h)		Yawning (1 time)	Drowsiness (1.63 s, 38 km/h)	Yawning (2 times)		
2	Day 4 (5-7 a.m.)	Yawning (7 times)	Drowsiness (5.16 s, 28 km/h)	Yawning (1 time)	Drowsiness (2.44 s, 28 km/h)	Yawning (5 times)	Drowsiness (1.87 s, 31 km/h)	Drowsiness (2.43 s, 64 km/h)	Drowsiness (2.20 s, 36 km/h)	Drowsiness (2.78 s, 35 km/h)

APPENDIX B. DRIVER SURVEY FORM



Evaluation of Seeing Machines fatigue/ distraction monitoring system in log-hauling fleets



1. How effective do you consider the Seeing Machines' system in preventing distracted driving?
 1 2 3 4 5 6 7 8 9 10
Not effective at all -----Moderately ineffective-----Effective-----Moderately effective-----Very effective
2. How effective do you consider the Seeing Machines' system in preventing fatigue related incidents while driving?
 1 2 3 4 5 6 7 8 9 10
Not effective at all -----Moderately ineffective-----Effective-----Moderately effective-----Very effective
3. Do you feel that fatigue/distraction infringed on your privacy? Yes No
4. Did the Seeing Machines system alerts distract you while driving? Yes No N/A
5. Were the systems' warning signals and feedback adequate? Yes No N/A
6. Have your driving habits changed as a result of use of this system? Yes No
7. Were there situations when having the system installed helped to avoid an incident? Yes No
8. Did you take breaks when this system indicated that you were fatigued? Yes No
9. Are there improvements that you would recommend to the system? If so, what?
10. Rate this technology for monitoring and preventing fatigue/distraction from 1 to 10
 1 2 3 4 5 6 7 8 9 10
Highly disliked-----Moderately disliked-----Somewhat liked-----Moderately liked-----> Highly liked
11. Did this technology improve your safety while driving? Yes No
12. Would you recommend this system to others? Yes No
13. Do you have any other comments or feedback regarding the Seeing Machines system?

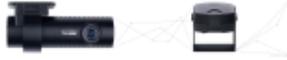
APPENDIX C. FLEET MANAGER FEEDBACK FORM

June 2018

FPInnovations 

Fleet Manager Survey Form

Evaluation of Seeing Machines fatigue/distraction monitoring system in log-hauling fleets



1. Rate ease of deployment and maintenance for this technology from 1 to 10

1 2 3 4 5 6 7 8 9 10

Very difficult -----Moderately difficult-----Easy-----Moderately easy----->Very easy

Comments: _____

2. Rate the training required for this technology from 1 to 10

1 2 3 4 5 6 7 8 9 10

Intensive training -----Moderate training-----Minimal training----- Very minimal ----->No training required

Comments: _____

3. Rate this technology in ease of use from 1 to 10

1 2 3 4 5 6 7 8 9 10

Very difficult -----Moderately difficult -----Easy-----Moderately ease----->Very easy to use

Comments: _____

4. Rate this system's performance and reliability from 1 to 10

1 2 3 4 5 6 7 8 9 10

Highly unreliable -----Unreliable-----Somewhat reliable-----Moderately reliable-----> Highly reliable

Comments: _____

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5. Rate the ease of data management for this technology from 1 to 10

1 2 3 4 5 6 7 8 9 10

Very difficult-----Somewhat difficult-----Easy-----Moderately easy-----> Very easy

Comments: _____

6. Did you or your staff take corrective action when critical alert messages were emailed to you? Yes No

7. What has been the general reaction from operators? Was there a resistance to using the system from drivers? If so, why?

8. Rate the level of support received from the technology provider during pilot test

1 2 3 4 5 6 7 8 9 10

No support -----Minimal support-----Some support-----Moderate support-----> High support

Comments: _____

9. Did this technology improve safety of your trucking operations? Rate the impact from 1 to 10

1 2 3 4 5 6 7 8 9 10

No impact -----Some impact-----Moderate impact-----> High impact

Comments: _____

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BC Forest Safety
Safety is good business

10. Rate this technology for monitoring and managing fatigue and distraction from 1 to 10

1 2 3 4 5 6 7 8 9 10

Highly disliked-----Moderately disliked-----Somewhat liked-----Moderately liked-----> Highly liked

Comments: _____

11. Rate your satisfaction level for this technology from 1 to 10

1 2 3 4 5 6 7 8 9 10

Unsatisfactory ---Somewhat unsatisfied-----Satisfied -----Moderately satisfied-----> Highly satisfied

Comments: _____

12. Would you implement this technology in your fleet? Yes No

13. If the answer to question 12 is no, then please specify reasons for not implementing (select all that apply)

Cost Driver rejection No impact Difficult to manage Technology not ready

Intensive training required No support Difficult to deploy Others _____

14. Do you have any other comments or feedback regarding the Seeing Machines' Guardian fatigue and distraction monitoring system?





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