How sensors can streamline vehicle maintenance

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Improve maintenance efficiency by leveraging sensor data.

By Stefanie Von Rueden

You may have heard it before: the modern truck is essentially a computer on wheels. Today's trucks can have up to 400 sensors and 130 million lines of code, and with the drive towards improving fleet safety and maximizing efficiency, not to mention autonomous vehicles, that number is only growing, says Gerry Mead, executive director of innovation, Phillips Industries.

"If it can be sensed, it can be monitored," Mead says. "The equipment today can monitor everything from vehicle location, to sensing approximate load weight, to selecting the appropriate transmission gear for performance and fuel economy."

There are sensors that can monitor tire pressure, wheel end temperature, whether a door is open or closed, anti-lock brake (ABS) faults, load sensors, vehicle emissions and more.

In order to communicate useful information to a driver or technician, these sensors must work as part of a larger system. Think of it like a human body: There is a controller area network (CAN bus) that operates like a nervous system, allowing communication to all parts of the body. Electronic control units (ECUs), sometimes called nodes, control each individual system of the vehicle, and these are all connected and able to communicate with each other using the CAN bus. There are ECUs for the engine, transmission, brakes, suspension—the modern truck can have as many as 70 ECUs.

These ECUs are made up of sensors and actuators (components responsible for moving and controlling a mechanism or system). Sensors are like nerves: their job is to collect data, and that data is then transmitted to the larger system via the CAN bus.

However, the CAN bus is only a tool for communication. It operates sort of like a telephone, connecting ECUs and allowing them to communicate, but not providing the "language" for them to talk to each other. Most of today's commercial vehicles use the Society of Engineers (SAE) protocol J1939. J1939 is a standardized language across ECUs, meaning that instead of relying on manufacturer-specific protocols (or languages), all of the ECUs in a vehicle communicate using one language. That standardization is important, because it streamlines communication and enables in-vehicle connectivity and advanced telematics.

As technology evolves, sensors are being tasked with providing an increasingly complex and accurate picture of what's happening to the vehicle and it's various systems. This is what Ed Renna, eastern regional fleet sales manager, PRECO Electronics, refers to as a "perception system."

"In a perfect world, this highly accurate perception system would be combining multiple sensing technologies, with all of their own strengths and weaknesses, in which strengths offset weaknesses so they are each stronger when they are together," explains Renna. "But, much like in the human body, there has to be some redundancy to keep it going."

Renna explains the communication of vehicle systems can be compared to that of the organs of the human body.

"In the human body, our survival depends on the integrated activity of all the organ systems," he says. "However, certain parts of the body have been known to pick up the slack if one should fail. A person can live without their spleen because of the liver, and other lymphoid tissues in the body overlap in functionality and play a role in recycling red blood cells and their components as well. Similarly, for full-automation and for the [vehicle] system to understand maintenance needs, perception systems and similar technologies are needed—combining multiple sensor systems to offset deficiencies is key, and redundancy within sensor fusion [combining sensor systems with other technologies to improve system performance] is essential," Renna says.

Telematics and data analysis

There are numerous sensors generating data points, but those data points alone are too technical for the average fleet to use to inform maintenance decisions, says Scott Sutarik, associate vice president of commercial vehicle solutions, Geotab.

That's where telematics and data analysis come into play. "Analysts can take these measurements using telematics and funnel them through machine learning algorithms, and are able to predict based on thousands or hundreds of thousands of instances of different failures and outcomes," Sutarik explains. "And, in turn, they can extrapolate that back to, 'If we see this, we believe this vehicle's going to fail.'"

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So, even though the data points are too technical to self-identify if a vehicle is failing, there are third-party telematics providers and analysts that can utilize machine learning to analyze that data and provide good predictions on vehicles that are likely to fail, even before fault codes occur.

“Sensors and systems are the key to gaining operational efficiency and increasing the uptime of fleets,” says Lee Alexander, director of product management, IoT platforms, STEMCO. “Fleet managers can become aware of issues before they turn into more costly secondary issues.”

How does telematics work? Any sensor operating on J1939 protocol assigns a parameter group number (PGN) to the sensor message. The PGN is an ID used for looking up the function of a J1939 message. From there, it is split into parameters called subject parameter numbers (SPNs). These messages can be broadcast via the CAN bus, explains Sutarik.

“A telematics provider can either go in and listen to a given message if it’s broadcast, or we can request that PGN and pull that into the fleet’s data cloud,” he says.

Vehicle telematics can collect all of the data generated from the sensors and enable fleets to better monitor, diagnose and maintain their vehicles. It is also a key component of remote diagnostics — some telematics devices are able to take information monitoring a step further to offer information on the severity of a fault, as well as a recommendation for repair. This can notify a driver or fleet whether a fault code is something that needs to be immediately addressed, or whether it is something that can be repaired after the driver has finished the route.

Examples of sensors in use

There are a number of different sensors on vehicles today. Here are some examples:

TPMS sensors
Tire sensors can monitor air pressure and temperature to notify of potential tire problems before they lead to a significant loss of air, or a blowout. TPMS sensors can come prefitted in tires on OE vehicles, prefitted in replacement tires or installed in existing tires through an aftermarket retrofit, says Michelle Reinhart, head of digital solutions for commercial vehicle tires in the Americas region, Continental.

“Continental’s ContiPressureCheck transmits data from the tires into an in-cab display for the driver,” she says. “It can also be connected to third-party telematics providers to make tire data visible remotely in the telematics dashboards.”

This data helps fleets catch tire problems early, prolonging tread life and helping to prevent uneven wear and premature tire failure. Continental is also in the process of beta-testing a more integrated solution called ContiConnect Live, which, when paired with the Continental Driver App, will show tire information on Daimler Fleetboard, TomTom Telematics devices, smartphones and tablets, in the driver’s cab.

“ContiConnect Live integrates our digital solutions for commercial vehicle tires into the existing in-vehicle systems and displays,” explains Nikolai Setzer, Continental executive board member and head of the tire division. “We are enabling fleet customers to draw an even greater benefit from digitalization and achieve a new level of efficiency in tire management.”

“Tire sensors and other vehicle sensors allow fleets to gain a holistic view of vehicle performance and reduce overall costs by predicting maintenance needs and preventing breakdowns over the road,” Reinhart says.

ADAS sensors
Advanced driver assistance systems (ADAS) consist of multiple integrated technology systems, including cameras, radar and LiDAR says PRECO Electronics’ Renna.

“The majority of automotive ADAS implemented have sensors on the front and back of the vehicle to offer lane change assist, lane departure warning, rear cross traffic alert and adaptive cruise control. All of these sensors communicate with one or more ECUs in order to make the proper decisions,” Renna says.

ADAS is still in the development stages, and not yet in complete control of the vehicle, but many companies are working towards autonomous vehicles that will use information detected by sensors to completely control the vehicle. Examples of this budding technology include obstacle detection and avoidance and automatic braking. Object detection technology such as PRECO’s PreView Side Defender II uses sensors to improve vehicle safety by alerting drivers of objects in the vehicle’s side blind zones using audible and visual alerts. Technologies such as these can improve fleet safety, but they can also offer useful data when integrated with a third party telematics solution.

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"[For example,] the combination of PRECO's sensors and Geotab's telematics solution will provide data that will report collision warning alerts, including detection zones, to report incidents and near misses," Renna says. "The MyGeotab platform can combine this information with other safety analytics such as speed, acceleration, braking and location to give fleet operators valuable safety analytics. This advanced technology will help fleets create a safer route and driving habits while minimizing the costs and occurrences of collisions."

Not only can ADAS help prevent collisions, the information collected by these sensors, when integrated with telematics, can also inform fleets of near misses and incident reporting. Fleets can then use that information to identify opportunities to improve route efficiency and safety, and identify drivers who are exhibiting unsafe or aggressive behaviors before they are involved in an accident.

Trailer sensors

Sensors monitor a wide variety of functions on the vehicle, but there are also sensors for trailers, says Al Anderson, director of heavy duty sales, Peterson Manufacturing.

Examples of sensors that may be found on trailers include temperature sensors on reefer trailers, brake system sensors, TPMS sensors, trailer tail deployment, GPS sensing capability, cargo monitoring, gross weight calculations and more.

"In a perfect world, all sensors would report as nodes on a broad network of data bus [like the J1939 on the vehicle]," Anderson says. "Because trailer systems have lagged, many of the sensor manufacturers have chosen to develop their own individual reporting systems. This is neither cost-effective nor logistically practical for a fleet user because of the number of different systems they must monitor to maintain a complete picture."

As sensors become more commonplace on the trailer, they will need to become more standardized so they all speak the same "language" [such as J1939], to allow open communication between different systems on the trailer, and between the trailer and the truck.

"On trailers, the technology is only now becoming more commonplace," Anderson stresses. "For quite some time, sensors have had the ability to monitor load temperature and fuel levels, ABS and tire pressure. Today, 'smart trailers' are giving the industry the ability to more closely control and monitor equipment usage and condition."

Smarter vehicles, smarter maintenance

The modern truck is leaving the OEM with more sensors than ever, providing fleets with an abundance of vehicle information: in some cases, more than they know what to do with.

"As sensorization and digitization continue to move higher up the value chain, fleets must understand what they have on their equipment, and what they do not have that is currently available to them," advises Phillips' Mead. "They then need to look at it from a business standpoint, and understand that besides improved maintenance practices and improved costs, the information that can be available enables them to align with other functional areas for a much broader effect on their overall business that extends beyond their bottom line."

"Implementation of fleet technologies like telematics and ADAS will give a competitive advantage to early adopters," adds PRECO's Renna. "Operational efficiency is key to maintaining a cost-effective fleet."

The most valuable sensors are the ones that monitor the critical-to-performance parameters of the truck, says STEMCO's Alexander. If a fleet doesn't already monitor costly elements such as the tires and brakes using sensor technology, they should consider retrofitting sensors to monitor these aspects of the truck—monitoring "prone to failure" areas can help improve operational efficiency and uptime, as well as safety.

"You don't know what you don't know," stresses Mead. "Continually optimizing and leveraging data is a must in today's customer driven uptime environment. In order to move from a fix-as-fail mentality to a fix-as-predicted mentality, one must combine all of this data from the equipment with their historical maintenance data. That gives them a prescriptive solution. This prescriptive maintenance will be the step past predictive maintenance that gives the solutions needed for many of the problems fleets have today."