FATIGUE PREVENTION ON ROADS AS THE NEXT STEP TOWARDS 'VISION ZERO'

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Using WOMBATT's innovative voice-based AI fatigue prediction and FRMS App to support the EU Road Safety Policy Framework 2021-2030

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WOMBATT
Worldwide Online Monitoring By Alerting Tired Travellers

Introduction

Fatigue as a root cause for severe accidents on EU Roads

Around 40% to 60% of all European work-related fatalities are the result of road accidents that occur during work or while commuting to and from work. Every year around 22,700 people die on EU roads, of which fatigue is responsible for around 20% to 25%, and around 120 000 are seriously injured. Fatigue related microsleeps in drivers cause the most severe of accidents, often resulting in injury and death due to the driver's failure to respond to an emergency with any self-preservation actions, such as braking or swerving, resulting invariably in high impact speeds under full power with the foot still on the accelerator pedal. The fatigue problem leaves even the most experienced professional road users at the mercy of their own and others' human physiology. In fact, a European Transport Federation (ETF) driver fatigue study in 2021[1] found that 24% of European bus and coach drivers and 30% of truck drivers have fallen asleep behind the wheel more than once over the course of a single year, and a massive 60% of professional drivers have reported regularly feeling fatigued while driving

The dangerous microsleep is an event that causes the human body to temporarily shut down in order to reload as a result of a sleep debt an individual has acquired. Although microsleeps only last for seconds, a 4 second microsleep at a speed of 100kph results in 110 metres of road distance covered whilst not being awake behind the wheel. This distance asleep can easily put the driver on the other side of the road facing the dangers of a head on collisions or to drive completely off the road. Microsleeps re occur frequently during a single fatigue session once initially started, so after the first one has occurred, it's likely another will follow. The human brain switches rapidly from awake to asleep and back to awake again during these occurrences without the driver even being aware of it, as the brain only recognizes its asleep after 1 minute of being asleep.

In 2021 the Committee on Transport and Tourism adopted an own-initiative report by European Parliament MEP Elena Kountoura on the EU road safety policy framework 2021-2023[2]. This framework has been initiated to reduce road accidents on EU roads to zero by 2050 as part of the global 'Vision Zero' initiative.

WOMBATT's mission is to support the EU in achieving zero deaths by 2050 by using the worlds most advanced fatigue prediction technology combined with consistent technology enabled driver self-awareness to combat fatigue on the roads for commercial drivers, as well as private drivers.

Fatigue accident 1. Court case Zeeland, West-Brabant, NL. 8 April 2013

Fatigue related head on collision between two passenger cars.

The driver was charged by police for failing to display reasonable caution on the road. However, upon closer investigation, it became clear that it was a loss of control of the vehicle due to fatigue that actually caused the accident, not speeding or some other form of irresponsible driving. The driver, who was 80 years old, had worked in his garden during the morning, after which he drove to lunch in a nearby town with his wife. He had mussels, port and one beer for lunch. The driver claimed that he felt fit after the meal and proceeded to drive back home with his wife. After 30 minutes, he felt fatigued and while looking for a place to pull over and stop for a rest, struck an oncoming vehicle head on.

The driver was acquitted because he considered himself fit to drive at the moment that he got into the car after lunch, and fatigue only started to form a threat 30 minutes into the journey. In other words, he did not knowingly start driving the car while fatigued. The court found that the driver's fatigue was triggered by physical labour prior to the lunch and a lunch that included fatigue stimulating alcohol.

This particular case demonstrates clearly that humans are poor at self-assessing fatigue. Fatigue starts to develop long before an actual incident, but drivers will often wrongly consider themselves fit to drive and think they can safely start their journey. The driver in the Zeeland case said he felt fit at the start of the drive and was found to have acted responsibly by proceeding to stop at the next parking location as soon as he actually started feeling fatigued. Preventing an accident like this requires use of the correct tools to provide an accurate assessment of current fatigue risk, enabling drivers to reliably assess their own personal fatigue risk prior to getting behind the wheel in the first place.

Fatigue accident 2. Court case Noord-Nederland, 3 September 2015

A truck driver drove into a stationary vehicle in a traffic jam upon falling asleep behind the wheel.

The truck driver had already been behind the wheel for 12 hours, which was longer than usual for him. Issues with his load had caused delays, although he was still within the margins of his regulated driving time. Approaching the traffic jam, the driver suddenly felt fatigued, disengaged the cruise control and looked for an exit where he could safely park the vehicle. However, while doing this he experienced a microsleep and the truck collided with the last car in the traffic jam. The court found the driver had taken the correct precautions prior to falling asleep by disengaging cruise control, looking for a suitable place to pull over and not exceeding driving hours. The accident was therefore out of his control and he was acquitted.

This case shows that even though driving hours regulations are necessary to protect drivers from fatigue as a result of long hours on the road, they are not sufficient. Other tools are necessary to measure the fatigue level of truck driver even within their permitted driving hours.

The key cause of dangerous fatigue on the road is a buildup of sleep debt over a period of time, plus the hours since the driver has been awake. Not only the hours the driver has been driving. Fatigue risk prediction technology is an essential partner to hours of service and hours on the road regulations.

Existing EU Legislation to prevent Fatigue

In order to protect professional drivers from fatigued driving as a result of long working hours, a European driving time and rest regulation has been implemented. Regulation (EC) No 561/2006 of the European Parliament and of the Council of 15 March 2006[3].

This regulation applies to passenger transport and road haulage operations for both national and international, long and short distance, for employees and for self-employed drivers.

The regulations are as follows:

1. Daily driving period shall not exceed 9 hours, with an exemption of twice a week when it can be extended to 10 hours.
2. Total weekly driving time may not exceed 56 hours and the total fortnightly driving time may not exceed 90 hours
3. Daily rest period shall be at least 11 hours, with an exception of 9 hours a maximum of three times a week. Daily rest times can be split into 3 hours rest followed by 9 hours rest to make a total of 12 hours daily rest
4. Weekly rest is 45 continuous hours, which can be reduced every second week to 24 hours. Compensation arrangements apply for reduced weekly rest periods. Weekly rest is to be taken after six days of working, except for coach drivers engaged in a single occasional service of international transport of passengers, who may postpone their weekly rest period after 12 days in order to facilitate holidays
5. Breaks of at least 45 minutes (separable into 15 minutes followed by 30 minutes) should be taken after 4 ½ hours at the latest.

Another regulation in place is the new Vehicle General Safety Regulations[4], which relate to vehicle design playing a role in preventing accidents, such as a fatigue related accident, from happening. In order to be eligible, new cars must receive a 5 Star rating by the European New Car Assessment Programme (Euro NCAP)[5]. This new safety measure is expected to save over 25,000 lives and to avoid at least 140,000 serious injuries by 2038.

The new measures introducing safety features to assist the driver include:

1. **For all road vehicles** (i.e. cars, vans, trucks and buses): intelligent speed assistance, reversing detection with camera or sensors, attention warning in case of driver drowsiness or distraction, event data recorders as well as an emergency stop signal;
2. **For cars and vans**: Additional features such as lane keeping systems and automated braking;
3. **For buses and trucks**: technologies for better recognising possible blind spots, warnings to prevent collisions with pedestrians or cyclists and tyre pressure monitoring systems.

The rules will first apply to new vehicle types from 2023 onwards and to all new vehicles from 7 July 2024. Some of the new measures will be expanded to cover different kinds of road vehicles until 2029.

How can WOMBATT's Voice Based Fatigue App add to Regulation (EC) No 561/2006 of the European Parliament and of the Council in reducing the number of accidents on the road?

The main emphasis underlying Regulation No 561/2006[3] for commercial drivers are mandatory rest periods. These ensure drivers are not driving fatigued as a result of too many consecutive working hours. The leading cause of fatigued driving is lack of sleep, which is generally a lifestyle choice, with the exception of some sleep related medical disorders. However, excessive working hours can also result in a loss of sleep opportunity hours, resulting in it being impossible for drivers to receive sufficient sleep on a consistent basis.

The regulation does not ensure professional drivers sleep enough - it simply provides opportunity to do so. A professional driver who consistently does not sleep sufficiently despite having sufficient time available for sleep, whom instead uses the time for social and family activities, is just as dangerous on the road as a driver whose actual working hours do not allow sufficient sleep time.

In order to tackle both resting hours **and** actually sleeping as a lifestyle choice it is important to provide a visual indicator of a driver's fatigue risk in order to make fatigue risk a clear and visible danger. WOMBATT-VOZ does exactly this by providing a fatigue risk management based pre-shift questionnaire in the WOMBATT App which is in compliance with the technical requirements of ANSI/API Recommended Practice 755, Second Edition and ISO 310000[6] and a voice recording to predict whether there is a risk of a fatigue event occurring up to 5 hours ahead.

WOMBATT-VOZ requires an 8 seconds voice recording to be made in which the technology will predict the fatigue risk of the individual driver with up to 90% accuracy. Upon completing the recording, the driver self-reports on his/her sleep and diet by completing a short pre-shift questionnaire at the beginning of the day or the shift, thereby making him/her aware of the lifestyle choices leading up to a fatigue risk alert. Where the driver generates a fatigue alert, indicating that the risk of a microsleep occurring in the next few hours has risen to the point where action such as an immediate power nap must be taken, the driver must find a safe and convenient location to pull over for the power nap – a 20 to 30 minutes exercise. Going back to the court case West-Brabant, Zeeland 8 April 2015, by using a system such as WOMBATT-VOZ, the accident would not have taken place at all due to 2 alert events, the first from the questionnaire with the self-reporting of certain beverage and meal choices and the second due to the actual fatigue risk which is present hours prior to the accident occurring. Fatigue develops hours in advance and can therefore be caught timely enough to prevent a level 10 (microsleep) incident from happening.

With thin margins in the ultra-competitive road transport industry, there is currently little time to spare for a driver to take a 20 minutes power nap. Schedules are tight. The science is very clear that the key fatigue risk factor on the road is the microsleep, caused by sleep deprivation, and the only solution to lack of sleep is sleep. In industrial environments, there are only two possible solutions to the presence of a technologically proven fatigued driver behind the wheel of the truck or at the workplace, 1) a driver/worker swap out and replacement with a rested driver, or 2) a power nap. There is simply no third solution. As it is usually impractical to swap out tired drivers on the road, the sole solution for road transport drivers comes down to the power nap, which enables a driver to drive safely for several more hours. But by unilaterally adding additional resting periods for fatigued drivers outside of the common regulations that cover everybody, a company will incur additional costs that a less safety conscious competitor will avoid, making the power nap very uncompetitive. So in order to achieve 'Vision Zero', regulators must level the playing field, and mandate a power nap for all drivers who trigger a technologically based fatigue alert. There is no other way. Then the road transport industry

can incorporate a predictive fatigue risk management system into the regulated parameters allowing for a mandatory power nap upon a fatigue alert, resulting in driver fatigue becoming a plannable factor for the entire industry.

The following graphs show how under the WOMBATT technology and risk management system, implementing a nap into the drive time schedules of all drivers who have triggered a fatigue alert can interrupt and drastically reduce for a limited time their tiredness levels and with that providing the driver with additional hours where the risk of a fatigue alert is drastically reduced.

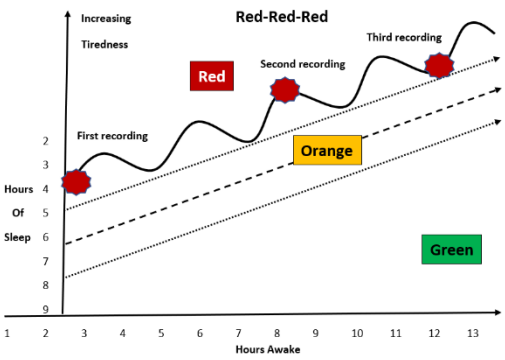


Fig 1. WOMBATT Fatigue cycle of a fatigued driver

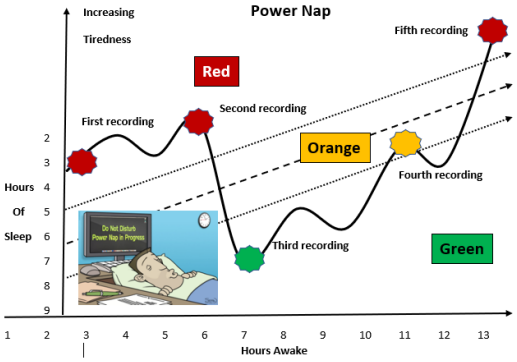


Fig 2. Introducing a power nap in the WOMBATT fatigue cycle of a fatigued driver

However, a power nap is only effective for a limited time, several hours at best after which time the driver reverts to his or her pre nap level of sleepiness as shown in the chart above. The power nap can never be a replacement for a good night's sleep.

How can WOMBATT-VOZ make Fatigue a plannable factor for the transport industry?

The Transport Industry is continuously planning ahead, short and long term plans are being made in order to adhere to lead times and capacity requirements. By predicting a fatigue risk event happening, with a commonly regulated solution at hand, the power nap, driver fatigue management becomes a factor the company can plan and allow for. The unique WOMBATT-VOZ fatigue prediction app can be connected to journey management systems via API. When the driver makes a voice based fatigue recording during his shift the results are automatically transferred into the journey management system. An Orange Alert allows a planner to plan ahead in the schedule for the possibility of a short break for a power nap if fatigue worsens. A Red Alert does not mean the driver is immediately at risk of a microsleep, but rather that the risk of a microsleep in the next few hours means that action must be taken now in order to remove the risk. This allows the planner to guide the driver to a safe location for a 20 minutes power nap, after which they will record again. If it's now Green, proceed with the drive. If Orange, proceed with the drive but make another recording within a set time, usually 2 hours. If still Red, then the driver cannot continue driving and further action needs to be taken under the protocols of the company's own fatigue risk management system. By recognizing that there is no solution to lack of sleep other than sleep, and that a sleepy driver must be taken off the road by common regulation, the roads will become safer with the elimination of the 25% of truck drivers who currently drive on regardless even while fatigued, thereby accelerating the achievement of 'Vision Zero'.

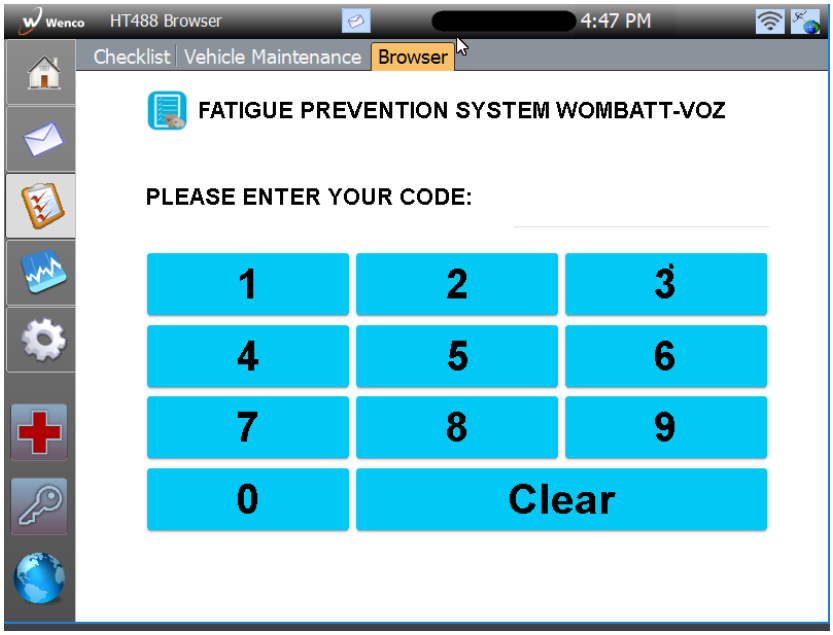


Figure 3. WOMBATT-VOZ Fatigue prediction and FRMS system integrated into dispatch/journey management system

Fatigue Monitoring Equipment Onboard Vehicles

The Euro NCAP 5 Star rating requires new vehicles to have fatigue monitoring equipment installed onboard that exceed the Karolinska Sleepiness Scale 7, which is a fatigue prediction scale as explained below. But all the technologies identified in the NCAP tests are based on direct fatigue detection by camera or indirect fatigue detection by vehicle movement device such as SDLP lane assist systems. From 2026, only direct technologies will be permitted under the regulations. The court case examples clearly portray that the drivers were feeling sudden oncoming fatigue leading to the microsleeps which caused the accidents. Both camera and lane assist devices warn drivers of the microsleep at the moment that the microsleep is actually occurring, allowing the driver no time to plan ahead to take a power nap, thereby preventing the accident from ever actually happening. A predictive system, such as is provided by voice analysis, makes fatigue more visible and manageable, allowing drivers the opportunity to take preventative action in good time to prevent an accident.

The Euro NCAP Driver State Monitoring (DSM)

The Euro NCAP (5) DSM allows two types of fatigue monitoring – **direct**, by measuring personal bodily parameters, and **indirect**, by measuring vehicle parameters. WOMBATT uses direct parameters, and indirect parameters will not be allowed after 2026.

Fatigue is divided into three progressive steps of growing fatigue leading to sleep.

1) Drowsiness
2) Microsleep
3) Sleep/Unresponsive driver due to sickness or extreme fatigue

Upon there being a **fatigue alert**, the vehicle must respond with an

1) Impaired Driving Vehicle Response – both a visual and a haptic alert
2) High sensitivity Mode – An earlier warning
3) Minimum risk manoeuvre – vehicle comes to an automatic controlled stop without driver input.

WOMBATT complies with fatigue steps 1 and 2, and with the fatigue alert steps 1 and 2.

General Requirements

For fatigue related driving behaviour, a system learning period is allowed of 30 minutes after the start of driving. WOMBATT over complies with this requirement by being able to predict the risk of fatigue and/or a microsleep up to 5 hours ahead.

Other requirements that are relevant for older fatigue detection systems such as cameras, are not relevant when using **voice**. These include Clause 3.5.2 Noise, Clause 3.5.2.1 Driver characteristics,

Clause 3.5.2.2 Occlusion, Clause 3.5.2.3 Driver behaviour, Clause 3.5.3 Driver State, and Clause 3.5.3.1.1 Driver Gaze Locations.

Vehicle Response Requirements - Fatigue

Drowsiness: Warning must be both visual and haptic. WOMBATT allows for this

Microsleep: Warning must be both visual and haptic. WOMBATT allows for this

In both cases, in the event of a fatigue alert from a voice recording sent to the WOMBATT cloud by the drivers vehicle connected mobile phone, the WOMBATT cloud immediately sends the alert to the OEM cloud, which sends a signal to the vehicle to engage either the FCW system or the LDW system onboard the drivers vehicle. At the same time the alert is shown on the mobile phone both visually and haptically.

WOMBATT EuroNCAP Compliance for Onboard Fatigue Technology

DSM -Inattention Type (Clause 3.6.2) Euro NCAP dossier requires in total 2 full points towards a 5 Star NCAP rating for new vehicles (see below).

Of these, WOMBATT complies with the following Driver State Monitoring (DSM) elements

WOMBATT DSM Points Contribution Weight

a) Fatigue Drowsy Warning 12.5%
b) Fatigue Drowsy Intervention 5.0%
c) Fatigue Microsleep Warning 10.0%
d) Fatigue Microsleep Warning 5.0%

Total WOMBATT weight points of 0.65 = 32.5% of the required DSM points.

The other DSM weight points are

e) Sleep 12.5%
f) Distraction 45.0%
g) Unresponsive Driver 10.0%

Total Weight: 2 points = 100.0%

3.6.2 Driver State Monitoring

The Euro NCAP Secretariat will review the DSM dossier provided by the OEM and will ask the test laboratory to spot check a number of Distraction, Fatigue and Unresponsive Driver situations before awarding the points.

Inattention Type		Distraction Scenario	Movement Type	Warning	Intervention	Sub Total	Total
Distraction	Long distraction	Away from road / non driving task	Owl	0.03	0.03	0.06	0.30
			Lizard	0.03	0.03	0.06	
			Body Lean	0.03	0.03	0.06	
		Driving Task	Owl	0.03	0.03	0.06	
			Lizard	0.03	0.03	0.06	
	Short Distraction (VATS)	Away from road / non driving task	Owl	0.03	0.03	0.06	0.30
			Lizard	0.03	0.03	0.06	
		Driving Task	Owl	0.03	0.03	0.06	
			Lizard	0.03	0.03	0.06	
		Away from road (multi-location)	Lizard	0.03	0.03	0.06	
	Phone Use	Phone Use Detection - Basic	Owl + Lizard	0.05	0.10	0.15	0.30
		Phone Use Detection - Advanced	Lizard	0.05	0.10	0.15	
Fatigue	Drowsy			0.25	0.10	0.35	0.35
	Microsleep			0.20	0.10	0.30	0.30
	Sleep			0.05	0.20	0.25	0.25
Unresponsive Driver					0.20	0.20	0.20
Total							2.00

Figure 4. Euro NCAP Driver State Monitoring weight points

WOMBATT OEM/Tier 1 Vehicle Integration Architecture

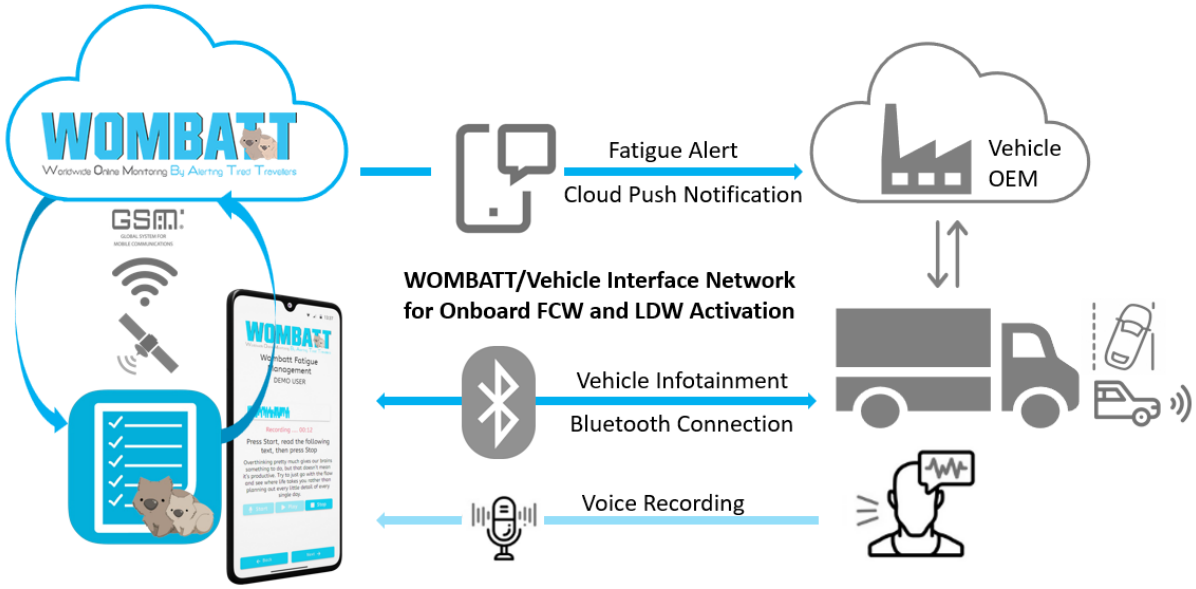


Figure 5. WOMBATT OEM/Tier 1 Vehicle Integration Architecture Scheme

The WOMBATT architecture allows for two methods of meeting the visual and haptic requirements for the fatigue elements of the EuroNCAP DSM.

1) The **mobile phone**: Although the WOMBATT fatigue algorithm and management system are located in the WOMBATT cloud, the WOMBATT-VOZ App on the mobile device visually shows the driver their fatigue result almost immediately on the screen of the phone, and can also haptically alert the driver by means of the phone's sound and vibration features.
2) The **vehicle** itself (see diagramme above): The mobile phone or other device carrying the WOMBATT-VOZ App is connected via GSM, WiFi or satellite to the WOMBATT cloud, which is designed to be seamlessly connected to the vehicle OEM cloud. The vehicle cloud is connected via proprietary OEM systems such as Ford Link to the vehicle, and can transmit data to the vehicle in real time. In this way the vehicle FCW and LDW systems can be activated in real time upon the receipt of the WOMBATT fatigue alert in the OEM cloud.

EuroNCAP Drowsiness Measure Requirement

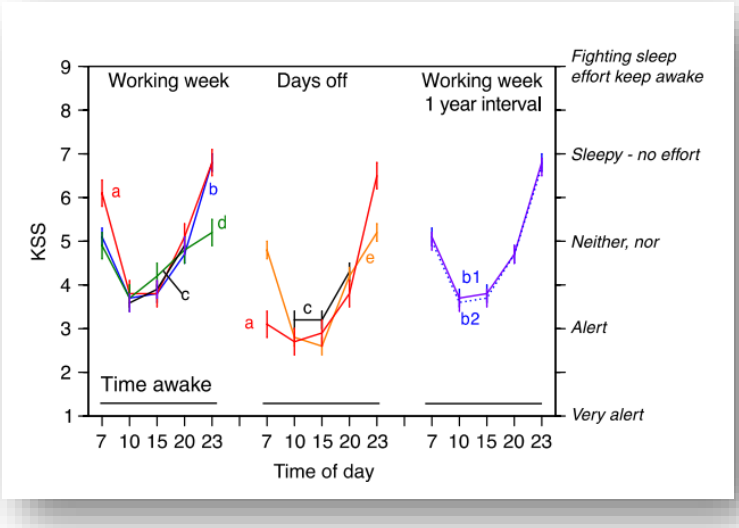
A critical measure by which the Euro NCAP measures drowsiness is the Karolinska Sleepiness Scale[7] (KSS). This is a subjective measure where the driver answers questions about how sleepy they feel at any given moment as follows:

1 Extremely alert
2 Very alert
3 Alert
4 Rather alert
5 Neither alert no sleepy
6 Some signs of sleepiness
7 Sleepy, but no effort to stay awake
8 Sleepy, some effort to stay awake
9 Very sleepy, great effort to keep awake, fighting sleep.
10 Extremely sleepy, can't keep awake

EuroNCAP sets "greater than 7 on the KSS scale or an equivalent measure" as the measure which on board vehicle fatigue technology must reach.

The WOMBATT voice-based technology was not tested against the KSS measure in the peer reviewed published articles describing the technology, as it was felt that KSS as a subjective a measure is not accurate enough for this purpose. However, WOMBATT was tested against the same parameter as KSS, namely "sleep latency" or time awake.

KSS Score against Time Awake (Sleep Latency)



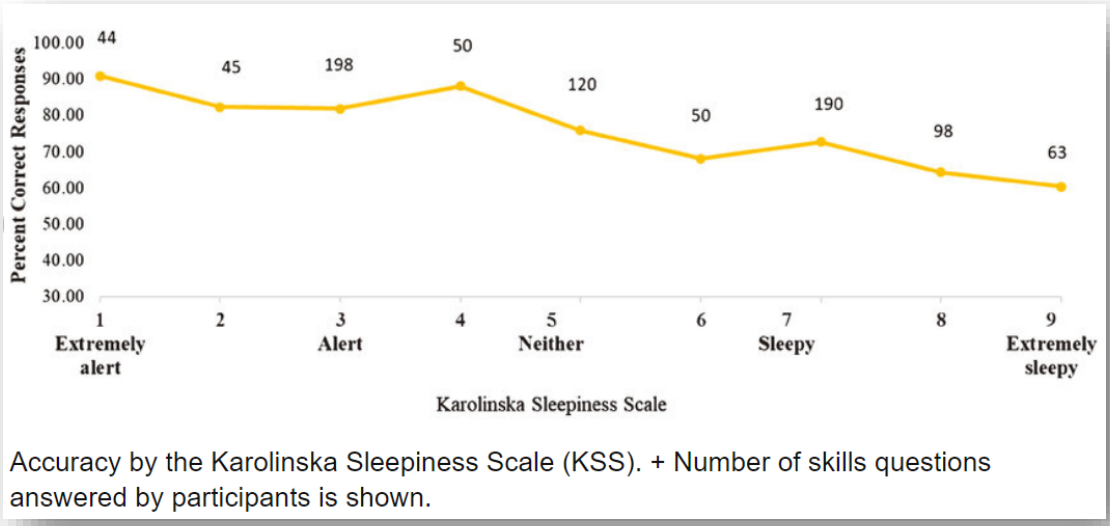
The chart KSS Score against Time Awake (Sleep Latency)[9] shows subject's KSS scores against time awake over 24 hours starting from 7 am in three different situations, 1) Working week, 2) Days off and 3) Working week, 1 year interval.

It is clear that KSS scores fall in the several midmorning hours after 7 am, but then rise rapidly and consistently after midday.

By 23 hours awake KSS scores approach the critical 7 mark.

Figure 6. KSS Score against Time Awake (Sleep Latency)

The accuracy of the KSS varies under test from 90% for Level 1 - Extremely alert, to 60% for level 9 - Very sleepy. (see chart below: Denise Smart et al, WSU, 2020[8]).



Accuracy by the Karolinska Sleepiness Scale (KSS). + Number of skills questions answered by participants is shown.

Figure 7. Accuracy by the Karolinska Sleepiness Scale (KSS). +Number of skills questions answered by participants is shown.

From the chart above by Denise Smart et al of Washington State University, the accuracy of the subjective KSS fatigue scale varies from 90 for Level 1, when people are extremely alert, to 60% at the other end of the scale, Level 9, when people are very sleepy. However, a key problem of any subjective fatigue scale is that people are proven to be very poor judges of their own tiredness, and generally over estimate their own level of alertness.

WOMBATT Scores in objective ESA Tests using Sleep Latency (Time Awake)

The WOMBATT hours awake test when tested with ESA astronauts[10] over a 60 hours period (3 days), shows a consistent correlation between growing sleepiness (predicted sleep latency from voice recordings) compared with actual sleep latency. This holds just as true over 24 hours (1440 mins) as over the entire 60 hours (3600 mins).

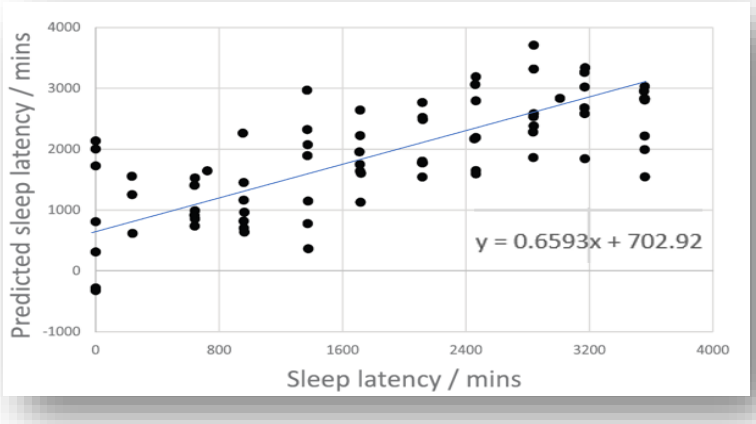


Figure 8. Sleep latency / mins The Prediction of Fatigue Using Speech as a Biosignal

Accuracy for the WOMBATT-VOZ voice-based fatigue technology when tested with astronauts using voice analysis compared with time awake, was up to 93.9% accurate over 16 hours awake and up to 93.8% over 24 hours awake.

16 Hours Awake

Measure	SVM Raw	OneR Raw	SVM Gauss	OneR Gauss
True Positive	42	38	46	39
False Positive	9	18	2	14
True Negative	39	30	46	34
False Negative	8	12	4	11
Precision	82.3%	67.9%	95.8%	73.6%
Recall	84.0%	76.0%	92.0%	78.0%
Unweighted Accuracy	**82.6%**	69.3%	**93.9%**	74.4%

24 Hours Awake

Model	Precision	Recall	Unweighted Accuracy
Raw features			
ZeroR	64.0%	100.0%	50.0%
OneR	72.7%	50.0%	58.3%
SVM	86.7%	81.3%	**79.5%**
Gaussianized features			
OneR	70.0%	43.8%	55.2%
SVM	100%	87.5%	**93.8%**

ANSI/API Recommended Practice 755 - 2019 American Oil and Gas Industry Standard[11], states that humans are very poor at self-assessing the near future risk of a fatigue event occurring, which is exactly the KSS method. As can be seen from the WSU experiments (see above), accuracy of the KSS method declines rapidly the more tired the driver is, from 89% accuracy at KSS 4 to only 60% accuracy at KSS 9. Using AI technology measuring neurophysiological elements of the body via the voice, WOMBATT maintains a consistent accuracy above 90%, subject to a short initial model training period lasting 10 days which starts at 70% accuracy.

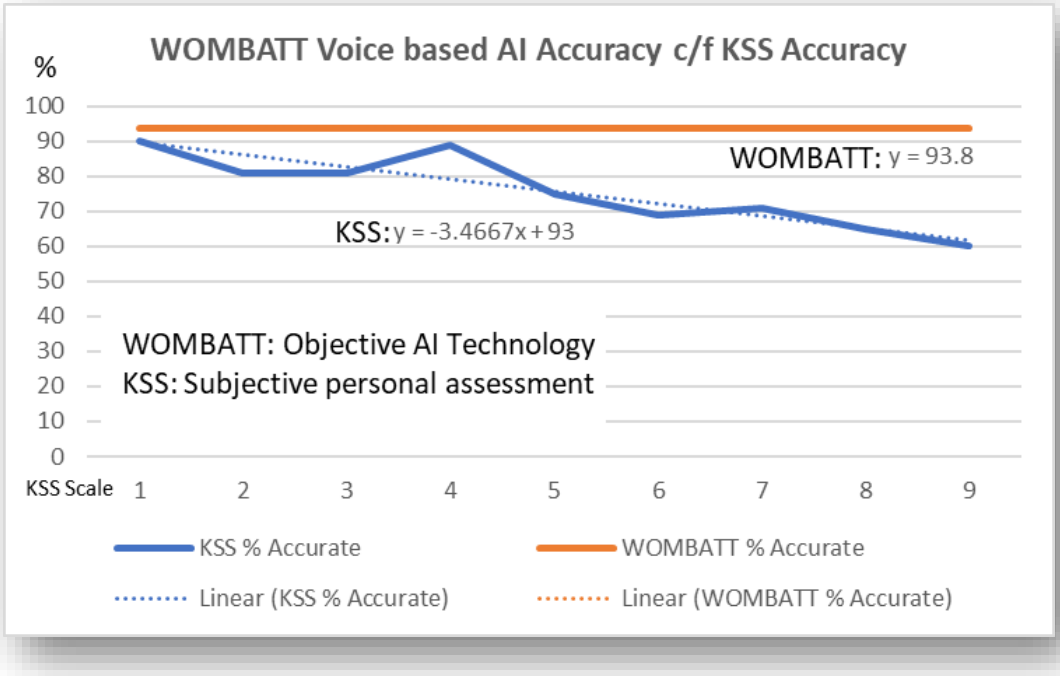


Figure 9. WOMBATT Voice based AI Accuracu c/f KSS Accuracy comparison modal

WOMBATT predicts fatigue, which in a sense is also what KSS does. The camera detects the microsleep at KSS Level 10 only (Extremely sleepy - can't keep awake)). What both KSS and WOMBATT are doing is predicting the risk of a microsleep. When a driver is at KSS 8 (I am feeling sleepy, but with some effort to stay awake), that person is automatically self-assessing the risk that they will progress to falling asleep (Level 10). This is the same manually as what WOMBATT does automatically.

WOMBATT method is very close to the KSS method in that both predict of the risk of a microsleep occurring, but WOMBATT is highly accurate (93.8% in the research tests at ESA) because it is AI technology based, not personal judgement based which is proven to be not accurate (see above).

It is clear that WOMBATT voice-based AI fatigue prediction is a more effective technology to use by drivers in accordance with the KSS predictive scale than the camera, which only detects fatigue at KSS Level 10, at the very moment that the driver is actually falling asleep.

The accuracy of voice analysis was also measured against a set of more objective tests[10] over the astronauts 60 hours awake test: Simple Reaction Test RT in milliseconds, Planned Reaction Test pRT in milliseconds, Predicted Memory Score and Predicted cognition in seconds.

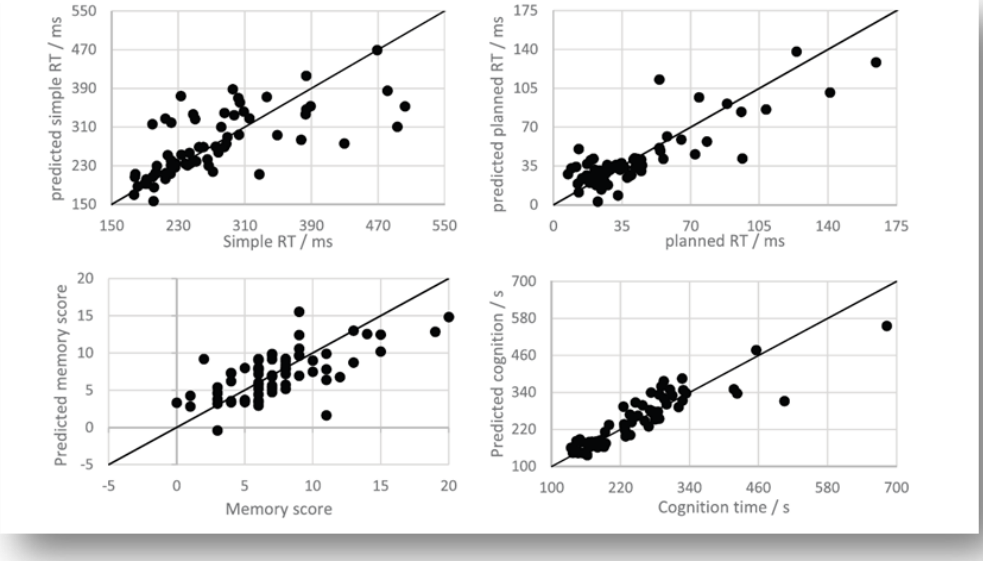


Figure 10. Sleep latency / mins The Prediction of Fatigue Using Speech as a Biosignal

The Accuracy using the above tests with astronauts at the European Space Agency was up to 90%.

WOMBATT's Compliance with the Driver Drowsiness and Attention Warning (DDAW) Regulation of the EU Parliament Vehicle General Safety Regulation (GSR)

Advanced Vehicle Systems - the GPSR[12] defines fatigue and drowsiness as *'driver drowsiness and attention warning' means a system that assesses the driver's alertness through vehicle systems analysis and warns the driver if needed.*

Article 6, Clause 3 of the EU GSR 2019 report to the European Parliament requires that

Driver drowsiness and attention warning and advanced driver distraction warning systems shall be designed in such a way that those systems do not continuously record nor retain any data other than what is necessary in relation to the purposes for which they were collected or otherwise processed within the closed-loop system. Furthermore, those data shall not be accessible or made available to third parties at any time and shall be immediately deleted after processing. Those systems shall also be designed to avoid overlap and shall not prompt the driver separately and concurrently or in a confusing manner where one action triggers both systems.

Drivers make their WOMBATT voice recording at a time and place of their choosing, and the data is either anonymised for the purpose of personal fatigue model improvement, or removed from the system as required. WOMBATT complies fully with GST requirements.

A Final Driver Fatigue Thought for Commercial Transportation and Logistics Companies Operating Road Truck Fleets

The first commercial standard regulating fatigue in industry was issued in 2010 by the American Petroleum Institute for the Oil and Gas Industry in conjunction with the American National Standards Institute and the American Steelworkers Union. This standard, ANSI/API Recommended Practice 755 – 2010 and Second Edition in 2019, was prepared following the British Petroleum Texas City disaster in 2005, which was caused by worker fatigue and where 15 workers were killed and 180 injured.

The new API fatigue standard, the first fatigue risk management strategy (FRMS) standard in industry worldwide, focusses primarily on the joint responsibility of both employee and employer to eliminate fatigue related safety risks. This is the 'fair culture' approach, where workers can alert their supervisors when they are feeling tired or when they have not had enough sleep, without risk of retribution. Technology to predict or detect fatigue is then an essential support for workers self-reporting of safety risk, which is always the most important.

The WOMBATT fatigue management service was designed in 2010 specifically to comply with ANSI/API RP 755. This means there are two parts to the WOMBATT App, a technology part, where the voice is analysed by artificial intelligence using the mobile phone App, for signs of fatigue, and the FRMS Questionnaire part, where the worker or driver has an opportunity in the App itself to self-report his or her sleep experience over the previous 24 and 48 hours, recent diet, any alcohol or drugs consumed, or medications taken. Global industry has now caught up with Oil and Gas, but WOMBATT is still the only fatigue system that combines both elements of a fatigue elimination culture, self-reporting, plus the latest, most advanced technology, in a single App on any mobile phone, tablet or computer.

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