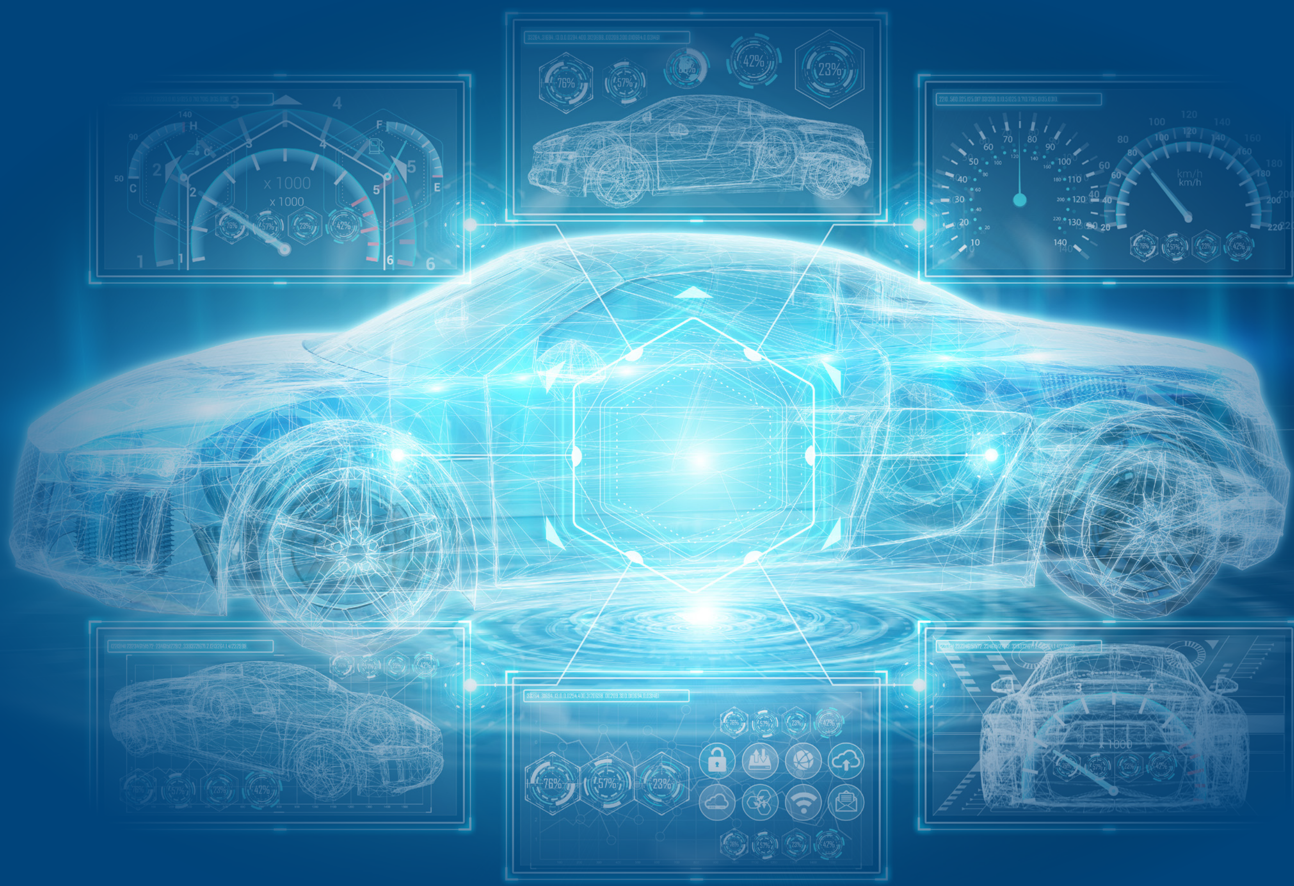
# What Does My Car Do?

By Dr Shaun Helman, TRL
& Prof Oliver Carsten, University of Leeds



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# Foreword

PACTS takes a cautiously optimistic view of the developments in vehicle technology and automation. There appears to be huge potential to help drivers to be safer in the driving task and, at some point, to replace the human driver in some or many roles with a less error-prone system. But we are not there yet and there is public confusion about the degree of "automation" in cars on the market today.

PACTS is pleased to publish What does my car do? by Dr Shaun Helman and Professor Oliver Carsten. They call for urgent action at global level, through the UNECE, to harmonise interface standards between the vehicle controls and the driver. They warn "…if we neglect the user in the brave new world of automated vehicles, we might be heading for a bigger mess."

Shaun and Oliver are longstanding members of the PACTS Road User Behaviour Working Party. Oliver was the Chair for many years until December 2018. This paper was their initiative and PACTS is very grateful to them for their time and advice. The Working Parties form an invaluable part of PACTS' technical expertise and structure.

## David G Davies

**Executive Director, PACTS**

# About PACTS

The Parliamentary Advisory Council for Transport Safety – better known as PACTS – promotes evidence-based solutions to achieve safe transport for all. Established in 1981, its founder members were responsible for the legislation which made front seatbelt wearing in cars compulsory in Britain.

The unique features of PACTS are that it is a multi-modal transport safety body and focuses on working with UK parliamentarians, government, professionals and other key stakeholders. It is independent and has no financial or sectoral interests. PACTS is a charity with over 100 member organisations which provide PACTS with a vital source of income, advice and technical collaboration. If you would like information about PACTS membership for your organisation, please visit www.pacts.org.uk/about/

## About the authors

**Shaun Helman** is a Chief Scientist at the Transport Research Laboratory, where he has worked since 2008. Before joining TRL, he worked at QinetiQ, and in academia, as an applied psychologist. His research interests have mainly been focused on traffic psychology and road safety, although he has also worked in wider transport psychology and human factors, transport security and in defence. He has over two decades of experience in applying lessons learned from behavioural sciences such as psychology to problems in these domains. Specific problems on which he has worked include understanding how to reduce conspicuity-related and perception-related collisions in vulnerable road users such as motorcyclists and pedestrians, and understanding how to bring about real behaviour change and safety improvements through road safety education, training, and licensing. He is a firm advocate for evidence-based policy, and user-testing of new technologies.

**Oliver Carsten** is Professor of Transport Safety at the Institute for Transport Studies, University of Leeds. His major research focus is on driver interaction and safety with new driver support systems. He led the UK national project on Intelligent Speed Assistance and has acted as chair of the Road User Behaviour Working Party of PACTS, the Parliamentary Advisory Council for Transport Safety. He has provided advice on safety policy to the UK Department for Transport and to the European Commission, especially on behalf of the European Transport Safety Council. He was a member of the European Commission's GEAR 2030 High-Level Group on the future of the European automobile industry as well as a member of the C-ITS Platform. He is an attendee at the meetings of UNECE in the area of automation and a member of the Informal Group of Experts on Automated Driving (IGEAD) under UNECE WP.1. He is editor-in-chief of the academic journal *Cognition, Technology and Work.*

# What Does My Car Do?

**In summary**

The lack of full standardisation of vehicle controls and the driver interface with driver assistance systems means there is often a 'human factors' deficit in which drivers are forced to use systems they do not necessarily fully understand. The onset of more vehicle automation may make this worse. We need urgent action to stop this from happening.

**Picture the following scene…**

A new worker begins their first day of work at a factory. They are shown a machine they will be operating. Naturally, they ask for training to operate the machine, to ensure that they know how to do so safely and efficiently; they have been trained previously on a similar machine, but the symbols on this one are different to those they have seen, and it has several additional controls and systems which they have never been trained on.

A supervisor comes to see the new worker before they start operating the machine and says "This machine is quite similar to the one you have used before. It might look a bit different, and some of the controls and systems are designed differently or are in different locations, but it's almost the same. You'll be fine. Just get on with it, and if you notice any problems, just look in this 300-page manual to see if that will help. Good luck!"

It seems unlikely that such a thing would happen on a factory floor, since the Health and Safety at Work Act (1974) places requirements on employers to ensure that workers are properly trained in the use of equipment they use in their jobs. This situation does occur every day however (in private life and in work) with a very specific type of machinery – the motor vehicle.

**Motor vehicle controls**

On first inspection, this claim may seem bold; every vehicle will have plenty of features that appear to be 'standard'. Obvious examples are steering wheels, brake and accelerator pedals in standard positions, parking brakes, indicator and light controls, and standard gauges and icons communicating things like fuel level, speed, and the status of various engine systems.

In truth many of these things are not as standard as you might think. For example, many different parking brake designs are now available on cars; the lever design in the middle of the two front seats is probably the most common, but a pedal operated by foot is also seen, and with electronic systems becoming more common a simple button has become a common interface.

It is not even a requirement to have a steering wheel. For example, the relevant UN regulation here (No. 79)[1] states that its intention is "…to establish uniform provisions for the layout and performance of steering systems fitted to vehicles used on the road." (p4) Note the term 'steering systems'. The term 'steering control' is also used later, with the caveat "…normally the steering wheel…" (p4). Numerous alternatives to steering wheels exist, although their fitment to personal vehicles is usually restricted to those driven by people with physical disabilities which make a steering wheel unsuitable.

[1] http://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2018/R079r4e.pdf

There is *some* standardisation of controls. For example, in an effort to reduce driver confusion when changing from one vehicle to another, ISO Standard 4040, originating from 1983, specifies that the turn signal stalk shall be on the left-hand side of the steering wheel. Commensurately, the wiper stalk is on the right. Despite individual examples like this, the norm though would appear to be *not* to require full standardisation of vehicle controls.

**Buying, hiring or sharing?**

Lack of standardisation in vehicles might be manageable if there was a formal handover and training on how to use the systems on a given vehicle before it was to be used. This does not appear to be the case. Even in the best case scenario when someone is buying a vehicle new, from a dealer who specialises in a particular manufacturer, there is no mandatory training in how to use the various controls and systems on the vehicle for a given make and model (even the basic controls needed to drive the vehicle safely, such as fog lights and full beam headlights); the assumption is made that there is sufficient normalisation to avoid the need for such training, or that the owner can 'read the manual' if required.

The same is true when buying a used vehicle, or when hiring one. An anecdote is worth mentioning here. At a 2018 meeting of the PACTS Road User Behaviour Working Party, one of the authors of this paper outlined a strange experience he had with a hire car, in which it had taken him a full minute and a half to find the parking brake; almost every one of the twenty or so people in the room had a similar story to tell, including one person who had been using a car sharing service, and had been unable to move the vehicle for five minutes due to not understanding the parking brake and ignition systems.

**Things might be even worse with current advanced driver assistance technologies**

If we are in this situation now with basic controls and symbols, one might ask what the situation is like in cars that benefit from the great leaps forward that we are currently seeing in driver assistance technologies.

Consider driver assistance systems like Autonomous Emergency Braking (AEB). A 2017 example from Toyota can be used to illustrate the general point. Toyota fits an AEB system known as the Toyota Pre-Collision System (PCS) to some of its models. This is described on page 198-210 of a vehicle user manual, which is available online[2]. The system is described as using radar and camera sensors to detect vehicles and (in some jurisdictions) pedestrians around the vehicle. It provides warnings to the driver in the event of it detecting a high likelihood of a collision, can provide feedback via the pedal to prompt braking, and finally can intervene when it knows a collision is imminent. As a driver, this seems great. One downside however is that the manual lists 23 ways in which the system may operate, even though no collision is likely, and 30 ways in which it may not operate, even if a collision is likely. Examples of the former include situations like "when passing a vehicle or pedestrian" and "when a crossing pedestrian crosses very close to the vehicle". Examples of the latter are "when approaching the side or front of a vehicle" and "if the vehicle in front is a motorcycle or bicycle". How, we wonder, is a driver supposed to anticipate all these potential exceptions?

This is not about individual manufacturers – there are examples from most if not all companies. Another one to discuss here is the owners' manual for the 2019 BMW X5[3] which takes nine pages to explain the operation of the Active Cruise Control, four pages to explain

[2] https://www.toyota.com/t3Portal/document/om-s/OM07007/pdf/OM07007.pdf.
[3] https://g05.bimmerpost.com/forums/showthread.php?t=1571400.

the operation of the "steering and lane control assistant" and an additional page and a half to cover the lane change assistance which is supplementary to the lane control assistance. There must be a better way of handling the safe use of technology than this.

Let's consider some other issues with existing driver assistance systems.

1. **Names are confusing**

Vehicle manufacturers seem to have a love affair with impressive names for the various driver assistance systems that they offer. Thus, BMW has Launch Control. Volvo has Pilot Assist. Mercedes has the Distance Pilot DISTRONIC which can be combined with Steering Pilot and Audi is planning to introduce Traffic Jam Pilot. There is clearly a fascination with the word 'pilot' as epitomised also by Tesla's Autopilot.

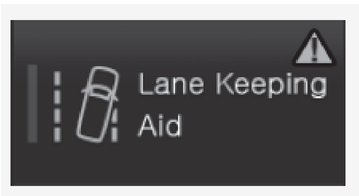
More concerning is that identical systems (or virtually identical systems, since there may be subtle operational differences between them) are given different names by the various manufacturers. Thus Adaptive Cruise Control (ACC), the system that matches the speed of a vehicle directly in front is actually called Adaptive Cruise Control by Fiat, Ford, GM, VW, Volvo and Peugeot, but is termed Intelligent Cruise Control by Nissan, Active Cruise Control by Citroen and BMW, and DISTRONIC by Mercedes.

2. **Interfaces can be different and unclear**

There is no standardisation of the buttons or switchgear to enable and disable the various systems. In addition, the dashboard symbols used to indicate system status vary substantially between manufacturers are not always clear in their meaning. For example, on an Audi Q7 the symbol:

means "Side assist currently unavailable. Refer to instrument cluster display for more details."[4]

On a Volvo XC90 the symbol:




means not that the vehicle is heading out of lane but rather that the lane keeping aid is faulty.[5]

[4] See https://www.myaudiworld.sg/services/MyGuide-Explore-Your-Audi-Q7-Dashboard-Symbols.
[5] See http://az685612.vo.msecnd.net/pdfs/e1b8cc6d423a879893a994f65d93bb7fb0eb950c/XC90_OwnersManual_MY20_en-GB_TP29137.pdf.

3. **Systems do not always respond in the same way**

For most manufacturers, a driver action on the accelerator to increase speed above the ACC set speed only temporarily overrides the ACC: when the accelerator is released, the ACC automatically resumes speed control. On the 2020 Volvo XC90, however, the ACC is set to standby mode (meaning that the driver must actively resume ACC operation if wanted) when the driver has exceeded the set speed for more than 1 minute.

**What about higher levels of automated driving?**

When automation really changes our understanding of the term 'driving' by taking on large portions of the dynamic driving task, especially in a vehicle with a 'some-of-the-time' driver, the situation may become even more challenging. For example, there will be a need for human drivers to resume control when the automated system reaches the end of its authorised zone of operation, which means that there is a need to design a new human-system interface for handover of control. Automation is likely to have dozens of modes, so there will be lots of potential for drivers to be confused about the behaviour of the automated driving systems.

If the manufacturers all have different approaches to the design of how automation interacts with humans, there will be enormous opportunity for misunderstanding and error. There is an obvious need for a high degree of commonality and for the standardisation of some of the symbols, display layouts and switchgear, to promote quick and intuitive understanding in users. This will be especially important in shared mobility models.

Based on what has happened so far with core controls, and what is currently happening with low level (so-called Level 2) automation[6], there is reason to be sceptical about the will of manufacturers to agree on common approaches.

In short, if we neglect the user in the brave new world of automated vehicles, we might be heading for a bigger mess than we already have with basic vehicle controls. This might lead to collisions which need not happen. A counter-argument is that users will adapt and work harder to understand systems and overcome the challenge. But this hardly sounds optimal.

**What actions are needed?**

Harmonisation, probably at a world level, is required. The responsible organisation is UNECE WP.29, *The World Forum for Harmonization of Vehicle Regulations*. WP.29 is already embarking on regulations for automated driving systems with significant UK involvement, but strangely there is no dedicated work on Human Machine Interfaces (HMIs). There needs to be.

[6] https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-%E2%80%9Clevels-of-driving-automation%E2%80%9D-standard-for-self-driving-vehicles.

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