

Transport Committee

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

Wednesday 26 October 2022

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[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 59–104

Witnesses

[II](#): Dr Alex Kendall, Chief Executive, Wayve; and Professor Paul Newman, Founder and Chief Technology Officer, Oxbotica.

Written evidence from witnesses:

- [Wayve](#)

Examination of witnesses

Witnesses: Dr Kendall and Professor Newman.

Q59 **Chair:** Welcome. Can I ask you both to introduce yourselves for our records?

Dr Kendall: Good morning. My name is Alex Kendall. I am the CEO of Wayve. I co-founded the business in 2017, following research at the University of Cambridge, setting out to build a new artificial intelligence approach for autonomous driving. Today, we have self-driving technology. The largest operation is here in the UK, testing in over 10 cities. We have a fleet of passenger vehicles and delivery vans. We have a team of 200 people based in King's Cross, here in London.

Professor Newman: Good morning, everybody. My name is Paul Newman. I am the founder and CTO of Oxbotica. Oxbotica spawned in 2014 from the University of Oxford. I am also the BP Chair of Information Engineering at the University of Oxford. I have had a most privileged life building early autonomy systems. My first was back in 1995—can you imagine—in the ports of Australia and mines.

It is great to be here today. I have also advised the Department for Transport as part of its Science Advisory Committee and I am part of the Prime Minister's Science Advisory Committee. It is a pleasure to be here.

Q60 **Chair:** The pleasure is all ours. You have just been described as the intellectual horsepower by the previous panel, so no pressure. You have obviously set out your company and the people there, Alex, but can you explain how the technology that you are advancing actually works?

Dr Kendall: We are building autonomous driving technology that can essentially learn to drive using machine-learning technology and learn to drive in a way that can really scale. Our technology is able to be adaptable across different vehicle types—today we operate passenger vehicles and vans—as well into different cities. We primarily train and develop here in London, but we have tested in areas like Liverpool, Manchester, Leeds, Coventry, Cambridge and Milton Keynes, to name a few.

Q61 **Chair:** We have talked about the five categories. What category have you been testing at? Do you recognise those five?

Dr Kendall: We do. We recognise those. The most helpful way to distinguish it is as the Law Commission proposed, which is no user in charge or user in charge. For us, we are developing level 4 or no user in charge. It is the kind of autonomous driving technology where passengers do not have to be liable or responsible for the vehicle.

Q62 **Chair:** Paul, the same question to you.

Professor Newman: Our vision is extraordinary. It is called universal autonomy. We have not limited ourselves to saying that it is cities first or



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personal transport first. The system that we have built using AI machine learning is in fact a whole smorgasbord of technology because we are building the system. It is applicable to mining—to answer your question about country roads, the mines of the Pilbara are certainly pretty hairy—through to ports, airports, light industry, wind farms, solar farms and shuttles.

We are now in production mode. We have production contracts to supply autonomy systems globally for light urban vehicles carrying 16 or 14 people around cities on limited ODD routes. It acknowledges the complexity of the arbitrary drive-you-anywhere with no windscreen and no steering wheel problem. That is some way off, but there is a real commercial opportunity now that we are engaged in, and that is what our system does.

We just build the software. We collaborate with industries, be they in agriculture, transportation or user operators of fleets, delivery, Ocado, BP or ZF. We provide software that then interfaces with the vehicles, sensor suppliers and provides all the upside for autonomy. That is our vision, and universal autonomy is it.

Q63 Chair: How does your technology interact with cars that are not autonomous and with pedestrians?

Professor Newman: The way you build the bridge is that you think about architectures and not algorithms. You start by saying the first thing that we want to be able to explain is all the stuff around us, without saying what category of stuff it is. That addresses the problem of the visually impaired person with the white stick. You do not try to say, "I need to know what kind of object it is." You say, "There's an object over there and it's moving. I will be cautious. I will not get myself into a situation where, if it behaved unpredictably at the speed it's going, I would get myself into trouble."

The interactions get built up through, if you like, a hierarchy from, "It's stuff; it's moving stuff; it is moving in the following way; I can predict its pattern. Oh, it's actually a cyclist or a tank or a horse," if you needed that at the top. Those interactions are built in. It is important to think of safety by design and not afterwards. As you are architecting the thing, you have to think about that question. The very first thing we did was to build just stuff. It was not what kind. It was not about what type of road user or type of thing in the mine. It was the stuff, as it moves or does not move. If it is a hedge, it provides risk. You can build it up through an architectural design, which is good because then you do not have to predict what kind of technology you want to use. You can always bring in what is the latest and great, and absorb that.

Q64 Chair: Thank you, Paul. Alex, does that also apply to your technology? Expanding that further, what role does a driver play in your technology?



Dr Kendall: Broadly, we are building technology that can have the onboard intelligence in the self-driving system to be able to navigate through all of the weird and wonderful and dynamic and chaotic scenes you see on the road.

Greg previously gave the example of a hedge that was overgrown. I was in one of our autonomous vehicles on Monday after the storm; if you were in London, there was a storm. There was a fallen-down tree on the side of the road. As our car approached it, it indicated, went on the other side of the road, went round it and came back in safely around a number of road users. Those are the kinds of behaviours that we are already starting to see our technology capable of today. For us, we have seen our system learn how to deal with traffic lights, roundabouts, pedestrian crossings, jaywalking pedestrians and dogs. We have seen some horses in our testing. It is about being able to learn more and more behaviours so that we can deploy safely and in a valuable way to society.

Q65 **Chair:** Does a driver have any role at all to play in your technology?

Dr Kendall: No. We are developing technology to supply to fleets and to car manufacturers. Today we work with fleets like Ocado, Asda and DPD, big UK fleets in grocery delivery and last-mile delivery. We develop technology to give them the benefits of autonomy. These vehicles will be operated in the future without a driver in the vehicle. It is a level 4, or self-driving system, without needing a driver in the vehicle.

Q66 **Chair:** Why did you start with that particular market? Is it because there is a concern that passengers will not want to get into a vehicle right now? Why not start with an Uber scenario?

Dr Kendall: We are building technology for ride-hailing, public transport, trucking and last-mile delivery—all of the transportation use cases. The reason why we started with last-mile grocery is fewfold. Broadly, it is a similar technical challenge. I do not think it is an easier safety problem per se. You still have to drive on the same roads.

The exciting thing for us is that in the UK there are world-class technologically enabled fleets, as in our partners Asda and Ocado. The ride-hailing companies that you cite, like Uber, do not own their vehicles. To be able to work with fleets today, there is a much faster opportunity in the grocery domain. Ultimately, we see this expanding into ride-hailing as well.

Q67 **Chair:** Paul, do you want to come back on any of those points?

Professor Newman: I think that is reasonable. It is very important for businesses, picking up on your point about commercialisation, to focus on where there is revenue and where you can prove that in order to build great businesses on that technology. There is an ordering of these technologies, and there is an ordering of the operational design domain.



How were they ordered? For me, they are ordered with three axes. One of them is regulatory complexity and one of them is safety complexity. The burdens are rightly different in some of these domains. It is different in a mine from Kensington High Street. Then there is opex versus capex. I have never come across a city that asked for more single-occupancy vehicles, ever. They have always said, "Fewer please." I do not think that personal transport/private transport is the future for this first, for sure, because cities want to change the way transport works. They want to make it more accessible.

The number of bus trips that Londoners take is absolutely extraordinary. It is in the billions. People are already electing for that mode of transport. Let's support that. I do not think it comes in private ownership fleets first. I agree with Alex, in that there are other domains that are first. You order it in terms of the complexity.

The other thing is technological complexity. That worries me far less than the regulatory. There is the complexity around providing trust. We should spend a lot of time talking about that. What do we need to do so that these systems are viewed as trustworthy by the public? That is not just saying, "You should trust us." What is great about some of the regulation that is coming through is that there are meaty, technical statements and requirements placed on the manufacturers of autonomy software that allow the systems to be explainable. Explainability has to be a foundation of being able to be trustworthy.

Q68 Chair: One can perhaps say that there may be some disadvantages of doing the last-mile grocery delivery part that may currently be dealt with by a cargo bike. You would be putting more traffic on the roads.

You touched on public transport. Where is the technology that is going to improve the public transport offer when it comes to autonomy?

Professor Newman: I can be explicit about some of the contracts in the public domain. We are working with a German tier 1 called ZF. They are a big automotive. We will be producing autonomous shuttles, with production beginning at the end of 2024. I would love them to be used here first; they can be used in our airports, around some of our cities and on some of our bus routes, and they are going to be exported globally.

Q69 Chair: How many passengers will they carry?

Professor Newman: They will carry about 16. We have another with a Swedish manufacturer that carries in the order of eight people. Those are shared public transport systems that will work in the easier routes through cities to start with. Of course, as the technology advances, as the safety case gets proven and as we get the statistics that we are talking about, you can then move further. In particular, as the vehicle starts to prove itself to regulators to explain its operation—the in-use regulation that you know about—that is a really big deal. The vehicles should all the time, to an independent third party, explain themselves. That third party should be privy to the data. They can say, "You know what, you were



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close to something there. That doesn't look right. What are you doing about that. Prove to me that you can fix it." Really strong thinking is coming through. We love that because it is something we can design against and deliver. It is a really big point, and you should think about that clearly.

Q70 Chair: Alex, I put the same thing to you in terms of how this will revolutionise public transport, and also potentially allow people with issues such as sight loss, to be able to use a car because they do not have to be in control of the car.

Dr Kendall: The fact of the matter is that today our vehicles are only utilised about 3% or 4% of the time. Most of the time they sit parked, not doing much. The opportunity is enormous. We can see fewer vehicles on the road being used more efficiently and more effectively. This gives a big opportunity for us to produce healthier streets with safer operation. I think these vehicles will be able to massively improve the experience of disabled people on our streets and vulnerable road users like cyclists and pedestrians. It will reduce the burden on car parking. There is a real opportunity to create healthy streets in our cities.

For our rural areas, this technology should increase connectivity in these spaces and provide more reliable, accessible transport. I think it is a massive opportunity for the UK.

Chair: Good. Thank you for the opening. Ruth, I hand over to you on how we get there.

Q71 Ruth Cadbury: Thank you, Chair. If we look forward 10 to 15 years in self-driving technology, do you see it still being used mainly in segregated contexts, or do you think we will be sharing road networks between conventional vehicles and level 4 and level 5 vehicles?

Dr Kendall: We will absolutely see mixed use. In fact, we have been testing our level 4 self-driving technology on public UK roads since 2018. We should absolutely see a mix. I think that is where the opportunity is. Over time, we will see the gradual increase in the prevalence of self-driving technology. The technology has to be designed to be integrated and not to add nuisance or contradict. It has to act naturally and add value to our existing road network and our existing structures.

Of course, there will be opportunities on top of that to improve the way our road network is structured, but initially I think we should look to co-exist.

Q72 Ruth Cadbury: Turning to the road infrastructure, not just the physical infrastructure but the digital infrastructure such as signalling and mapping, will that be ready to accommodate self-driving vehicles in 10 or 15 years' time?

Professor Newman: Yes, I think so. To be safe they have to be self-reliant. They have to be introspective enough to say, "I am fine. I'm not



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fine. I can deal with what is happening now.” If dealing with it is executing the minimum risk manoeuvre and explaining why they needed to do that, then so be it.

Obviously, if you want to tell an autonomous or self-driving vehicle what to do—I used “autonomous” there because there are two communities we talk to—you have to be able to communicate with it. There needs to be some 3G communication, but that is not to say the computation has to happen in the cloud. It is happening down on the vehicle. The things are designed to be losing contact. If there were enormous blackspots of 30 or 40 km, it is like trying to call a cab, but the phones don’t work. You cannot reach it. I am less worried about that.

Certainly, there is the quality of potholes and things like that, but that is true for all road users. We go out of our way to say that we have kind of built the infrastructure that they need; it is called cities. We have built roads, and you need to be able to deal with that.

Again, we are fortunate in that we deploy from ODDs that have remarkable ODD capex and opex opportunities like mining and industry. In terms of the infrastructure, we could not ask for any infrastructure because we would be asking for it for every industry we work with, which is for the birds. No, they are self-reliant.

Q73 Ruth Cadbury: When you talk about technology taking over the decisions of human intuition, there are multiple binary choices. One example I am thinking of is that, as a cyclist or a pedestrian, I look to see the driver, to see what I think that driver will do, with a fair amount of predictive accuracy. I cannot do that with a self-driving vehicle. That is one example.

One of my colleagues mentioned another. When it is a choice between hitting the pram with a baby in it or driving over a cliff, it is one or the other. Those are the things that I think worry people. When will self-driving vehicles be able to take over from our human decision making?

Dr Kendall: I appreciate that new technology like this can be a big change. It might be alarming in the first instance, but as we see the technology prove itself, I think it is one that will generate extraordinary value and trust by society.

Fundamentally, the systems we build are capable of seeing around the vehicle, both at short and long range, at over 20 times a second, making decisions rapidly. Essentially, it is like having eyes in the back of your head. They are able to observe the environment accurately and reliably. They are always attentive. We would never deploy vehicles that are not at least as safe as a careful and competent human driver. We see these vehicles as improving the level of safety on our roads.

Even last week, I was driving in a scenario near Highbury Corner in one of our self-driving cars. I was not driving; the technology was. To your point about interacting with others, there was a bus parked. Regularly,



we learn when to overtake a double-parked bus. In this instance, the bus driver put their arm out and waved. Our car actually slowed down and let the bus pull into the traffic ahead of us. We start to see that kind of vehicle to vehicle or vehicle to other road user interaction.

Q74 Ruth Cadbury: The car could tell whether the driver was waving you on or indicating that they were pulling out.

Dr Kendall: That is correct. Those are things that the self-driving technology will see and respond to.

Professor Newman: But I think it needs to be explainable. I think your question is about explainability; you were asking whether the vehicle could make the decisions. Unequivocally, it can make those decisions. Implicit in your question is whether we could trust why it made those decisions and were they reasonable. When we take the case of looking at that vehicle and expecting it to drive like a human, that would be reasonable. You should reasonably expect it to drive in a way that is familiar to you. That should be explainable, so were there an incident we should be able to unpack it and say, "We drove in the following way for the following reasons." If we think that is wrong, then we can make the alteration and we can prove that.

Q75 Ruth Cadbury: Another example is flashing your headlights, which means different things in different driving cultures. In London, you have people driving who come from different driving cultures and use signals and driving manoeuvres differently.

Professor Newman: Yes.

Q76 Ruth Cadbury: Finally, is the technology already capable of doing more than regulation and infrastructure allow?

Dr Kendall: No. We have been testing on public roads since 2018 and developing our technology. It is still in development. Making claims that it is next year and things like that are misleading. I do not think it helps to add to their hype.

Having said that, the one takeaway, if you have one from today, should be that we must see regulation brought forward in this parliamentary Session. The 2025 timeline is so important to step 2. We need to see the legislation put in place. The technology will come. We are developing it. It is behind other markets today. For us to see the UK realise the benefits of this technology quickly, for us to see the IP developed in this country and for us to see continued investment in growing this technology, it is really important that we maintain that timeline.

Ruth Cadbury: I think after yesterday's decision we will have a legislative backlog of several years, so good luck. Thank you, Chair.

Q77 Chair: Thank you, Ruth. I am surprised that you answered in that way, Alex. I thought that your technology would be ahead of regulation and infrastructure. What we tend to find with new forms of transport



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technology is that the innovators are further ahead than the regulators. Are you saying that that is not the case right now?

Dr Kendall: All of our vehicles today are operated with a safety operator behind the wheel, monitoring the system. That will need to be the case for the next couple of years.

Q78 **Chair:** But they are capable of being driven without that safety monitor in place.

Dr Kendall: Not in all scenarios. That is something we are developing and improving. It is improving at an extraordinary rate. A couple of years ago, as I mentioned, we learnt to deal with roundabouts, traffic lights and other kinds of scenarios. We are rapidly learning ways of driving on the road. What we are saying is that there is a huge opportunity and we need legislation on this timeline to be able to realise that opportunity for the UK.

Q79 **Chair:** The regulators need to be moving at the same pace as you, so the parallel process gets you both there by 2025.

Dr Kendall: That is correct. It is an extraordinary problem. The way we move around cities, or the country, in fact, has not changed in 100 years, since the late 1800s when we saw the horse and cart shift to the automobile. The automobile was meant to resolve all of the accidents and congestion that the horses and carts caused by kicking people and its taking ages to do three-point turns in a horse and carriage. The automobile was meant to solve that. In fact, we have not seen a massive change since then.

This is going to create that change. This is going to give us healthy cities. This is the future that we will see. It is an extraordinary transformation that is going to take time. It will be gradual to some degree, but it needs Government and industry to work together to make it possible, and that needs to happen quickly.

Q80 **Karl McCartney:** Alex, Dr Kendall, I am coming to you first because you have raised some things that I want to question you on. You mentioned that you have been dealing with fleets. That will be delivery lorries and so on. I understand that whoever owns those fleets—you mentioned various different companies—want to sweat their assets.

We were talking before about autonomous or individual vehicles. When you have a fleet, you want to know where that vehicle is. You want to know if it is on course to be doing the deliveries that it is supposed to be doing and getting back to base to get loaded up with the next load. It is a two-way system. How is that being controlled? Is it satellite technology, or is it going to be satellite technology?

Dr Kendall: That is a really interesting thing to understand. Our vehicles follow the route that they are given. Essentially, they follow a sat-nav instruction, very similar to how you might navigate today. They rely on high-level mapping, satellite navigation mapping. They communicate



where they are to our control centre. They need to be capable of making their own decisions on the vehicle. If the map is wrong or if the communication falls through, the vehicle should be capable of making its own decisions, putting itself in a safe position, to keep on driving or understand if it is not able to and put itself in a safe position like pulling over to the side of the road. It leverages sat-nav maps and tells us where it is, but it is designed to be capable of making its own decisions should that fall through.

- Q81 Karl McCartney:** You alluded to the point I was asking before about the length of time that delivery vehicles are on the road, obviously sweating assets. Those 5 million-plus vehicles are on the road an awful lot more than private vehicles. In that case, private vehicles are not going to go away. I am one of those who does not think that we will go straight to electric vehicles within the next five, 10 or even 25 years. Is it possible to retrofit your systems, or will it be in the future?

Dr Kendall: Technically, yes. In fact, the technology we are trialling today is retrofitted on to our partners' vehicles. Over time we would see that being manufactured by the manufacturing partners we work with. I am not saying it is not technologically possible but, ultimately, our business model would be that it is manufactured from a supply chain and not an after-market addition to a vehicle.

- Q82 Karl McCartney:** I am not going to ask you about costs because I am sure that over the next few years those costs will come down. I am going to give you a break and come to Professor Paul Newman.

Paul, in light of the fact that I have asked about two-way communications, and you mentioned trust earlier on, if a vehicle is going to be talking to a control centre centrally, potentially, and is learning itself—we have heard different examples of going round trees or whatever—are vehicles going to be able to, if not talk to each other, go through the central control point and pass information back, particularly, say, about a road with a new hazard or something that has happened? Are they going to learn in real time and pass on that very useful information?

Professor Newman: There are a few things. Let's not overload "learn". It is the sharing of information. It is about sharing situational awareness. For example, if a road is not passable because of roadworks and there is elevated risk, that would absolutely be communicated to the rest of the fleet in terms of the routes that the vehicles would take. It is as simple as that. That is no different from a bus currently saying, "There's a dustcart that has broken down in Abingdon Road and Abingdon Road is closed." That is totally fine. It is more about operations of fleets than the vehicles needing to have a particular skillset to do that.

Underneath your question was something about vehicles sharing experiences from which they can learn. That is something I feel very strongly about. Again, it comes to trust and something called verification



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and validation. Say there was an incident in Copenhagen. We can analyse that and learn from it. Perhaps there were very interesting circumstances. We would like to be able to get that learning out to all vehicles globally so that Cape Town had the benefit of it 12 hours later. I think we might be morally required to do so because we had learnt something about it.

The technology that we need to invent to be able to assure those upgrades, those changes, at an extraordinary pace that is utterly different from anything that happens in the OEM world at the moment is where the greatest innovation will be. Again, it comes back to trust. How can we keep developing at the greatest rate while not giving an inch on safety, and while sharing the experiences of every vehicle?

I failed my driving test five times. I had a forwards/backwards ambiguity with the test centre, and I might have crashed into it. I think it is important to be transparent.

Karl McCartney: We could offer a therapy session.

Professor Newman: The interesting thing is that, when I started to drive at 18, I only had my own experience. It was me and my skull. Every 18-year-old starts with the same set of experience. What we are talking about are vehicles of the future, when they drive you, having the benefit of every kilometre driven by every vehicle ever. That is just extraordinary. It is not just what you learnt from your test instructor. That is the imperative. What we are talking about is the ability to accumulate all of that evidence.

The interesting thing is, what was the relevant evidence? What was the relevant learning? It is not just all of it, but what should I learn from and then fold into how we develop and test and do over-the-air updates? That is extraordinary. For me, the assurance aspect of that, the testing, the trust and the sharing between manufacturers is really important. It is super interesting. That, for me, is where I get really excited.

Q83 Karl McCartney: Thank you for that. The rest of the Committee know that I love classic cars, but I think I am as excited as you by what could come in the next five, 10 or 15 years.

I asked the other panel this, and I will ask you, too. Do you trust the cars that you drive, and how autonomous are they already? I know you have the shared experience, in that you go out in your own company's vehicles, but what is your vehicle of choice?

Professor Newman: We would not run it if we did not think it was safe to be running in the way that we are doing it. We just wouldn't. I put my three-year-old in my vehicle five years ago. It was in a closed site but, if I didn't, we would not do it. There has been great work done by the BSI. It is something called PAS 1881. It sounds like a lot of numbers, but it is actually a great standard on, "Be better than this and you should be safe to operate in developed vehicles." There is lots of good work done on



that. That is really smart because it is a framework that you get examined by. Is our business operating in a way that gives trust that we can develop unfinished products, because that is what we are trying to do to be able to sell that to the world? That is really smart.

Q84 Karl McCartney: Thank you for that. I will give Alex a chance, and then hand back to the Chair. Do you want to add anything?

Dr Kendall: I have never owned a car. I have cycled to work my entire professional career. I get the most joy out of riding in our autonomous vehicle fleet at Wayve. For me, that is the future.

Chair: Thank you, Karl. Let's carry on with public perception and safety. First of all, Greg Smith and then I will bring in Gavin Newlands.

Q85 Greg Smith: Thank you, Chair. From the answers you have given already, Alex and Paul, I am going to presume that as a given the first part of your answer will be that the public can be assured. Fear of the unknown will always lead to doubt, and surveys show that at the moment. As a baseline, actually seeing them in practice—the example of the bus driver hanging his arm out of the window—will be part of that process. What else actually needs to happen to get the public mood on the side of self-driving vehicles?

Dr Kendall: The first thing is that it is all about collectively going on the journey together. We need to avoid dumping this technology on the public. I think we need to learn. We need to gradually deploy and understand how to make it most effective.

Contrary to the previous panel, I want to make the point that there is today a commercially available level 4 self-driving system in the world. If you fly to Phoenix in Arizona, you can download an app, call a vehicle and it will come. There will be no one in the front seat. It will self-drive you around an area of that city. That is available today.

I visited there and had a go at that. It is remarkable. The interesting thing is that the community told me that they really felt part of developing the technology; there was mutual engagement. That is why, when we have been testing throughout the UK, we have gone to the local councils and briefed them on what we are doing before we start testing. We have talked to them and answered their questions: "This is why we are starting a trial in the next couple of months, with our partners Asda and Ocado, to trial grocery delivery to people, starting in north or west London. This is why we want to develop this in conjunction with the public."

There is also an opportunity for Government to take action. There is an extraordinary opportunity with this technology, not only when we think about the change it will make to the labour force but to educate the public about it and how we can best utilise it as a nation. I think there is a real opportunity there for Government too.



Q86 **Greg Smith:** Do you have anything different to add, Paul?

Professor Newman: Only that I think the central agent is to think about users as customers. What is their experience? What do they want it for? What do they get to use autonomous transport for that fixes something for them? It might be a change in a cost point. It might be a convenience thing. You would work everything back from that: "Why would I want shared transport? Is that right? Where should those places be?"

Everything works back from the customer. That could be the user, but also the public who are not electing to use it. They are still a customer of our roads and our transport systems. That is super important. You get a lot of things right if you work the technology back from the application. That is why the point about commercialisation and the first programmes that are commercially viable, wherever they are, is so important. The customers and the public start to think, "That's helping us," and the economy sorts it out for you.

Q87 **Greg Smith:** That is helpful. On a very practical level, you will be aware of the Law Commission's recommendations and the way the Government propose to take them forward. Do you have any concerns? Do you think we are at the happy medium of a good, proportionate place, or is there too much push or pull one way or the other?

Dr Kendall: Broadly, the message is that we are really happy with the Law Commission's proposal. We have been engaged with them on it over the last four years and we think it is a really balanced approach. It is a very proactive approach, and it is desperately needed to realise the benefit of the technology. Broadly, we think it makes sense. In the balance of priorities, it is in the right place. The recommendations, in particular for primary legislation, are what we need to see come forward quickly.

Professor Newman: I agree. It is a well-thought-out thing. The Law Commission did a cracking job. They listened and they engaged. I think CCAV has done a cracking job in supporting it. There are lots of catalysts and facilitators. There are also some battery and energy suppliers for it. That structure is really smart. I think the ASDE—autonomous software development entity—has separation. The responsibilities that we would take as a business to the public can stand up. The way you build into that is a way to share and build trust, so that you do not build a culture of blame. You build a culture of learning. That is really smart. The way you build into it safe by design rather than setting a number at the end is really smart.

Just keep the pace up. Just keep it going. We are going to be all right because you have done the hard part of the thinking. Now you have to do do-age. Now, you have to do the do. Push that through, because other countries are. We will export globally. It will be all right, but I did not build this somewhere else to find out that we cannot be leading it. We have an intellectual leadership point, not just on the tech but on the way



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we have thought about the legislation, the way we have thought about trust and the way we have thought about testing. Those are some really hard miles. I think they are some of the best-thought-out plans I have seen globally. So now execute them.

Dr Kendall: I fully agree.

Q88 **Greg Smith:** This is the last question on this from me before I hand over to Gavin. It was alluded to in the previous session this morning and in this session. The pressures on the Government's legislative agenda are pretty high. There is some talk of there not necessarily being the legislation in this session, or indeed this Parliament. For you, what is the point at which you need this on the UK statute book for you to be commercially viable or to carry on with your activities in the United Kingdom?

Dr Kendall: In terms of timeline, we are right on the precipice. If this slips beyond this legislative Session, we are at risk of the 2025 timeline for it to be legalised. That is a real concern for us. We have raised another \$260 million of capital. We are pouring investment into building this technology and this IP here in the UK.

The fact of the matter is that, if it is not legalised, we are in a really tough spot. Other countries are legalising it or they already have. We are going to see the IP developed offshore. We are going to see other countries benefit from this technology first. The opportunity will be left waiting.

Paul made a really good point that we have an excellent position in the UK in developing this core IP and thought leadership. There is a lot of work in universities and companies such as ours, represented here today. It will be a real shame not to see that executed and this opportunity taken hold of. The message is that we must see it in this legislative Session. Without that, we really jeopardise the opportunity for the UK.

Professor Newman: Come back to the customers. If we want the customers in the UK to benefit, and the customers are our citizens, you need that. Obviously, our market is not the UK; it is the planet. It is called universal autonomy, but we will start with Earth because space is niche. I think it is really important.

We are exporting our contracts. They are global, not for the UK. What a mare if we built it here and we led, and our citizens do not get the benefit. We will have it in our airports, our ports and our industries. Think about transport; it is the movement of people and goods wherever. It is coming here wherever, but the bit that you can do is to make sure, and that it can move out on to the roads in the right way. That is with you guys to hold.

Greg Smith: That is very clear. Thank you.



Dr Kendall: To motivate the need for it to go beyond specific use cases like airports and things like that, the opportunity is really on public roads. That is where the Government's own estimate is that this is a £40 billion opportunity by 2035. We heard before that six people sadly lose their lives on UK roads every day, and road accidents take 3% off our GDP each year. That is where the opportunity is, and that requires this legislation.

Greg Smith: Thank you. That is very clear.

Q89 **Gavin Newlands:** I have one question and one very brief follow-up question to Professor Newman. Surveys say that the public are wary of this technology. I have to say, as I have said before in this Committee, that I am probably one of those wary people. I never thought I would be a Luddite, but here I am in my 40s, and I have turned out to be a Luddite. I do not like anybody else driving me, let alone the car itself, although my wife would say that she prefers me driving her even less, just for balance.

I am hoping to be convinced. I have been open-minded throughout the course of this inquiry. Do you think the Government are cognisant of how important it is that you take the public with you as the tech is developed and deployed? In the dealings you have had with the Government, do they get it? Do they understand how important that part of it is?

Dr Kendall: I think there is a broad understanding. We have had great engagement with CCAV—Centre for Connected and Autonomous Vehicles—around this, and with the Vehicle Certification Agency, the VCA, which the Law Commission recommends as the regulatory body that offers these approvals. The trials that the Government are funding through Innovate UK have helped catalyse engagement and cross-industry collaboration. We need to see more as the technology comes out of development and into commercialisation. It is a question of us being on the right track, but we need more.

Q90 **Gavin Newlands:** I am conscious of the time, but I need to follow up on something Professor Newman said about the cars being connected and about 3G and blackspots. In the previous panel, I think David Wong said that the cybersecurity risk is if the car is connected. You were talking as if the car would be connected all the time or almost all the time. What would be your vision, moving forward? Would the car be connected? Obviously, that would increase the risk.

Professor Newman: We are right in there at the moment in a cybersecurity conversation. When you want to send an instruction to the vehicle to start something, it has elevated risk. It is not just, "Go to this place," but maybe to restart or transition itself into autonomy remotely. We did our first zero occupancy trial, no one in the vehicle and no seat, back in May. We had to really think about all of that.

It needs to be connected because otherwise you cannot tell it to do anything, and it is worthless. An autonomous vehicle that cannot do your



bidding is not very helpful. Somehow you have to get your bidding to it. That is the minimum connectivity you would need. That is not to say that if the phone masts went down they are dangerous. They have enough autonomy on board—I use that word deliberately—such that in elevated risks they can pause and get themselves out of an elevated risk situation. That is okay.

The issue about 3G and 4G connectivity is that, as a customer, how do you tell it to come and deliver your Ocado goods, or how do you tell it where to go? There is a way to talk to it. At that point, you have to think profoundly about cybersecurity. That is why you bring in the best experts in the world on how to do it. The good thing about that is that you should care about cybersecurity and risks. One of the things about this technology is that you can borrow best practice from banking, for example. You expect your banking to be secure, so you might use the same kind of technology. You do not have to invent everything yourself. We do not invent batteries and we do not make vehicles. There will be new kinds of vehicles. It is good in that sense.

Again, BSI has done a cracking job on there being a standard for cybersecurity for autonomous vehicles. The point that is important to bring up about cybersecurity is that it is not just your vehicle, it is your organisation too. Is your organisation cybersecure if you are going to be writing software? Do you know who is contributing to it? Do you have provenance of the data you have used for your machine learning? Where did that come from, and is it proper?

That is quite interesting. People think, “What if someone hacked into my car? That’s really bad.” For sure it is. Again, the vehicle has checks and balances around it. If it thinks, “It doesn’t look right and it’s not what I was expecting, I feel unsure,” it will stop. It is a big deal. It is good to challenge that, and it is never finished. There is a threat about cyber all the time. It is almost as much to do with the stack and provenance of verification and validation. It is a complicated answer. If I said it simply, I would be doing you a disservice.

Gavin Newlands: I suspect that is an issue we will have to drill down on a fair bit during the inquiry. Thank you.

Q91 **Mr Bradshaw:** We are on our third Transport Secretary in two months. We have lost the Transport Bill because of the chaos in Government. What on earth gives you any confidence that this Government are going to prioritise updating our regulatory framework in the way that you desire?

Dr Kendall: We have had a few of the Ministers you describe for a ride in our vehicle, to show them the technology at first hand. We are enthusiastic to engage with Government. As we have seen these teams evolve, I think the key thing right now is that there is uncertainty and that means we are nervous. We are unsure about where the legislation is going to land.



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Earlier this year we were told it was going to come in this Session. Now we are unsure. It is really important that we get certainty and public commitment from Government that it will come this Session. That will fuel increased investment, increased confidence and ultimately the benefit of self-driving vehicles in the UK.

Q92 **Mr Bradshaw:** It is more on a wish and a prayer than any hard evidence.

Professor Newman: I am pathologically positive. That is how we got to here. I cannot comment on the political situation. I can comment on the power of FOMO, though. We will be deploying this and selling it around the world, in the right places at the right time. I am absolutely sure, with the people that we have in the legislation, in CCAV and in BSI, that there is enough expertise to make this not a big deal. You have done the hardest part. Now there is some do-age to do, and I back you to be able to do that.

Q93 **Mr Bradshaw:** Apart from learning from other countries on updating our regulation—you have already touched on Arizona and we were given the example of Germany—are there any other things we can learn from other countries about where best practice is, and implement or copy that?

Professor Newman: The UN is doing great work. There is great work in the UN committees about writing true, comfortable, reasoned regulation and standards. Again, you do not have to boil an ocean. There are plenty of people thinking about this. We are not saying that you have to build it all yourself. That is for the birds. You can lift a lot of this thinking and add it to the great thinking we have. I back you.

Mr Bradshaw: Thank you.

Q94 **Jack Brereton:** Has the overall Government approach been the right one?

Professor Newman: Yes. Let me give you a crisp example. I made the call at the end of last year that we were ready to take a completely new kind of vehicle on to publicly accessible roads with no operator in it at all, not even a seat. There could not have been anyone in it. There was a delighted reply, then it was mild panic, and then it was, "Okay, let's figure out how to do this." We got every single agency we could think of—the Crown Prosecution Service, the police, insurers, BSI and VCA—to have a look at it. That attitude was great.

That is a projection of the way we are thinking about the legislation and with where the Law Commission is as well. The way that CCAV has operated, and the original code of practice that came from the vehicle that we put on the roads the first time back in 2014 has been great. I couldn't fault it. It might be getting a little bit slow now, but that is what we are talking about. On this one, don't beat yourselves up. You have done really good thinking. Now you just need to complete it.



Q95 **Jack Brereton:** What are your thoughts on it, Alex?

Dr Kendall: Similarly, I think the cross-departmental collaboration that CCAV is bringing together has been wonderful. The thing I would call out in particular that we were most excited about was a clear distinction in the Law Commission's proposals between no user in charge and user in charge. That will be really helpful for the industry going forward, and in particular in how we educate the public about this technology. Drawing a distinction between driver-assistance technology and self-driving technology is a really important thing so that the public can know what they should be able to trust. That came very clearly through the Law Commission's proposal. That is a step forward for the world. It is setting global leadership and precedent.

In general, the message is the same. You have done great work so far. We cannot drop the ball. We must see this through.

Q96 **Jack Brereton:** In terms of how quickly we can develop this technology, do you think the Government's view and the approach of Government has been realistic, or is there a bit too much optimism about how quickly we can get to where we want to be?

Dr Kendall: I think it is on the precipice. The Government's role is to create an environment to bring commercial success, to bring societal success and ultimately increase the prosperity of the country. Aiming to get this in place for 2025 is striking the right balance. It is not wildly optimistic, but any later and it really risks the benefits of the technology. It is striking a balance.

Q97 **Jack Brereton:** Are there any specific changes that you would like to be made in the approach that the Government have taken?

Dr Kendall: We made a number of recommendations to the Law Commission, many of which have been taken up. Where it is now, we are excited and ready to go. We just have to see Parliament make time to consider it.

Q98 **Jack Brereton:** Professor Newman, are there any particular changes that you want to see?

Professor Newman: None beyond what our detailed reply was. A Government providing a framework by which to develop and on which you can then hang assurance and trust is important. I violently agree with Alex. Some of the differentiations and statements about what these entities are, and the stages we might go through, are super helpful. It is very important for a business too. We get this question: "Will you be able to use this in the UK?" We say, "Yes, of course, and globally." Good job. I don't normally say that, but this was genuinely well thought through.

Q99 **Chair:** Alex, I think you want to come back.

Dr Kendall: There is one other point to make. The converse is that if we do not have regulation in place, and we do not know what safe is, we will



not have definitions for what is safe and what can be deployed. We would never deploy self-driving vehicles that are not at least as safe as a careful and competent human driver, but that is not to say that others might not.

One of the other imperatives for getting this on the road is that as the technology becomes ready, if there is no regulation, it could also open the door for people to deploy technology that we would not agree is safe. It is needed to protect against that and make sure that we set this up for success.

Chair: I was going to bring Robert Largan in to discuss the perils of not having legislation on time, but you have covered that. I will bring him in anyway because he can pivot around it.

Q100 **Robert Largan:** Absolutely. Professor Newman, you mentioned earlier that you are pathologically an optimist. I am pathologically sceptical, but I have to say that after listening to the evidence from both panels today I profess myself a bit of a convert. I am really optimistic about the technology and the things you have talked about. With that in mind, we have covered regulation and legislation, but is there anything else that Government could be doing to support you?

Professor Newman: Yes. Just stay the ground. Keep supporting CCAV. Keep supporting links and force them between DFT, BEIS and VCA. Do everything you can to break down silos because everyone has a voice in this. There are many stakeholders. It would be easy to do it as a series of batons passing. That would be super slow. You can have the fastest runners in the world in a relay team, but if the baton passing is rubbish, you have a rubbish relay team. That is something you can do.

One of the things that was great about CCAV was that it disrespected the boundary between DFT and BEIS and said, "It's between us." You should think about doing that as well and bringing DCMS in—the whole show. They are all going to be part of it. Don't partition it. Don't just make it a Transport thing because it is more than that. It might be a Defence thing as well. Think broadly and you will get very surprising secondary outcomes that are beneficial as well, beyond what you may be thinking about for moving people on roads.

Q101 **Robert Largan:** Dr Kendall?

Dr Kendall: I have one thing to add. I would love to see the UK and the Government celebrating support for entrepreneurs and innovation. Here you have two home-grown British companies that are developing technology that is going to take on a trillion-dollar market. Too often have we seen development ideas here bought by big tech firms offshore. Too often have we seen companies here fail to get this to global industry defining levels. We have an opportunity to create technology that is at the forefront and that can create a massive positive change for society.



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It is a hard road, of course. We face sceptics all the time, but we are endeavouring to build something that will ultimately transform society for the better and create an environment that can celebrate, support and nurture entrepreneurial innovative success. That is something I am really passionate about and would love to see more of.

Robert Largan: Fantastic. Thank you both. That is really interesting evidence.

Chair: Thank you, Robert. You should have an ally in the new Prime Minister because this is his bag.

Q102 **Grahame Morris:** I think you have covered all the ground in response to earlier questions. To emphasise it for the record, are you happy to characterise your relationship with Government and their agencies as very good? Is that your opinion?

Dr Kendall: Yes.

Professor Newman: Yes.

Q103 **Grahame Morris:** I noted the emphasis you gave to the importance of the 2025 timeline, if it is not to slip. No pun intended, but is there an alternative legislative vehicle? We pressed the Minister previously, because there are a number of issues we want to see in the Transport Bill about pavement parking, e-scooters and aspects of the railway. Is there some other method that could be employed to ensure that the timeline does not slip?

Professor Newman: I cannot comment on your process. I wish I could, but that is only for you. I would want to think carefully about this rather than just thinking on my feet, because it is so important.

On 1 January 2025, I do not think there are suddenly going to be 60,000 autonomous vehicles driving round the place. There will be some, going to many. You can think along those lines. We will be at scale much quicker in other countries. I do not like binary things. There might be some way you can think about that, but please don't use it as, "Phew, at least there is another way." I would like to keep that pressure on you because I am pathologically positive, and you have done the work. I am going to keep saying it. You are in a good spot.

Dr Kendall: The key thing is that we just need certainty to make the investment and to grow the technology, but it will be gradual.

Q104 **Grahame Morris:** I wanted to give you the opportunity to put on the record how important it is to have a Transport Bill that addresses this issue as soon as possible.

Professor Newman: It is totally important, and you should absolutely do it.

Chair: That is a very good note to end on. I think we are going to see Wayve at King's Cross. We are just fixing a date. We will bring another



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Transport Minister with us.

Dr Alex Kendall and Professor Paul Newman, thank you so much for your incredibly exciting evidence. We look forward to keeping in touch. I hope you will take note of our recommendations and even agree with them as well.