

Toyota's recalls and the electronification of the car

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By Bryan Betts



Recent problems with both Toyota and Ford cars that required software fixes, not mechanical ones, have raised important questions over the increasing electronic content of modern vehicles, reports *E&T*.

Toyota's recent recall of almost half a million Prius and other hybrid cars to fix an issue with their braking system is hugely important to the motor industry. It's partly down to the sheer embarrassment to Toyota - the company that pretty much invented Lean manufacturing. Mostly, though, it's because the issue was not - like Toyota's previous accelerator-related recall - mechanical in nature. It was the software.

And problems like it have now surfaced at other carmakers too: Ford is set to update brake-related software on its 2010 Ford Fusion Hybrid and Mercury Milan Hybrid (although the situation is a 'customer satisfaction programme', says Ford, rather than a fully-fledged recall), and questions have been raised over the safety of the electric power steering systems in 2005-2009 Chevrolet Cobalts.

What these cases highlight is the increasing electronification of the car, says Krishnasami Rajagopalan, a global programme manager at analyst Frost & Sullivan. Legislators and the motor industry alike have automatically assumed that increasing the electronic content of cars is a good thing, he says, pointing to the appearance of safety regulations that will mandate Advanced Driver Assistance Systems (ADAS) such as electronic lane departure warning (LDW) and advanced emergency braking (AEB) technologies.

'Whilst electronics has increased efficiency and passenger comfort, it has also exposed the consumers to higher risk of accidents and manufacturers to painful recalls. It has also caused an inordinate blow to consumer trust,' and could yet lead to a slowdown in the electronification of the automobile, he adds.

Electronics in cars

How did we get to this state? Many people driving today can remember when the radio was just about the only electronic thing in a car, yet now it is hard - in the developed world, at least - to buy a new car that isn't electric-just-about-everything. Even the doors and the seat adjusters are often operated via electric switches, rather than manual handles.

According to many in the business, the era of mechanical innovation is almost over, for mass market car-makers, at least. Innovation is now electronically-driven instead, with analysts predicting that electronics will soon account for 50 to 60 per cent of the value added during car manufacturing.

'The whole story of automotive electronics started in the 1970s, after Motorola invented the microcontroller,' says Denis Griot, senior vice president and EMEA chairman at Freescale Semiconductor.

'What forced semiconductors into cars was California's clean air laws, which later on led to the Federal Clean Air Act,' Griot says. 'The microcontroller provided online monitoring of key parameters such as temperature and pressure, and processed those in real time to reduce emissions. We found it could also improve fuel consumption by improving the combustion yield. Those are still the two key factors for the internal combustion engine.'

He adds that we are now on the third or fourth wave of automotive electronics. 'The second started with passive safety technologies such as airbags and ABS, then it went to active safety - ESP/ESC [electronic stability program/control] is now almost 100 per cent - and it's now moving on to preventative safety, for example collision prevention.'

Powertrain

The use of electronics in the powertrain has greatly increased too. From those primitive microcontrollers, we now have highly sophisticated engine-management systems capable of automatically switching the engine off when the car is at rest for more than a few seconds, then restarting it almost instantly. And with the electrification of the powertrain we not only need electronics to control the motors, but we also need control systems for the battery, the regenerative brakes, and so on.

'Start-stop engine technology will be standard in a few years,' Griot predicts. 'EU regulations will require cars to have smaller engines and full start-stop. Probably 10 per cent of cars by 2015 will have some level of electrification, from a low level to a full hybrid or plug-in EV.'

'Today, the average semiconductor content - you have to multiply by two or 2.5 for the total electronic content of a European, US or Japanese car is over \$300, that's up from \$150 seven to 10 years ago. Chinese cars are typically a generation back, but are over \$150. For cars in development, the average platform is already at \$400 in the West and Japan, and China is catching up very rapidly.'

'The most sophisticated computational device a person will own is a car,' agrees Drue Freeman, vice president for global automotive sales and marketing at Philips spin-off NXP Semiconductors. 'You could have 20 or 30 microcomputers around the car, you could have GPS, telematics with the equivalent of a PDA and a mobile phone. Even car keys are now highly secure devices, with some manufacturers looking at using them for banking or e-cash.'

This could mean a bright future for individuals and companies able to bring together disciplines such as mechanical, electrical, control and semiconductor engineering, and blend them into the converged systems engineering discipline known as mechatronics. The increasing software element in modern cars could push carmakers to buy in not just chips, but software and systems expertise too - which in turn means semiconductor firms must also acquire car industry expertise.

'Developers will have to engage with companies such as Freescale during the early design phase - we're no longer just software suppliers but co-designers,' says Denis Griot. 'It means we need to understand car simulations and models, do mechanical engineering from mathematical modelling and do heavy joint R&D with car OEMs. We have absolutely been recruiting systems engineering experts, it's a space where Europe can play a real leadership role.'

To achieve more via electronics also means engineers and designers must understand how the car communicates with its driver - and that's not just the visible information it provides via its dashboard, but also the audible and tactile feedback that drivers expect from a machine.

It now remains to be seen whether the recent recalls will lead to stricter testing and regulation. The future design and deployment of these systems is at stake, as are price increases for consumers and potential liability issues for suppliers.

'The recalls will have repercussions not only for vehicle manufacturers but also for electronic system suppliers and regulators who have been slow to act on consumer complaints,' predicts Rajagopalan. 'Until this problem is sorted out, consumers are likely to sit apprehensively in their cars, surrounded by electronics they no longer trust.'

Further information

- <http://kn.theiet.org/magazine/issues/1004/weblinks.cfm>
- kn.theiet.org/magazine/rateit/control/mechatronics.cfm
- kn.theiet.org/magazine/issues/1002/blind-drivers-1002.cfm
- blog.toyota.co.uk/third-generation-prius-brakes-recall-your-questions-answered
- media.ford.com/article_display.cfm?article_id=31983

Comments

As Dr Gilbert of Southern Indiana University has demonstrated, a shorted input to the electronics control module causes Toyotas to open their throttles full, perhaps the problem is due to lead free manufacturing (which Toyota admits it began in 2002)? It's a known fact that parts plated in pure tin will grow tin whiskers. The EU was warned this would happen but went ahead and banned lead from tin-lead solder and tin platings. The result? Perhaps we are seeing it. Henning Leidecker, chief engineer of the electronic parts office of NASA's Goddard Space Flight Center in Greenbelt, Md., and an expert on tin whiskers, said in the last four years his office has been contacted by seven major suppliers of automotive electronics inquiring about failures in their products caused by tin whiskers. He said his office has contacted Toyota offering to help analyze its acceleration problem, but hasn't heard back. For full context, read the rest of the article here: <http://wtop.com/?nid=108&sid=1898265> And for more on tin whiskers go to the NASA website <http://nepp.nasa.gov/WHISKER/>

Mr Bob Landman,
04 Mar 2010
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