A guardian angel called 'DVTCS-L'

By George Kamensky

Most of us have confronted user-unfriendly electronic devices that occupy our homes and offices. Did your TV refuse to remember your favorite channel? Has your house alarm's siren continued to scream no matter what do you press on keypad? Don't worry; you are not alone.

Consider the Vigilance Button installed in each and every locomotive cab, which support operational safety on railways around the world. The concept is very simple – every 60 to 90 seconds an illuminated push-button demands to be acknowledged so as to know that the Train Driver is alive and active. In the absence of a response over a period of minutes, the vigilance control will automatically apply the train brakes and bring the train to a stand.

If we multiply the resetting of the vigilance control 60 times per hour by a 10-hour shift it equals 600 presses of the button during the shift that a Train Driver must pay attention to and acknowledge.

This adds a fair bit of pressure on the train driver's job, particularly when he/she is driving through stations, with passengers moving about on platforms in an environment of complex signaling arrangements – all the while looking out for restricting signals. From this perspective, the Vigilance System's demand to be acknowledged every 60/90 seconds is disturbing and can unnecessarily take a driver's attention away from what is happening outside the confines of the cab.

A much more dramatic situation can happen when a train driver is driving hour after hour at night when, by Mother's Nature request - people need to sleep. Experience and research shows that the Vigilance Control button can be pressed by train driver in a state of deep relaxation and 'micro-sleep' (also known as 'zombie mode').

Under the influence of monotonous ambient noise, soft vibration and repetitive visual imagery of 'running' sleepers (which modulate the visual cortex in the driver's brain) – relaxation, 'micro-sleeps' and 'deep-sleep' are not far away from a Train Driver's mind at any given time during the silent hours. It's not far away from an accident either.

20 years have passed but I still remember an accident which happened in the St. Petersburg (then Leningrad) subway system at 5.15 a.m. The train driver was finishing his 12-hour night shift in the Metro and a gang of maintainers was going home aboard his early morning train. Suddenly the train driver got the impression that he had passed a subway station without stopping (as a matter of fact - he didn't, it was just a micro-sleep). He then stopped the train and changed ends of the subway train from the leading cab to the rear cab.

"What happened?" asked one of the maintainers in the first railcar. "No worries, under control!" said Train Driver, who passed through the train and forced the train to roll in the opposite direction. He was desperate to fix his 'mistake' and be back to the 'missed' station – which, of course he never missed. Minutes later, a following subway train driver couldn't believe his eyes – a huge monster with five bright external lights was rolling towards to him at 40 km/h.

He stopped his train and jumped out of the cab into passenger's saloon. "Run with me!" – he screamed to the passengers. They had a few seconds to run into the second railcar when a huge 'Bang' got them.

The Subway railcars jumped vertically with a squeezing noise and blocked the Tube with a huge plug made from bogies, seats and twisted metal. I don't know how many millions of Roubles this collision cost, but the good news is that one of the train drivers I mentioned above is still alive and still attending a Church service every Sunday, albeit in his wheelchair, of course.

So-called 'human factors' are contributing factors for more than half of accidents on the railways around the world. Professionalism and knowledge can be passed to staff by education and training, but guaranteeing that our trained professionals will not fall asleep when driving in harsh conditions is impossible - well almost.

The Bureau of Air Safety Investigation (BASI) inquiry into the collision between a moving and a stationary coal train at Beresfield (NSW) in October 1997 found that fatigue from rotating shift work and broken sleep patterns were major factors contributing to the collision. The limitations of conventional vigilance control systems were also highlighted during the investigation. Richard Whitford

We have known for a number of years that the neural signals passed from the human brain to the body can be detected: these signals could be commands to stand up, move one's arms, to lie down, or even, for example – to sleep. Do you remember the famous 'Lie Detector' (or Polygraph) machines? Experienced polygraph operators can confirm truth or lies by analyzing the neural signals of the brain measured by precise sensors located on the body. By the same token, it is possible to identify and record the 'sleep' signals from the brain. How many lives could potentially be saved by controlling the sleep of train drivers and railway signallers, operators of nuclear power stations or even astronauts in space?

This is how researchers from Neurocom were thinking when they created advanced technology bio-sensing technology for the Russian Aerospace Industry in the 1980s. Later on in 1997, as a part the process of converting military to civilian production, Neurocom utilized this technology by designing a new bio-sensing Vigilance System for train drivers.

DVTCS-L stands for a "Driver's Vigilance Telemetry Control System – Locomotive". 3000 locomotives in Russia, Latvia, and Ukraine were equipped by DVTCS-L System from 1997. Locomotive tests of the new-generation Vigilance System are at present also being conducted in Italy and India. In Australia, the DVTCS-L system is currently undergoing evaluation testing by QR human factors specialists and rolling stock engineers in Brisbane.

Worldwide, some 8000 Train Drivers are being protected by a guardian angel called DVTCS-L sitting quietly on their wrists, alert for the critical moment when they have to take over the control of the vehicle in an emergency situation. The primary reason why DVTCS-L has been so successful is that it is a proven, non-invasive, fail-safe vigilance system for train drivers. Can you imagine a train driver finishing a shift during which he/she did not press the Vigilance Button at all? When a DVTCS-L microcomputer sees no symptoms of sleepiness after analyzing the Driver's brain signals to body –the Vigilance Button doesn't need to be acknowledged at all. It means the Driver can pay more attention to the operational situation he or she finds himself or herself in and reduce the probability of deep relaxation or falling asleep to near zero.

A small LED Bar on the cab console visually demonstrates to the driver the level of his brain activity. If the level of the yellow LED is going down, the driver needs to stand up or move around and become active to reverse the relaxation and fight the urge to sleep.

When the 'Activity' scale has reached the bottom LED, the Red LED will turn on and an alerting signal will demand: "Activate yourself, we are on Duty! Press the Vigilance Button to let me know that you are OK".

In the current configuration of the DVTCS-L system, should the train driver reach a state of 'deep relaxation' three times, then DVTCS-L will take over control and stop the train by Service or Emergency Brake applications.

If required - DVTCS-L's memory of a shift can be downloaded to illustrate the activeness of a driver before the forced brake application for investigation purposes. The wrist-mounted watch/bracelet with a sensor-transducer is a small, but important component in the system. It continuously predicts the probability of the Driver entering a micro-sleep in the next 60 seconds, sending this data to the base unit by radio using failsafe principles (i.e., if there's no signal, the system interprets it as a lack of vigilance.)

The DVTCS-L microcomputer has three outputs – those relating to the operation of the Vigilance-related PLC, Control Relays or Communication System. Its radio receiver decodes the digital signal from the wrist-fitted bracelet with sensor/transducer and the LED bar visually indicates the level of Driver's activeness. The feedback link between DVTCS-L and a train driver via the LED visual indicator is an important part of the objective of self-control and estimation of fatigue by the vehicle operator.

If you still would like to know a little bit more about the "DVTCS-L" – the Neurocom website address is: www.neurocom.ru. To contact Neurocom by email, enquiries can be directed to: neurocom@tpg.com.au

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Above: Inside the sheds at Brisbane's Redbank locomotive depot, Neurocom staff pose beside their QR colleagues and 2470H the locomotive chosen as the test bed for evaluating the DVTCS-L technology in Australia. Neurocom

Inset: The main elements of the DVTCS-L system: A wristwatch-mounted biometric sensor; a dash-mounted LED showing a driver's level of brain activity display and its larger counterpart. Neurocom