Artificial assistance

Computer systems can listen in to data streams generated by a truck's normal operation to help find and prevent faults, finds Will Dalrymple

Modern trucks incorporate semi-automated features such as GPS-driven cruise control that cut across multiple engineering systems. The greater the sophistication of the truck, the taller grows the fault tree for the technicians working to find a technical fault code.

At the top of each truck's functions – engine, transmission, aftertreatment, braking – sits an electrical control unit that monitors and controls their operation within narrow parameters. These ECUs lead separate lives, reading data from sensors and tweaking performance in response, according to automotive CAN-Bus systems such as SAE J1939.

Håkan Warnquist, Scania research scientist, explains that operation and service are locked in an ever-escalating technological race. He says: "If we don't develop better diagnostic tools, the repairs will be expensive on an increasingly complex truck. If we don't evolve the truck, it will be a less good and profitable product."

Each of the hundreds of sensors on a truck emits more or less continuous information, some of which will be received and responded to by electrical control units on the truck. Similarly, transport companies' back-office systems also tend to accumulate quantities of truck-related data, such as maintenance records. Earned Recognition is an example of a programme that is using operational data systematically (see article, *https://is.gd/oyiyoh*).

Magnus Svensson, uptime technology specialist at Volvo Group, explains: "We continue to search for new ways of working. Big data and machine learning and artificial intelligence are good tools to extract information from data. They give the possibility to continue learning, to learn over time, even after the start of production."

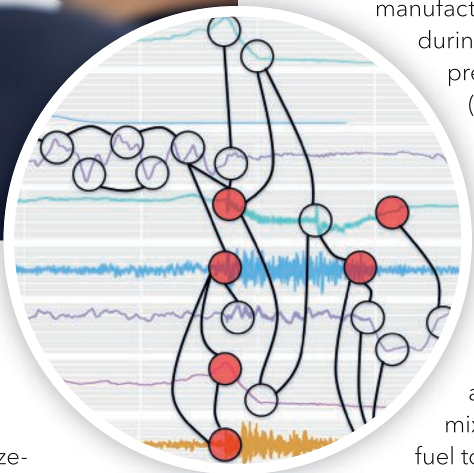
He describes machine learning as a system that uses an iterative process of querying datasets to search for information – where this is content that could provide useful intelligence about truck maintenance. As the process repeats, it can generate better results: "Depending on what we get back, we might ask new questions," Svensson adds. Because ultimately, the goal of generating information is to develop new customer services.

For example, given enough data, computer programs can develop a model of the cause-and-effect relationships between the components that generate signals in a truck system, based only on statistical probability. This is useful because it creates a baseline against which to judge the significance of unusual signals, anomalies, that might indicate a potential mechanical problem (or might be nothing). He continues: "If you start to compare this model to parameters with similar vehicles, or the same one over time, then you can detect a deviation: suddenly this parameter is peaking in a certain direction."

EARLY WARNING SYSTEM

Early detection of faults is a particular application of this technology that is available now. For example, Preteckt is a US start-up that provides a $30/vehicle/month software-as-a-service system for heavy trucks and buses and refuse collection vehicles in the US and Canada. One of Preteckt's current contracts is to monitor a fleet of passenger buses for the Memphis (Tennessee) Area Transit Authority. The buses can automatically regenerate on-board diesel particulate filters in situ, but the process takes an hour and can only happen when immobile. The Authority had an issue with the buses stopping to regenerate the DPF while passengers were on board. Now, the Preteckt service tracks relevant signals including soot concentrations and notifies the Authority well in advance of a looming DPF regeneration.

The same idea is being applied to truck maintenance schedules,



reorganising them based around the needs of the truck, rather than applying a one-size-fits-all approach based on live operational data. Warnquist says: "That enables providing better uptime and fewer breakdowns, due to optimal maintenance intervals that are continuously updated." Scania's offering is called Flexible Maintenance *(https://is.gd/unilur),* which includes some big data elements; Volvo has a similar service. Truck OEMs have a lot to gain from this technology because of an increasing market trend to provide all-inclusive maintenance contracts; in these, any efficiency gain improves its bottom line, and can improve its competitiveness.

Another method of machine learning, employed to help diagnose vehicle problems, requires building a computer-readable fault tree. Warnquist explains: "You need to have a form of classification for every fault code that specifies which root causes on the vehicle are connected to this." For example, a code that might mean an overpressure in the fuel system would be linked to potential causes such as a leaking injector or blocked valve.

Even if such systems can't identify the exact fault, they can help narrow down its potential causes. Jean-Christophe Petkovich, CTO of Canadian start-up Acerta, explains that the company's system uses AI (artificial intelligence) systems to help car manufacturers spot problems during end-of-line and pre-production testing (example: inset left). It helped discover an air leak in a pre-production vehicle. Exhaust oxygen sensors signalled the engine. The engine compensated by adjusting the air/fuel mix, but used excess fuel to do so, which was inefficient. It eventually led to misfires, so it couldn't run. In this example, the output provided to the engineer was a series of signals relevant to the problem – it highlighted regions of unusual activity.

This reduced the amount of information the engineer was looking at to a tiny fraction of the total: 0.01%. Acerta identified the issue, passed it on to an independent combustion engineer, who understood the problem in about an hour. By comparison, Petkovich said that a team of OEM engineers without access to Acerta took two weeks to solve it.

An essential technical enabler of this technology is connectivity; to be of use, truck data has to be processed. Low weight requirements limit the amount of processing possible on board the truck; in fact data needs to be beamed off-site for proper analysis.

But with the total amount of data produced totalling a couple of Gb per day – down to 150Mb with compression, according to Petkovich – transferring everything remains infeasible. As a result, much data is simply ignored. In addition, once a problem is found, the data provider needs to inform the operator – digitally, of course. Engine maker Cummins is trialling a program with a London bus fleet that provides component reports that are colour-coded by urgency (below).

Another potential benefit of using these truck monitoring techniques is the ability to warn a garage in advance, increasing its productivity. Magnus Svensson predicts: "When I look into the crystal ball, we will know exactly what to do [when the truck enters the garage]. That will enable us to secure the right spare parts and equipment when we perform servicing."

Adds Shaun Stephenson, past president of the SOE: "My belief is machine learning will be pivotal to maintenance practices and programmes in the future. The systems' capabilities to dynamically understand failure rates and intervals will allow for decreased unexpected component failure. This will lead to improved breakdown rates, less downtime and increased efficiency with technical support staff."

The data does not spell the end of the technician; in fact, quite the opposite. Concludes Warnquist: "There will always be odd behaviour that AI doesn't catch, but that human experience and common sense can see. They take in so much more, and catch things that don't seem to fit." TE