

Transport Committee

Oral evidence: [Self-driving vehicles](#), HC 519

Wednesday 26 October 2022

Ordered by the House of Commons to be published on 26 October 2022.

[Watch the meeting](#)

Members present: Huw Merriman (Chair); Mr Ben Bradshaw; Jack Brereton; Ruth Cadbury; Robert Langan; Karl McCartney; Grahame Morris; Gavin Newlands; Greg Smith.

Questions 1–58

Witnesses

I: Steve Gooding, Chief Executive, RAC Foundation; Professor Nick Reed, Founder, Reed Mobility; and David Wong, Senior Technology and Innovation Manager, SMMT.

Written evidence from witnesses:

- [RAC Foundation](#)
- [Reed Mobility](#)
- [Society of Motor Manufacturers and Traders](#)

Examination of witnesses

Witnesses: Steve Gooding, Professor Reed and David Wong.

Q1 **Chair:** This is the Transport Select Committee's first evidence session in our new inquiry "Self-driving vehicles". We have two panels before us. I ask the first panel to introduce themselves for the record.

Steve Gooding: Good morning. My name is Steve Gooding. I am the director of the motoring research charity, the RAC Foundation.

Professor Reed: Good morning. My name is Nick Reed. I am an independent transport consultant for my company, Reed Mobility. I am also a visiting professor at the University of Surrey, a trustee of the road safety charities Brake and RoadSafe, and the chief road safety adviser to National Highways, but I am not representing those organisations here today.

David Wong: Good morning. I am David Wong, senior technology and innovation manager at the Society of Motor Manufacturers and Traders, SMMT, the UK's automotive industry body.

Q2 **Chair:** Good morning to all three of you. Thank you very much for being with us. On this Committee, we always like to look into the future, with a bit of science, technology and innovation. We are aware that the Government have plans to see self-driving vehicles operational by 2025. I will start with a question that could take us into the next two hours. What is a self-driving vehicle?

David Wong: A self-driving vehicle, or, in industry's parlance, an automated vehicle, is a vehicle that is fitted with an automated driving system capable of performing the entire dynamic driving task without human intervention within its operational design domain.

I appreciate that there is a lot of jargon in there, so let me explain. An automated driving system is a combination of hardware and software. The dynamic driving task refers to control and monitoring. Control is the lateral and longitudinal control of a vehicle: steering, acceleration and braking. Monitoring refers to the need to pay attention to the road ahead, which is required by the highway code, and to pay attention to the vehicle and the way the vehicle drives. Only if the automated driving system could perform both control and monitoring can it be deemed self-driving.

The operational design domain is basically the conditions under which the automated driving system could function. For example, it could be certain types of roads, certain speed limits, certain geographies or the weather, but it is more likely to be a combination of those factors.

Q3 **Chair:** Before I bring in Karl McCartney, who is already out of the blocks, do you, Steve or Nick, want to add anything to that or to disagree with anything that David has just said?



HOUSE OF COMMONS

Professor Reed: That is a superb answer from David. The only thing to add is that there are different ways in which self-driving vehicles have been characterised. There are the Society of Automotive Engineers' levels of automation, which people may have heard of: levels 2, 3, 4 and 5, indicating greater levels of automation. They work from an engineering perspective, but they do not work very well from a communications perspective in terms of public understanding of how automated vehicles work.

In its recent work reviewing the regulations around automated vehicles, the Law Commission has described self-driving vehicles as being UIC or NUIC—user in charge or no user in charge vehicles. A user in charge is a vehicle where a driver might take control for some of the time. There are controls in the vehicle, but you can allow the vehicle to do your motorway driving, for example. A no user in charge vehicle is one that is designed not to have any controls in it. It might be purely for delivering parcels. It might be a self-driving bus. That distinction is quite useful in thinking about the sorts of application we might use self-driving vehicles for.

Q4 **Chair:** Steve?

Steve Gooding: I agree with them.

Chair: We like those answers when that is the case. Karl, do you want to come in straightaway?

Q5 **Karl McCartney:** This could be a quick question. It could also be a long question. It is for the three of you. How many cars do you have at the moment, and do any of them have any automated systems? I know that some do already. If you don't have an automated vehicle now, do you expect to have changed your vehicle by 2025? When do the three of you think that you will have an automated car that you will own and drive?

Steve Gooding: I am happy to go first. I own a 2007 Volkswagen and a 2021 Triumph motorcycle, in neither of which have I have found any automation that I can spot, as yet.

On a completely different tack in which the Committee has taken an interest, I will probably be replacing those when I have got myself a bit more comfortable with the electric revolution that is coming, in a separate part of the forest. I don't have them yet, and I am probably not going to get them for a little while yet.

Professor Reed: As a family, we have one Volkswagen Golf and several bikes. The Golf has some basic automation features, such as adaptive cruise control. Like Steve, electrification will drive our decision to change vehicle, rather than automation.

Q6 **Karl McCartney:** You are being very good at being politicians but you are not giving me a year. Do you think that you will be driving one by 2025, 2030, 2035 or 2050?



Professor Reed: By 2025, I think it will be possible to use a vehicle that can do some of the driving for you in a self-driving capacity. I suspect that it will be one that I cannot afford.

Q7 **Karl McCartney:** Very good answer. David?

David Wong: In fact, I have some good news. The world's first passenger car fitted with an automated driving system is already on the market, just not in the UK. It is currently available in the German market. It is approved internationally by the UNECE as an automated driving system. It is currently fitted in a passenger car belonging to a particular brand. There are two models available in the German market. Should those models fitted with the automated lane-keeping system, which is the name of the automated driving system, hop over the channel to the UK market, consumers in the UK will be able to acquire a vehicle fitted with an automated driving system.

As for me, it depends on the affordability of these vehicles going forward. Certainly, way before 2025, should these vehicles become available in the UK market, consumers will be able to avail themselves of automated driving.

Karl McCartney: Those were very useful and informative answers. Thank you very much indeed.

Q8 **Chair:** You touched on the different categories of vehicle. We have chosen to call the inquiry "Self-driving vehicles" just for public understanding. It was "Autonomous vehicles".

If you look at it at its most basic, 71% of new cars have advanced emergency braking, some form of assistance. Can you talk us through the different levels of automation? You have touched on it a little, David. We see from our evidence that the Society of Automotive Engineers has established six levels of driving. I wonder whether all of this just becomes terribly confusing. There are also different arguments about what is safe and less safe. Is there anything you can add to that?

David Wong: Absolutely. As my friend Nick mentioned just now, the SAE J3016, which sets out those six levels, is automotive engineering-speak. It is industry convention, which is not necessarily helpful when describing self-driving or automated vehicles to the general public. None the less, for the benefit of the Committee, levels 0, 1 and 2 are driver assistance. Driver assistance is not self-driving. It is not automated driving. These features support the driver in performing the driving task; the driver is still fully responsible and they do not replace the driver. Levels 3, 4 and 5 are automated driving systems, with increasing levels of sophistication. The one I mentioned just now, in a passenger car that is available in the German market, is SAE level 3.

SAE levels 3 and above are automated driving systems because they pass the control and monitoring test that I mentioned just now. When they are safely activated within their operational design domain—within the



conditions in which they are supposed to function—the user no longer needs to pay attention to the road ahead and no longer needs to perform the driving task. The system or the vehicle will perform the driving task. SAE level 3 requires the user to be vigilant to a request to retake control, should the system reach its limits. SAE level 4 does not require the user to retake control. SAE level 5 is the ultimate.

The problem is that a lot of people make the mistake of thinking that SAE level 5 is necessarily a type of vehicle without steering wheels and brakes. If people see a port or a shuttle without steering wheels and brakes, as we have seen in the UK in all the trials that have taken place, they think that they are SAE level 5 vehicles. They are not. The Society of Automotive Engineers defines SAE level 5 as the sort of vehicle that can travel anywhere, without any restrictions, meaning that they could bring you anywhere you wished to go, point to point, in the UK, in all types of weather and through all types of roads and geographies.

SAE level 4, which is the level below SAE level 5, is the level that is being aimed for by most people in the industry and by technology developers. SAE level 4 refers to both UIC and NUIC vehicles—user in charge and no user in charge, as Nick mentioned just now—with or without steering wheels, as long as there is no expectation of the user retaking control.

Q9 **Chair:** Which of those five are currently in use in the UK and, indeed, elsewhere around the world? California has gone up to 5, has it not?

David Wong: No one in the world has gone up to 5.

Q10 **Chair:** What is in California? What category is that? Four?

David Wong: SAE level 4.

Q11 **Chair:** No one has 5 yet.

David Wong: No one has 5.

Q12 **Chair:** California has 4. Is there anyone else on 4?

David Wong: SAE level 4 has been trialled in many places in the world, but it has never been deployed commercially anywhere in the world. The only one that has been commercially deployed so far—available in the market on a commercial basis—is SAE level 3, in the passenger car that I mentioned just now.

Q13 **Chair:** So 5 is the holy grail. Steve, you wanted to come in. I will then bring in Karl and Ruth.

Steve Gooding: There is another way of describing this that I find helpful, which is to think of it as three levels: hands off, eyes off and nod off. Hands off means that the vehicle will drive itself, but you need to keep alert. Eyes off means that the vehicle will look after itself entirely. Nod off means that you can go to sleep and the vehicle will take you where you want to go.



HOUSE OF COMMONS

Chair: We like that. Karl, let me bring you back in. I will then bring in Ruth. We will try not to career off our brief and our order, because otherwise we canter over one another's sections.

- Q14 **Karl McCartney:** I am going to ask this question for the man or woman in the street. Thank you very much for the technical breakdown. This applies to the high end of cars in this country perhaps, but I am aware that in 2005 Range Rovers had lane assist and distance assist. If you set the distance for whatever speed you were going at, it applied the brakes automatically.

David Wong: Adaptive cruise control.

- Q15 **Karl McCartney:** Indeed. That was 17 years ago. Back in 2015, 2016 and 2017, Volvo took that further with its latest XC90s. Mercedes has done the same, and other car makes are available. Where were they on the scale of 1, 2, 3, 4 and 5? Were they 2s or just 1s?

Professor Reed: Ones and 2s.

- Q16 **Karl McCartney:** That is where we are in the UK at the moment. We have not progressed from that at this point in time with things that are readily available to people.

Professor Reed: Correct.

David Wong: One of the brands that you mentioned just now, which I will not pinpoint, has gone to level 3. It is the one in the German market.

- Q17 **Karl McCartney:** Do tell us.

David Wong: Other brands will be available soon, but Mercedes-Benz is the first in the world to offer automated driving that is approved by the United Nations in its S class and EQS in the German market.

Chair: Ruth, you want to come in.

- Q18 **Ruth Cadbury:** This is a question for Professor Reed and maybe David Wong. I am trying to understand whether the technology is driving the transport agenda or the transport agenda is driving the technological change. If the answer is a self-driving vehicle at level 5, where one can nod off, what transport challenge is that trying to address that cannot be addressed by other, technologically easier forms of transport that probably involve less capital infrastructure?

Professor Reed: There are probably three main reasons. The first is safety. Most companies developing this technology would cite that as their main reason. The majority of crashes have human error as a contributory factor, and the thought is that if you automate the driving task you will remove some of the crashes that have human error as a contributory factor. The opportunity to improve safety is one of the priorities.



Second is the efficiency of car use. You might not need to own a vehicle. You would be able to share vehicles, so we would reduce the need for parking and ownership of vehicles. We can make mobility more accessible for many more people if we remove the need for ownership. You use a vehicle on a per-trip basis, and then it goes to serve someone else's needs.

The last thing is accessibility of transport. By using automated vehicles, you could make rural bus services more efficient, potentially, as you would remove the cost of drivers. You could use vehicles that are accessible to people with disabilities more readily. Currently, blind people are not able to drive. They could have independent mobility served by an automated vehicle. Safety, efficiency and accessibility.

Q19 Chair: Before I hand over to Ben, this is a last question from me. It relates to testing. What has testing of the categories taught the industry about how successful they are? What pitfalls have been identified?

David Wong: The UK has one of the world's foremost testbeds, if I may put it that way. All in all, thanks to Government and industry partnership, we have no fewer than six testbeds in the UK that are open for business or will be open for business. That is notwithstanding the numerous trials and testing projects that have taken place since late 2014. All in all, there have been more than 90 projects, involving more than 200 organisations. There are some Government-sponsored competitions that are still live at the moment.

A lot of the trials and testing projects that have taken place have been conducted with a safety driver in the vehicle. The next frontier is to remove the safety driver for applications that, eventually, are likely to be operated without a user in charge. These include automated passenger services—ride-hailing and robotaxis—and automated delivery and logistics, which, ultimately, will not have a driver. They do not include passenger cars, because there will always be a driver in passenger cars that you own or lease. For the no user in charge applications, it is quite crucial that the next step is to remove the safety driver altogether, whether the safety driver is inside the vehicle or remote. If we are to breach the next frontier, there ought to be no safety driver at all.

Once we have done that, we can progress to pilot deployment, which we have already been seeing in the States. You mentioned California; it is also in Arizona. Automated ride-hailing vehicles are accepting fee-paying passengers on a pilot deployment basis, and there is no safety driver in the vehicle or off board. That is the next challenge for us in the UK.

Professor Reed: You asked about what we have learnt. When I have been leading trials, one of the things we have focused on is what the public make of these vehicles. How do they experience them? What is their appreciation of the technology?



For the most part, when they come to a trial of this type of vehicle, they come slightly anxious, with some trepidation. They may be excited about the experience they might have. After a few minutes, there is curiosity. What is it doing? Is it doing the right sorts of things that I would expect a vehicle of this nature to do? Five minutes later, there is boredom. That is the right thing. That is what we want people to feel, that this is part of a natural, mundane mobility experience.

They then start to think about how the applications of the technology could be useful: "How does it help my life?" When people have had that experience, they start to think, "Yes, I can see the value now. I can see that this could work for me in a transport context." They think about how it would be useful to them.

Chair: We will go into each of our sections now and drill in. We are going to look at safety, some of the benefits and the infrastructure that is required. Ben, over to you first of all.

Q20 Mr Bradshaw: Professor Reed, the three potential benefits that you cited—safety, accessibility and efficiency—were all benefits to the individual, it could be argued. Could there not also be huge wider societal and environmental benefits? Draw me a picture of a future utopia where our urban landscapes, in particular, are transformed. So much of our urban space is taken up by roads and cars, and 90% of the time private cars sit there doing nothing. All of this space could be liberated for trees and vegetation, couldn't it? You could completely transform the quality of life in our towns and cities, as well as moving people around a bit more efficiently and with zero or near-zero carbon. Paint me that picture.

Professor Reed: Happily. I would say that the three answers I have given have individual and societal implications. There is certainly a safety benefit if, as a society, we do not kill as many people we do currently; five or six people a day lose their lives on UK roads. There is an opportunity for that to be greatly reduced.

I fully agree on the urban design aspects. We could really change the way cities operate. The flows of people and goods around cities could change dramatically. There are implications for equality of access to mobility from having a more accessible transport system.

All of those are potential benefits. They are not proven yet. There are nine principles in "Future of mobility: urban strategy" that try to capture the utopian vision that you described. I think they do that very well. It is a DfT document that describes the principles around how the technology must support all areas of society and all groups within society, that data should be shared and we should be moving towards a safer and more sustainable transport system. If those principles are applied, I feel very positive that we will move towards the positive vision that you portrayed.

They are only principles. You could argue that they need more teeth to make sure that those things happen, but as a structure around which we



have characterised what we intend this technology to achieve, I think they are very useful.

Q21 Mr Bradshaw: How will the transition be managed? There is a very deep-seated psychology in the developed world about car ownership and individual car ownership. It is almost a religion. People feel that they have a human right to own their own car and not to share one with somebody else. How do you transition to a world where you have this lovely system of people going on an app and a car arriving at their door to take them where they want to go cheaply and efficiently when other people insist on sitting in their car and driving themselves to where they are going? That is a recipe for a certain amount of anarchy on the roads, isn't it, and, potentially, even more congestion?

Professor Reed: Yes. That is why those principles are so important. One of the principles is not to increase congestion.

Carefully is the answer. You would want to see use cases for automated vehicles that illustrate the benefits and then allow people to come to their own conclusions about whether they wish to use those benefits. Similarly for local authorities, do they wish to see those sorts of services supporting improved mobility for their particular environment? Does it work in their particular environment? Does it deliver the sorts of benefits that their residents and businesses are hoping to see? With careful deployment of use cases, and selection of use cases to highlight where the greatest benefits can be achieved, it can grow from there.

Steve Gooding: Can I offer a rider to what Nick said?

Mr Bradshaw: Please do.

Steve Gooding: I am as guilty of this as anyone, but very often when we talk about this technology we tend to think about cars—private cars that we own. The sort of scenario you are painting of the city of the future is really more dependent on the automation of buses, minicabs, taxis and services of that sort.

Nick talked about use cases. The use case that would be interesting is who is developing the driverless bus of 2040, and—something I put in our written evidence to you—what if the driverless bus does not have a driver but does have a conductor, which makes us all feel safer travelling at night? The impact of the technology, once it starts to be mainstreamed into public transport-type services, could change the economics and improve the passenger experience all in a bundle.

To achieve the sort of utopian vision that you are describing, it is very important to set the technology in the broader context of what, say, the mayor of the city is hoping to achieve. If you look at what is happening in the City of London, quite a bit of it is coming regardless of the driverless technology. You do not see that many private cars in the City of London, and they are repurposing some of the road space.



HOUSE OF COMMONS

Q22 **Mr Bradshaw:** There will need to be a price and a convenience premium to encourage people to make the psychological shift from private ownership to sharing whatever these systems are, won't there? They have to be quick and convenient. How can you achieve that in the short term? One of you said that in the short or medium term this is going to be a lot more expensive for the public to utilise. You often hear the argument now that it is cheaper to drive than to go on the train or a bus.

Professor Reed: It would be expensive if you wanted to buy one. If you were operating them as a fleet, the individual trip cost could be much lower. That is the intention. The only caveat to that is that cities are doing a lot to encourage active travel. You would not want it to become so cheap and convenient that people stopped walking and cycling and chose a motorised form of transport instead.

Q23 **Mr Bradshaw:** Is interaction with animals and human beings—pets running across the road—an issue, or is that also surmountable?

Chair: Don't go too much into safety, if you don't mind. Someone else has a whole section on that. Could you address Ben's specific point?

Professor Reed: For me, those are issues that can and will be surmounted.

Chair: Welcome back, Jack Brereton, to our Committee.

Q24 **Jack Brereton:** Quite a lot of people—taxi drivers, bus drivers and lorry drivers—rely on transport for employment. Have you thought about how we would manage that transition? There are a lot of people who, potentially, will find themselves out of employment.

Steve Gooding: Yes, we have thought about it. In part, that could just be another industrial change, where a whole range of jobs that we used to have are not there. If you go to a modern factory, you will see a lot of robotics that has taken the place of industrial workers. Hopefully, there will be other jobs that such people can do.

Nick talked about somebody who has sight difficulties, who would not be able to drive. I stress that if we are going to have an automated vehicle that is enabling people with disabilities to get around, they have to be able to get out of their house and into the vehicle. When my aged mother was going in minicabs, she was helped from her house by the minicab driver. The future world Ben was asking us to think about, in which the vehicles are driving themselves, does not necessarily have no people in it helping us to engage with the transport system. Potentially, on buses, there could be rather more.

Professor Reed: There is a shortage of bus drivers and truck drivers at the moment. I think that people who are working in those roles currently are likely to have jobs for life and that the transition will work in such a way that it will be filling gaps that exist currently. It will evolve over time.



HOUSE OF COMMONS

David Wong: What we have seen with any new, emerging or disruptive technologies over the decades is that there may be a transition as regards jobs, but new jobs are created as a result of the proliferation of these technologies. A study that we commissioned back in 2019, based on modelling over a decade, suggests that, should automated vehicles be mainstreamed and deployed in sizeable quantities in the UK, up to 420,000 new jobs could be created, but only 20,000 of those would be in automotive. That means that, as a spillover effect, about 400,000 jobs will accrue to other sectors: digital, servicing, consumer services, insurance, maintenance of vehicles and, not least, operation of the services.

Chair: Let's move on to how we are going to get there and some of the challenges that will no doubt be involved. I ask Robert Largan to do just that.

Q25 **Robert Largan:** Good morning to the witnesses. We have already covered this a little. Is it realistic to expect the majority of vehicles to be self-driving in future? If so, roughly how long do you think that it will take for us to get to that tipping point?

David Wong: A study commissioned by the Government suggests that by 2035 40% of new passenger cars in the UK market will be available with automated driving capability, but there are 40.5 million vehicles on UK roads, 35 million of which are passenger cars and the rest commercial vehicles. It is very unlikely that at some point in the next 20 years, or even 30 years for that matter, the majority of the 40.5 million vehicles will be automated vehicles. For a long time, there will be co-existence between automated vehicles and manually driven vehicles. Our data shows that, even today, legacy vehicles remain on the road for an average of 13.9 to 14 years before they are scrapped. The churn rate has been quite consistent over the years. These are legacy vehicles that are manually driven. To expect them to be off the road by 2040, for example, is unlikely.

Q26 **Robert Largan:** Is there anything to add?

Professor Reed: There is the way insurance works. If we see that they are genuinely significantly safer than human-driven vehicles, there might be a big incentive to make that shift more quickly. If we are operating them in a more shared manner, where you do not need to own a vehicle, the transition might happen more quickly. I share David's estimation of the timeline.

Steve Gooding: As David explained, we have different operating domains, which is the technical term. Frankly, I suspect that if I was able to buy a new car in the 2030s it would have self-parking as either an option or built in. I would really rather like that. It might well have automated lane keeping, so that when I am on a motorway I could just tell it where I want to go and nod off.



HOUSE OF COMMONS

It would not necessarily be at the higher levels David said, where it will take me to the motorway junction and then take me all the way to my final destination. It is worth reflecting that in that 40% lots of vehicles will have a degree of automation in them, but it will only work in certain parts of the trips you are making and, quite possibly, only work if you remember to turn it on. Many of us have cruise control in our vehicles but we do not always put the cruise control on.

Q27 Robert Largan: Thank you; that is very helpful. It feels like it is quite a long way off before we would be at the point where the majority of vehicles were either category 4 or 5 that we talked about earlier.

Professor Reed: Yes.

Steve Gooding: Yes.

David Wong: May I quickly clarify that? We think it is unhelpful to even discuss level 5. That is because, as I mentioned just now, level 5 is a hypothetical, theoretical, level. It means that the vehicle could potentially travel, for example, from your farmhouse in the middle of nowhere in the highlands of Scotland, all the way through different regions and bring you to the doorstep of Threadneedle Street, to the Bank of England, through all weather conditions and all types of situations.

Q28 Chair: That sounds fantastic, but you said it would be unhelpful to talk about that.

David Wong: It would be unhelpful to talk about it for that reason. Part of the reason is also that it may not be needed, and it may not be achievable in our lifetime. Somebody mentioned the holy grail. Actually, the holy grail is level 4, not level 5. Level 5 is a theoretical level.

Q29 Robert Largan: That is very helpful. Moving back to perhaps more practical issues, we have talked about the sharing of conventional vehicles with self-driving vehicles on the road. It would be helpful if you could talk us through some of the challenges of that co-existence and how we can go about solving those issues.

Professor Reed: The infinite variability of the environment is the challenge. It is the unpredictability of the behaviours of others in some of their testing in America. Google encountered a woman on a mobility scooter chasing a duck with a broom. You would have to go a long way to find those kinds of examples or think that that was something for which you might have to prepare. You encounter such strange things, so ensuring that a vehicle is capable of responding safely to those unpredictable scenarios is vital.

Some of that might need remote support. The vehicle might say, "Okay, I'm not sure what to do now—hand control or hand decisions back to a remote operating centre." That in itself brings some challenges. I think the main challenge is understanding and being able to make sound predictions about the behaviours of others.



HOUSE OF COMMONS

Q30 Robert Largan: Is there anything the other two panellists want to add? Are there any other challenges that you envisage?

David Wong: In terms of co-existence with legacy vehicles, as well as vulnerable road users, that is absolutely the case and I agree with what Nick mentioned. It is also important to understand that one of the reasons why we have not seen automated vehicles, particularly the type without a driver or a user in charge, deployed on a commercial basis on urban routes or in city centres in the UK is that it is quite difficult to fine-tune the system to an acceptable level of safety that is robust and resilient enough to take into account reasonable edge cases.

The case that Nick mentioned just now is an edge case. You do not often encounter that; it is probably one in a million or one in 10 million. It has taken a long time because of the challenge, but at some point, with enough resources, investment, time and energy put into cracking the problem, we will be able to get there. Any technical issue or challenge is an engineering challenge. An engineering challenge can be overcome.

Perhaps the slightly more challenging barrier is social attitudes and how people behave when they see an automated vehicle. We have heard a lot already about, for example, people playing chicken with these vehicles because they know the vehicle will stop if they step in front of it. They may just take a chance with the vehicle.

It is for us collectively, as a society, to think about how we may wish to discourage such behaviour. I quote an example. Some years ago, one of our members, a vehicle manufacturer, was trialling their automated vehicle in Europe. I won't say which country. They thought that that particular country had very civic-minded and very rational citizens—so they thought. They marked the vehicles as an automated vehicle trial. When people saw those automated vehicles being trialled, they actually took a chance with those vehicles. This was on the motorway in that particular country. It is about people's psyche, their psychology and what they might do when they see an automated vehicle on the road.

Q31 Robert Largan: Thinking about some of those challenges and what progress we have, how successful have Government agencies, such as the Centre for Connected and Autonomous Vehicles, been at driving progress for solving the challenges?

Steve Gooding: They have been very active and are funding a great many trials, as Nick and David have mentioned. I think they have been doing a great deal of work.

I would say the most important work is not actually being done in CCAV. It is being done by the international vehicle standards team in the Department for Transport. I suspect we will come on to this. That is where the thinking is going on about what the regime should be for establishing whether a self-driving vehicle is roadworthy.



Historically, we have had very clear demarcation. Testing whether a vehicle is roadworthy is largely an engineering exercise, and we test drivers as a human exercise. Now, we are going to have to put the two together and find a way of testing a vehicle that takes real-time decisions. That is taxing some of the great brains in the industry. I would say that they are engaging well with it, but it is a big challenge, not least because they have to engage with the industry globally, hopefully to come up with a reasonably common approach, not just across Europe but across the world.

Professor Reed: I have been really impressed with what CCAV are doing. That it is a joint policy unit between DFT and BEIS is, I think, really important. That indicates both the transport and the business opportunity there is for this technology. There is also the creation of Zenzic, which is a Government-owned organisation that runs the test facilities for connected and automated vehicles. Then, of course, there is the Law Commission's work in the regulatory review for automated vehicles. Across those organisations, there is a huge amount of good work happening in the UK.

David Wong: We have a lot of respect for the Centre for Connected and Autonomous Vehicles. We have worked very closely with CCAV since its inception in summer 2015. We think it has done a lot of good work from the very beginning, developing the code of practice for testing and trialling automated vehicles, the first edition of which was in 2015—it has been refreshed twice since—through to funding a number of the projects. As Steve mentioned just now, with the international vehicle standards collectively, the Department for Transport has been instrumental at the UNECE in influencing the development of international technical regulation, as well as spearheading domestic regulatory reforms following the Law Commission's proposals.

What we would like to see going forward, and what CCAV should strongly pursue, are four key areas. One is quickening the pace of regulatory reform as set out in its recently published policy paper, CAM 2025. The Government vision is to have the entire suite of regulation in place by 2025 to enable the full commercial deployment of any types of automated vehicle applications.

It is quite important that this timetable must not slip. The UK is already behind, for example, the EU as well as Germany. The EU actually passed its automated driving system implementing regulation just this summer for small series and, in 2024, it will be extended to unlimited series vehicles. Germany passed laws back in 2017 to enable automated driving, long before we passed ours. In May this year, they adopted an ordinance for automated vehicle approvals and operations, to allow for the deployment of robot taxis and ride-hailing as well as delivery services using automated vehicles. It is quite important that we pursue regulatory reform at pace to ensure that we keep pace with other jurisdictions.



HOUSE OF COMMONS

Second would be to clarify how the advanced trials without a safety driver could be done within the current regulatory framework, and what the processes are for obtaining approvals and exemptions and providing guidance along the way. Third would be to harmonise internationally, particularly with the United Nations. It is in the interests of industry that there are harmonised international and technical regulations. These reduce cost and enhance time to market. It promotes international trade when there are harmonised regulations.

Lastly, we think that, going forward, Government should target their support and their funding to advanced R&D projects that really have a chance to make it to the market. We have progressed through about seven years' worth of funding for collaborative R&D, feasibility studies, demonstrations and trials. It is time to be more targeted and to ensure that the technology can be commercialised.

Robert Largan: I hand back to the Chair in the interests of time. Thank you so much, witnesses, for very informative answers.

Q32 **Mr Bradshaw:** Why have we fallen so badly behind Germany and the rest of Europe in terms of legislation and regulation?

David Wong: We have not fallen badly behind. We are just a little bit behind, but sometimes being a close follower rather than a first mover is no bad thing, particularly in an emerging area of technology. We are getting there, particularly if the regulatory reforms that have been proposed to be completed by 2025 are on track.

Chair: E-scooters are a good example where it is, perhaps, best not to go first.

We are going to cover interaction with other road users and readiness of the roads. Just bear that one in mind and park it when I say we are now going immediately to safety. Over to Gavin Newlands. I remind you that we have 17 minutes left, so perhaps not every witness needs to answer.

Q33 **Gavin Newlands:** Good morning. How safe are self-driving or conditionally automated cars?

Steve Gooding: Since we do not have any at the moment, we do not know yet. I do not think we are going to have a regulatory regime that lets them on the road unless they are safe. The way the Government are thinking about this at the moment is that they would want the self-driving vehicle to be as safe as a fully competent human driver would be in the same circumstances. That is the test they are applying. They are just trying to work out how to take that from words into something you could actually test in a testing environment.

It is highly likely that they will operate safely. I think they will operate on the same sort of principle as a guide dog because they will be more cautious. If they do not know what to do next, they will just stop. I think they will be safe in that respect.



Q34 Gavin Newlands: Given that response, would the rest of the panel say what the biggest dangers could potentially be and also the biggest benefits with regard to safety and self-driving cars?

Professor Reed: The biggest benefit is the potential for the reduction of human error as a contributory factor in many crashes. The challenge is that achieving that level of competence—the standard of a careful and competent driver, a driver who does not commit those types of error—is very high. For the UK there is about one fatality for every 200 million miles of driving. That includes all fatalities where there was fatigue, intoxication or poor judgment by drivers. We are taking all of those out and saying that we are going to have vehicles that operate at least as well as that competent driver. That means it is more like one fatality per billion miles of driving, at least. That is comparing it against all types of driver, and all ages of vehicle. If we are making the comparison, it should be against a modern vehicle with the latest safety systems, so that you make the bar even higher.

There is a huge opportunity in safety. Being able to prove it on the roads with testing of the fleets of vehicles today is not practical. There will need to be simulation. We will need to simulate many miles of driving, but we also need to trust that that simulation is a true representation of what happens in the real world. It is all of the complexity that I have described about the interactions with other road users, the age of the infrastructure and so on.

Q35 Gavin Newlands: Do you have anything to add, Mr Wong?

David Wong: Two main points. First, safety is the priority of the industry. We agree with the Government proposal that automated vehicles should be as safe as a careful and competent human driver, subject to clarification and a bit more definition of what a careful and competent human driver is. Apart from a mention in sections 2A and 3ZA in the Road Traffic Act 1988, in relation to dangerous driving and careless or inconsiderate driving, there is no definitive explanation of what a competent and careful human driver is. We agree with the term and we agree with the ambition, but we seek greater guidance.

The second main point in relation to safety—because you mentioned conditional automation just now—is that conditional automation is regulated under regulation 157 at the UN. Regulation 157 has provisions that clearly require a high safety bar to be met. For example, regulation 157 stipulates that the activated system must prevent collisions that are reasonably foreseeable and preventable, as well as the system identifying risk and being able to perform manoeuvres to minimise the risk to safety of the occupants of the vehicle as well as other road users.

If that is not enough, there are higher requirements. At the moment, conditional automation is only allowed on motorways. By law, at least in the UK, pedestrians and cyclists are not allowed on the motorways. Despite that, the regulation goes further, requiring the system to be able



to prevent a collision with an unobstructed pedestrian crossing in front of the vehicle. There is a high bar to be met.

- Q36 **Gavin Newlands:** I am conscious of the Chair's stipulation about how much time we have left. There are a couple of specifics which I will put to one or two of you in terms of safety. What cybersecurity risks are potentially presented by self-driving cars?

Steve Gooding: Self-evidently there is a cybersecurity risk. We saw some years ago the weaponising of motor vehicles by people seeking to conduct terrorist acts. Of course, that is a worry, but it is a worry where we know a lot of work is going on at the moment to make sure it is safeguarded.

- Q37 **Gavin Newlands:** Do you have anything to add to what Steve has covered?

David Wong: It is basically just to clarify, as well as perhaps to correct, a misconception. The greatest cybersecurity or hacking risk is not with automated vehicles; it is with connected vehicles. As long as the vehicle is not connected it is very difficult to hack it or penetrate its communication system, if there isn't one. Regardless of whether the vehicle is automated or not, as long as it is connected it presents a cybersecurity risk. That is why industry has worked together with international regulators, in a forum that is actually co-chaired by the UK at the UNECE, to pass two laws. Those are regulations 155 and 156 at the UN for cybersecurity management systems and software update management systems to ensure that industry and all its stakeholders, including suppliers, do their utmost to maintain the system to a level whereby they could practically ensure that it is state of the art, as well as secure by design of course.

- Q38 **Gavin Newlands:** Lastly from me, because I think Karl wants to come in on this section, one of the biggest areas of concern—certainly from insurance companies at the moment—is the moment when control is transferred back from a car to the driver or user, however you want to describe them. What risks are there currently with that, and what can be done to address them?

Professor Reed: The risk is that the driver is not ready to resume control and that control is handed back. I think we will need monitoring of the driver, or the occupant of the driving seat, to show that they are indeed ready and able to take over, and also that the vehicle is capable of managing the situation should the driver not be ready or able to take over. If the driver was having a medical episode, for instance, it would be that the vehicle can manage that situation and take the vehicle to a safe position—a minimal risk manoeuvre, as it is described. Making sure that the driver is aware and able to take over is the risk of that transition process.

Gavin Newlands: I am sure the Chair is ready to take back control.



HOUSE OF COMMONS

David Wong: Can I very quickly mention—

Chair: Sorry, David. I am going to completely take over control and hand over to Karl. We only have nine minutes left, and there is a heck of a lot to cover.

- Q39 **Karl McCartney:** Very quickly, I am going to Steve on this one. Going back to the systems that have been in place for a few years and how insurance companies use that information, are drivers blaming autonomous systems that are already in place for any of the accidents that have happened? Is there a proportion? Obviously, there is not a proportion of accidents that are not happening because of those autonomous systems, although we might have anecdotal evidence, or you might have some that you can make available to us at this point in time.

Steve Gooding: We do not have fully autonomous systems running on our roads at the moment in this country. We only have—

- Q40 **Karl McCartney:** I understand that, but we have lane changing, we have distance control and automatic braking systems. Has any driver blamed an accident on those systems?

Steve Gooding: I am not aware of there having been a claim from a driver from one of those systems operating, or indeed from it failing. I am aware that there have been some issues with things like the vehicle applying its own braking system, but it is very rare. I am not aware of those actually leading to insurance claims. The best bet is for the Committee to ask the ABI to come and talk to you about that.

Chair: They are coming next time.

- Q41 **Karl McCartney:** Moving to David quickly, you have touched on this in an answer already, but autonomous and autonomy are two different things. With the systems that are in place at the moment, how fully autonomous are the vehicles? They are perhaps taking sat-nav information from maps and whatever, but are they feeding back to a system, or is the likelihood that at level 3 or 4—whatever level it might be—that the car is autonomous and not taking instruction from anywhere else or communicating with anyone else?

David Wong: As an industry we are in fact retiring the use of the terms “autonomous” or “autonomy”. We use the term “self-driving” or “automation” as opposed to “driver assistance systems”, as I mentioned just now. There is a clear dividing line between the two. It is not autonomy or autonomous because, from our engagement with the public over the past seven or eight years, we have discovered that it is an unhelpful term to the general public. An autonomous vehicle describes it as though the vehicle actually has a mind of its own, that it has autonomy and can make decisions of its own volition. That is not the case.

- Q42 **Karl McCartney:** It is independent, basically.



David Wong: It is not as independent as people think. It is predicated on machine learning. A lot of data is being fed to it. It learns and then produces a set of outputs based on the inputs that it has learned over time, but it does not have a mind of its own such that it can decide, for example, who to crash into or where to bring you against your wishes. Therefore, the use of the term “autonomous” is something that we have decided not to progress further. We use the terms “automated vehicles”, “automation” or “self-driving vehicles” in line with—

Q43 **Karl McCartney:** I am going to stop you there because we are getting into the realms of “1984”. Nick, I want to ask you a question about the future, which academics may be looking at more than others.

We have heard that there are 35 million passenger vehicles and 5 million goods vehicles. Do you think we will see autonomous or independent vehicles—call them what we like—using the roads and also the air to do deliveries rather than taxis? Is that safer?

Professor Reed: I am cautious over it. If a self-driving road vehicle gets into difficulties, it can stop and bad things tend not to happen. If an air vehicle has to stop, that is a bigger problem. I am cautious over the use of self-driving aerial vehicles. For small packages for certain urgent deliveries, they might be useful. For me, the focus is on the road.

Q44 **Karl McCartney:** Some companies have made very big orders for autonomous—if I’m going to call them that—or independent air vehicles in this country. Do you think that will happen quicker than autonomous vehicles on the road?

Professor Reed: No.

Q45 **Chair:** For our records, do you agree with the figure that 80% of all collisions involve human error? Do you agree with that statistic?

Professor Reed: It is reasonable, yes. It is at least that many.

Q46 **Chair:** So this technology could actually make the roads safer.

Professor Reed: Yes.

David Wong: The Government statistic is 88% in 2020.

Chair: Even more. Thank you. It is good to get that on the record.

Q47 **Greg Smith:** We have talked a lot about the theory. I thought as we delve into how self-driving vehicles will interact with other road users, and we look at the infrastructure that exists in the United Kingdom road network to be ready for self-driving vehicles, I would throw in a few practical examples to see how things might play out.

Example one is that you are on a country road. There is very little else on it and you come across a very slow-moving vehicle, probably my father-in-law or a caravan, or something like that. If you were driving it yourself you would make a human judgment, “It is perfectly safe to get out,



overtake and get back in, in a perfectly safe and legal manner.” What would the autonomous car do?

Professor Reed: That is a challenging use case. If the narrow lane with a caravan on it is part of the operational design domain of the vehicle, it should be able to do that. It is not going to be one of the things that they do in their earliest forms.

Q48 **Greg Smith:** Does anyone have any other thoughts?

David Wong: In the first instance, it is quite unlikely that will be an operational design domain within which early generation automated vehicles will operate. In later years and in the longer term, that may well be an operational design domain, when the technology matures, at which point I would fully agree with Nick’s assessment that the vehicle would be capable enough to assess the best way to overtake the slow-moving vehicle.

Q49 **Greg Smith:** Thank you. Let us take another example. It happens a lot in my constituency. You are driving along and you come across somebody riding a horse. I imagine that unless there is very sophisticated camera technology that can identify different animals, an autonomous car is unlikely to distinguish the horse from another large object on the side of the road. Obviously, there is a very different set of decisions we make as a human to go past a horse slowly and very wide, than it would be to go past something stationary at the side of the road. How would a self-driving car assess the difference between a horse and something else of a similar size on the side of the road?

Professor Reed: I am 100% certain that, if the likelihood of encountering a horse within the operational design domain of an automated vehicle is there, it will be able to recognise that road user and respond to them appropriately. It will manoeuvre slowly and carefully around the horse, as a careful and competent human driver would.

Q50 **Greg Smith:** This is example three. If I am driving along and there is somebody partially sighted, or perhaps blind—maybe they have a white cane or a guide dog—I can very easily identify as a human driver that that is someone you need to be very cautious around because they cannot see. How would an autonomous car differentiate somebody who clearly has sight loss and somebody who might even wave to you because they can see, and they are just walking a dog?

Professor Reed: It is the same answer. It would behave appropriately around all pedestrians. That would include those who are visually impaired.

Q51 **Greg Smith:** But you agree that you apply, as a human, a much greater deal of caution, particularly if the dog walker, who can see, literally smiles or waves at you or something. You know that they have seen you. These are the real-life, practical circumstances of other road users. I am trying to understand how we can be sure and certain that a machine can



differentiate and understand the differing levels of caution that need to be applied.

Professor Reed: You would have to ask other witnesses later in the panel to say how well they are able to distinguish between different types of pedestrian. I would say that in general the automated vehicle would be more cautious than most drivers around all pedestrians as a baseline. Whether it can do those specifics is a question for others.

Q52 **Greg Smith:** I am very conscious of time. Perhaps we can look at the infrastructure that is required. I am presuming, unless you tell me otherwise, that things like road markings, GPS tracking and the car understanding precisely where it is are all very important. There are roads in our country where the road markings may be worn out. I can think of many examples in my own constituency, which is predominantly rural, where there are roads where it is feasible for two cars to pass, but you probably wouldn't. You would be cautious, stop and wait for the other person to come past, or they would wave you through first, whatever it might be. How much physical infrastructure would need to change in terms of road markings, other equipment or the way traffic lights operate? How much would need to be put in before a self-driving vehicle could itself, as a machine, know where it is and what it has to do in different parts of the road network?

David Wong: As a matter of principle, an automated vehicle does not require any alteration or addition to the physical infrastructure above and beyond what we already have today. What it requires, though, is good maintenance of the existing infrastructure, such as road markings. Another example could be to ensure that signage is not obscured by overgrown shrubs, for example, because the exterior cameras would read the signage.

However, there is another part of infrastructure that has often been overlooked and is quite important to complement the proper functioning of an automated driving system. That is the digital infrastructure. Being able to plan ahead, the automated vehicle's path planning software will require information on, for example, what is happening a mile ahead or five miles ahead. That means vehicle-to-network connectivity must be decent enough on the roads in this country. Research that Steve's team has done has shown that, of the 247,800 miles of the great British road network, only 51% has full LTE 4G coverage across all four mobile operators. That is not good enough.

Q53 **Greg Smith:** My last question marries the first set of questions and the infrastructure question. Certainly, in a rural setting, although it could happen in an urban setting, hedges become overgrown. They go into the road. You could still go past, but you will have some nice scratches up the side of your car if you go through the hedge. How would an autonomous car cope with things like that? It would not necessarily show up as a barrier. The car knows that this is a road where two cars can pass; this is a road that is normally fine. If there happens to be a fallen tree branch or



an overgrown hedge, how would it cope with something like that?

Steve Gooding: It is highly likely that the vehicle camera systems would pick up that there was an obstruction. Whether it would know that it was a tree branch, a bush or whatever, I am less clear about, but it is almost certain to observe that there is something in its path. Most of the systems being developed use a mix of radar and camera technologies to observe what is going on, not just ahead but around the vehicle. The vehicle is well informed in that way.

On that point, I agree with David that the infrastructure and mobile connectivity is where we should focus. If the vehicle systems are not being designed to cope with the roads we have, they are not going to work. In your constituency, and I suspect in all of your constituencies, if all of the road markings and all of the road signs have to be properly maintained, it will be nice for all of us who are driving round now, but that is a hell of a job because quite a lot of those road markings aren't.

Chair: My 85-year-old mum drives round in your constituency, Greg. I am going to send her a driver. It sounds terrifying.

Jack Brereton wants to come in briefly, and then straight over to Grahame after that.

Q54 **Jack Brereton:** Following on from that, I can understand if the operational design domain is constant, but often it is far from constant. I am particularly thinking of weather conditions. How will a self-driving vehicle deal with adverse weather conditions? Even the slightest impact of our weather is often disruptive to transport infrastructure. How will we deal with those sorts of issues?

David Wong: For passenger cars, if there is inclement weather that the system cannot deal with, the system will issue a request for the user to retake control. At level 4, where there is no expectation for the user to retake control, if it is truly very inclement weather that the system cannot deal with, the system will actually perform a minimum risk manoeuvre. That is basically a manoeuvre to bring the vehicle to a standstill in a safe place until the inclement weather has passed. For no user in charge vehicles, like robot taxis, delivery or logistics vehicles, it is quite likely that in inclement weather the operations will probably be suspended for a period of time.

Professor Reed: The operational design domain includes weather. The Met Office is fully engaged in designing how the operational design domain is defined. The vehicle's choice to operate will include the weather conditions.

Q55 **Grahame Morris:** Good morning. I think you have covered some of the ground that I was going to ask you about. Just to clarify, Steve, David told us that the holy grail was level 4 and that some countries—the EU and Germany in particular—had given legal permissions to allow the development of the technology some years ago. Are there any areas—



HOUSE OF COMMONS

Steve, you mentioned digital autonomous systems—where, in the UK, we have a competitive advantage?

Steve Gooding: Do you mean in—

Q56 **Grahame Morris:** In the development of self-driving technologies.

Steve Gooding: I would say we certainly have an intellectual competitive advantage because quite a lot of the thinking about how to design these technologies is being done in this country. Indeed, I think the next panel contains some of the intellectual horsepower we have here to deploy. I would say that was a feature.

One of the other features that the Government and Zenic have picked up is that we offer quite an attractive test environment to the world because we have such a variety of roads in this country. If you can make your technology work here in a built-up area, you can probably make it work anywhere.

Q57 **Grahame Morris:** David, you mentioned that sometimes it is better not to be first and to let others trail-blaze—the fact that Germany and the EU are further down the road than us, so to speak. Do you think the target of 40% automated vehicles by 2035 is achievable and deliverable?

David Wong: The caveat to what I said is that it is as long as we are close followers. We must not be left behind or left too far behind. At the moment we are close followers, which is good.

The 40% is not a target. It is a study that the Government commissioned. It was suggested that, by 2035, 40% of new passenger cars in the UK will be available with automated driving systems, which is plausible.

Grahame Morris: I am going to leave it there, Chair, as I know we are very short of time.

Chair: Thank you, Grahame. The very last question is around the legislation and regulatory landscape.

Q58 **Greg Smith:** It is a difficult one to go quickly and last on. What is your view on the Government's approach to the regulatory framework to come? If there is unlikely to be legislation in this session of Parliament, how big a problem is that for the development of this technology and its future application? To summarise, what is your biggest message to the Government right now in this field?

Steve Gooding: If we do not get the regulation in, we cannot have the vehicles on the road. We need the regulations that were due to be made to enable the automated lane-keeping system and were part of a Bill. I think the Government are currently considering their legislative programme. If that is not part of it, there will be a delay.

David Wong: We would be very disappointed if primary legislation could not be tabled in this Parliament. That would mean that it is quite likely



HOUSE OF COMMONS

that the Government's 2025 target timeline will slip and, as Steve says, we will not be able to put the vehicles on the road, particularly with regard to vehicles with no user in charge. Today, technically, it is possible to put passenger cars with automated driving systems on the road, thanks to the regulatory reforms that were passed this summer in the form of the highway code and construction and use regulation 109.

Going forward, it is very important that the Government do not let the regulatory timetable slip. They must pursue the completion of the regulatory reforms by 2025.

Professor Reed: The work by the Law Commission was superb. That four-year review of regulation was really helpful. It made a number of recommendations, 70-plus. Deliver those recommendations and keep going with the research programme that CCAV is commissioning, focused on use cases where we can see real benefit from automated vehicles.

Greg Smith: Thank you, gentlemen.

Chair: Thank you very much indeed, Greg. Steve, Nick and David, thank you so much for all of the evidence you have given us, and for giving us a great start. I wish you well and thank you very much for being with us.