Voice-based AI Fatigue Prediction for Mining Projects

AI Gives Workers the Voice to Monitor Fatigue

WOMBATT-VOZ is a voice-based technology originally developed for fatigue prediction among astronauts. So far, the technology has achieved groundbreaking success in multiple industries. Now, inspired by the outcome, the application team at WOMBATT, the technology's developer, tell MINING BUSINESS AFRICA that they see immense opportunities for the innovation's deployment in the African mining sector.

Operator fatigue is a high safety risk

By Jimmy Swira

Necessity is the mother of invention, so goes the saying. And this would apply to the WOMBATT-VOZ, a groundbreaking fatigue risk prediction technology.

Interestingly, what started as a long-duration Space travel project with a scope limited to the client's brief, has opened the door for application in multiple industries and activities.

Research & Development
The European Space Agency (ESA) in Noordwijk, The Netherlands, requested WOMBATT to develop a new tool to monitor astronaut fatigue risk for the manned mission to Mars. Thus, precision was key and in addition, the technology adopted should be non-intrusive and predictive.

WOMBATT-VOZ Voice technology
Usually, all current fatigue technologies are based on detection, raising an alert as or just before the microsleep actually occurs. And so, for ESA, it was important to have a robust predictive fatigue solution that was not intrusive for use in Space, as well as GDPR compliant. This culminated in WOMBATT-VOZ Voice technology.

Accordingly, WOMBATT performed a research and development project from 2014 to 2019. After the development of the voice-based generative artificial intelligence algorithm, the tool passed the ESA Factory Acceptance Tests, scoring 90% accuracy in predicting the risk of a fatigue event occurring up to five hours in advance.

Later, in 2019 and 2020, the product was further developed for commercial use in combination with WOMBATT's patented real-time fatigue monitoring and reporting solution.

On the record-breaking scale of fatigue prediction, Emma Verhardt, WOMBATT's team leader, comments: "Exceptional accuracy combined with non-intrusive user friendliness sets our new fatigue technology's performance apart and makes it a game changer." Indeed, the technology continues to receive glowing reviews across the industry.

Meticulous planning and thorough execution
The technology's plaudits are well-merited. It is a fitting product of meticulous planning and thorough execution.

Available options
WOMBATT's R&D team explored the available options they could exploit. They considered three main ways the body expresses fatigue to the outside world: Electrode-based, Video-based and Acoustic-based.

Then, to arrive at the most effective solution, the team examined four key fatigue monitoring parameters in the industry and on the road:
- Biological parameters e.g. from the voice;
- Vehicular parameters, e.g. lane deviation;
- Physical parameters, e.g. yawning and head nodding; and
- Mathematical parameters, e.g. sleep/wake times, circadian rhythm.

1. Two parameters
Distinctly, the WOMBATT-VOZ Voice technology incorporates two out of the four possible parameters - a biological parameter (voice) and a mathematical parameter (sleep/wake). Justifying the selection, Verhardt explains, "The combination of two parameters consistently increases the accuracy of fatigue risk prediction over time to levels well above 90%, and complies fully with the oil and gas industry standard ANSI/API 755 recommended practice 2nd ed 2019. Research has proven that human physiological fatigue effects are almost infinitely variable, so a two-step process in managing fatigue is more accurate than relying on the effects of just one parameter."

Verhardt demonstrates the effectiveness of the voice-based system: "The voice is actually a powerful window into our body. This is because our voice is a muscle, and when we are feeling fatigued our muscles will start to become fatigued as well. We have all felt that at some point in our lives, some more often than others. However, the voice muscle is the only muscle that can express fatigue (amongst other things) via acoustics without physical contact.

So, what we have done is taken the acoustic data coming from the voice, which expresses developing fatigue, and combined it with our generative AI to build an individual voice model for each user, creating a technology that can predict fatigue up to 4 to 5 hours ahead of time with 90% accuracy. Without a doubt, what makes WOMBATT-WOZ cutting-edge is leveraging AI.

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The WOMBATT generative AI
The WOMBATT generative AI is data-based, so it is always adapting and learning the unique characteristics of each user's voice. To complete the product the technology is linked into the WOMBATT management system which allows operations to plan both for and with fatigue before it becomes an ad-hoc risk or event. WOMBATT has integrated a stoplight system (green, orange, red) in which companies can integrate the results into their fatigue risk management protocols.

WOMBATT-VOZ's Features
As a result of the integration of generative AI, the technology has proved effective. The end-user can rest assured of the following benefits:

i. High accuracy and non-intrusive
WOMBATT-VOZ achieves high levels of accuracy in the field without additional hardware and is non-intrusive for workers. It is a system that can be used broadly within any organisation, for haul truck drivers and service equipment operators, but just as well as for workers in the processing plants.

ii. Integratable
Furthermore, as an SaaS technology, WOMBATT-VOZ can be integrated with dispatch systems or on existing hardware already present at the mine. It can be used as a stand-alone service or as an additional service to existing detection technologies complementing the risk management systems in place.

iii. User-friendly
There is always concern with new technology and how mineworkers adapt to it. WOMBATT-WOZ caters for this. It is available as an app which anyone can download free of charge. So it can be on a mobile phone, a tablet or integrated into onboard systems.

"The app itself does not store data and record without the worker's intervention. For us, this was specifically important during the development to make sure that the worker has agency.

To sketch an outline, the technology requires an intervention of under { five minutes} per day. The worker keys in their code and has to tell the system to start recording by pressing the button. The worker can then see when the recording starts. After 8 seconds, the option to stop the recording is available, and after 15 seconds it stops on its own. The recording can be done anywhere and anytime. In order to comply with the two-step process required by the oil and gas industry fatigue standard ANSI/API 755 Recommended Practice, the worker is required at the first recording of the day or shift to also input their sleep/wake data, i.e. time to bed and wake up time. All subsequent interventions by the worker that day are just voice, and a smart

band or smartwatch can optionally be integrated into the system to automatically record and upload sleep/wake data to the WOMBATT reporting cloud at the start of each shift.

What makes it so effective based on what is available in the field, is that workers gain awareness of their developing fatigue levels. Then, they integrate this knowledge into their personal lives, making them more well-rested before starting work. WOMBATT has found in the field that as the AI becomes more knowledgeable about the individual user's sleep characteristics over time, and becomes more and more accurate, workers adjust their sleep time. Where a worker has sleep deprivation, the technology feeds this information back to them and they increase their sleep times. WOMBATT has seen in the field a direct relationship between increased sleep times and lower fatigue alerts.

Huge potential in mining environments
WOMBATT-VOZ has a huge potential to enhance fatigue management in mining environments. It is a new generation of fatigue prediction solutions, different from products available on the market. Consequently, by predicting fatigue up to five hours ahead, the technology enables companies to make the most out of risk management and fatigue training.

Deployment
Verhardt shows how WOMBATT-VOZ is deployed, "Lack of sleep is almost always a choice. Of course, there are exceptions where workers have medical issues such as sleep apnea, or perhaps a new family member is keeping them up at night. However, for the majority of us, sleep deprivation and the resultant fatigue is, in fact, a choice. So, with this in mind, raising fatigue awareness already tackles a large part of the problem. We advise users to make a minimum of three recordings per day – the first at shift start to act as a fitness for work, the second during the middle of the shift to assess fatigue risk over the following 4-5 hours and the last as a fitness to drive home measure."

Typically, most road accidents due to fatigue, for example, occur on the commute home. And so, by giving workers insights into their actual fatigue risk levels, WOMBATT-VOZ creates an awareness of fatigue risk among all employees using the technology which is just as important as a company's role in fatigue management. This is considering that lack of sleep starts with the employee.

Success
Significantly, WOMBATT-WOZ has registered great success in the reduction of fatigue-related risks. The technology has been running for four years in the field in multiple industries and both management and workers are impressed with the system's accuracy in predicting the user's fatigue risk level. Workers and unions especially appreciate the fact that workers have agency, in that users can decide when and where to make their voice recordings – they are not being continually observed or measured in real-time which is a major problem with all other existing fatigue detection systems.

WOMBATT has developed fatigue risk management protocols for monitoring the technology's performance within companies. Fascinatingly, thus far, the team at WOMBATT have no records of fatigue incidents on the job. Recently, they received customer data on a reduction in safety incidents of 61% in processing mills since the installation of WOMBATT-VOZ, and customers have observed that fatigue risk within the shift decreases over time.

Significantly, an interesting and general finding has been that at the start of WOMBATT-VOZ implementation at a site, sleep time is relatively lower with commensurate higher fatigue risk. In contrast, for sites that now operate the system regularly, there has been an increase in sleep time and a decrease in fatigue risk.

Regarding the data, Verhardt deduces, "In general, the risk reduction demonstrates that fatigue risk management as a predictive measure contributes to the overall safety of the worker. It allows workers to operate more efficiently and alert them to developing fatigue risk during a shift, keeping both them and fellow workers safe."

WOMBATT recommends WOMBATT-VOZ to African mines. In addition, Emma Verhardt believes that with non-intrusion, worker agency and very high forward-looking accuracy, unions can easily support the system as well. "It is in everyone's interest to ensure we all stay safe on the job."

WOMBATT is an Australian-origin fatigue management company, with 25 years of worldwide experience in monitoring, managing and eliminating the fatigue of mining haul truck operators and road transport drivers.
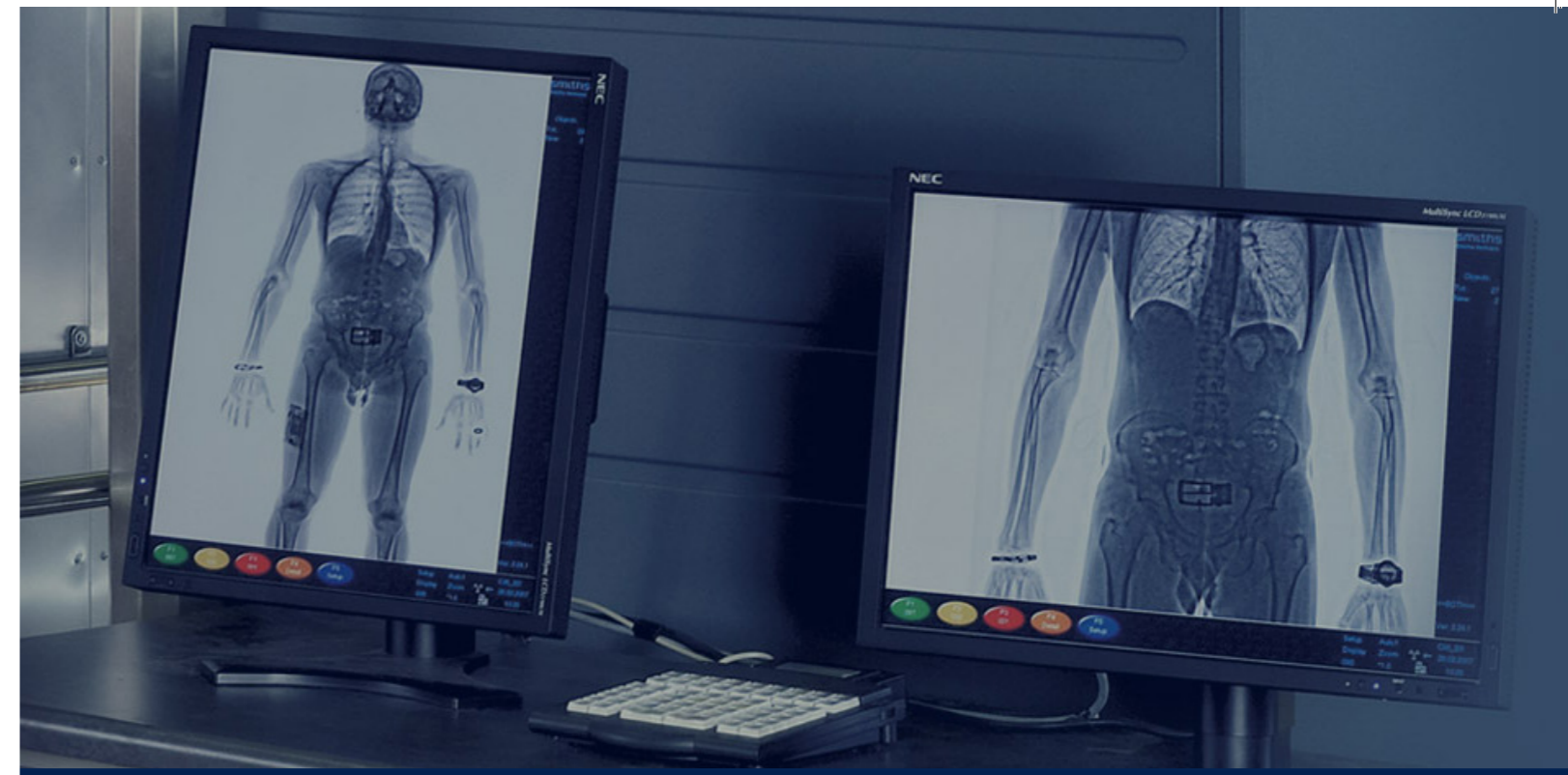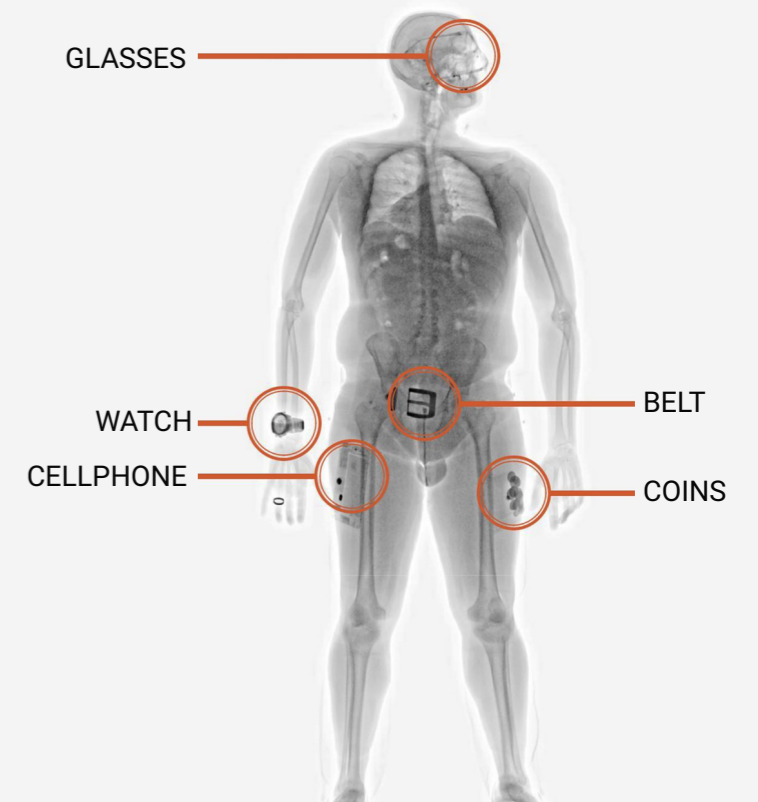
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XMS reporting includes: X-ray totals by radiation, X-ray totals by name, Over quota individuals, Excessive entries, Excessive dummy scans, Excessive holds, Scan logs, search logs, etc.

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