



## Select Committee on Science and Technology

### Corrected oral evidence: Autonomous Vehicles

Tuesday 1 November 2016

10.40 am

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Members present: Earl of Selborne (The Chairman); Lord Borwick; Lord Cameron of Dillington; Lord Fox; Lord Hennessy of Nympsfield; Lord Hunt of Chesterton; Lord Mair; Lord Maxton; Baroness Neville-Jones; Lord Oxburgh; Viscount Ridley; Lord Vallance of Tummel; and Baroness Young of Old Scone.

Evidence Session No. 1

Heard in Public

Questions 1 - 10

#### Witnesses

**I:** Ian Yarnold, Head of International Vehicle Standards Division, Department for Transport (DfT); and Iain Forbes, Head of the UK Government's Centre for Connected and Autonomous Vehicles (CCAV), Department for Transport (DfT).

#### USE OF THE TRANSCRIPT

1. This is a corrected transcript of evidence taken in public and webcast on [www.parliamentlive.tv](http://www.parliamentlive.tv).

## Examination of witnesses

Ian Yarnold and Iain Forbes.

**The Chairman:** Could I extend a welcome to our two witnesses to this first session of our inquiry into autonomous vehicles? Welcome to Ian Yarnold and Iain Forbes. I am going to ask you in a moment whether you would like to introduce yourself for the record. We are being broadcast and if either of you would like to make an opening statement, please feel free to do so. Ian Yarnold, would you like to start?

**Ian Yarnold:** Good morning, everyone. It is a great pleasure to be here on behalf of the Department for Transport. My role is head of the international vehicle standards division within the Department for Transport. I am an engineer and I have the opportunity to head a team of engineers within the department. We, collectively, handle all the regulations concerning new vehicles coming on to UK roads. My team negotiates both in Brussels, in the EU, and in the United Nations in Geneva. We have a great deal of contact globally. I cover the whole range of vehicle regulations, from emissions to noise, fuel quality and vehicle safety, including automated vehicles, which we are talking about today. I had not intended to make a statement, so I hope we will be able to cover those issues during the questioning.

**The Chairman:** I am sure we will. Thank you. Mr Forbes?

**Iain Forbes:** Thank you for the opportunity to speak to the Committee today. My name is Iain Forbes. I am head of a team called the Centre for Connected and Autonomous Vehicles, which is a joint unit of two different government departments, the Department for Transport and the Department for Business, Energy and Industrial Strategy, which has been set up to try to keep the UK at the forefront of the development and the deployment of automated road vehicles.

We have four broad objectives which we are pursuing, the first of which is to work with industry to try to build a world-class, vibrant industry in this sector in the UK. The second is to try to prepare the UK for the advent of autonomous vehicles, including looking at any changes that might be necessary to the regulatory framework. The third is to make sure we get maximum value from our research and development, both the Government's programme—and the Government are investing over £100 million in this area—and research being done elsewhere. The final one is to look at cybersecurity issues, to make sure that vehicles of the future are secure by design.

Q1 **The Chairman:** Thank you both. That is a helpful introduction. I should now declare my own interest before I ask a question, as this is the first session. I am an honorary fellow of the Institution of Engineering and Technology. It would be helpful if you could add to those brief introductory remarks an overview as to how within government there is responsibility, not just in your department but with other departments, for policy relating to autonomous vehicles. Are there other government departments with major interests?

**Iain Forbes:** I think the work that will be done on road vehicles is probably more in depth than has been done in other sectors. That is partly because a lot of the early challenges and opportunities are emerging in the automotive sector. The changes, though, that we are discussing are likely to have an impact across a range of sectors, including everything from maritime, aviation, agriculture and military applications too. There is a need to make sure that that is co-ordinated. The Cabinet Office has convened a meeting of senior officials to check that the work that the Government are doing is co-ordinated; but alongside that, for applications that have a transport policy implication, the Department for Transport takes an interest, for example, in looking at the potential applications for unmanned aerial vehicles. As you might imagine, the Ministry of Defence takes an interest in military applications too, with other government departments covering areas relevant to their policy.

Alongside that, the Department for Business, Energy and Industrial Strategy works to try to co-ordinate the activity in industry and in academia, including through Innovate UK and the knowledge transfer network that is part of that body. A special interest group to try to share knowledge in robotics and autonomous systems was set up a few years ago and has been operating for a number of years with about 1,000 members, all with an interest in this field.

**The Chairman:** We have just received evidence from BEIS which gives a sort of scorecard on the relative global capability of our technology in this area, ranging from limited capability to world-class. It seems, for example, on what I might call the social sciences side—traveller behaviour and psychology and data visualisation—we do not seem to have more than moderate capability, whereas on the world-class end of the spectrum we can include real-time control and interaction and design. Would you describe how government ensures that policy development keeps ahead in this rapidly changing field? What do we do when we find we have an area where we are, perhaps, either world-class at one end or weak on the other end?

**Iain Forbes:** I think this is a constant challenge. A number of the technologies which are underpinning autonomous vehicles are moving very quickly, with developments happening right the way around the world. To keep abreast of what is happening, government uses a range of different means, both formal and informal. A key way in which we do that is through our industry councils. For example, the Automotive Council, which is a body set up to engender strategic dialogue between government and that industry, has done some great work looking at technology road-mapping and the strategy necessary to make sure that the UK has the capability to succeed in that area.

Alongside that, another group called Impact has a broader membership, considering, for example, the implications of this technology for infrastructure and other users of the transport system. Formal means are important to do that, and the Government has invested a lot in those councils over the years. Alongside that, my team is very outward facing and we spend quite a lot of time visiting researchers and companies to understand what the world looks like from their perspective, as well as commissioning research into what the state of the art is in particular areas.

As I said at the beginning, this is a constant challenge in such a fast-moving area, but we have a range of different means we use to try to stay abreast of what is happening.

**Lord Maxton:** If you have private company investment, as presumably most of it is in this technology, what are the benefits to a private company of sharing their knowledge with another private company who will be a competitor to them?

**Iain Forbes:** Something which distinguishes the UK research programme relative to other countries is the collaborative nature of the work that is going on here as well as the transparency with which it is happening. There will always be some work happening within private companies which they will want to retain because they have invested the money to develop the intellectual property, but some challenges are recognised as shared. The projects we have taken forward with government funding, I think, have brought in a range of different partners working together around a shared set of challenges.

I know you are speaking later on in this inquiry to some of the projects we are funding in Greenwich, Coventry, Bristol and Milton Keynes. What is really interesting for me about those projects is the range of partners involved. Yes, you have car companies who are keen to develop the technology; you also have technology companies from a range of different sectors, insurance companies, local authorities and others, including representatives of members of the public, all trying to learn together around a shared set of challenges. Some stuff will be done within companies and that is right, that is the development of their products and services, but in this area quite a lot of the challenges are shared. It is a great testament to the work going on in the UK that so many companies are working together around those challenges.

**Q2** **Baroness Young of Old Scone:** Can you give us a feel for what you realistically think the time-frame is for autonomous vehicles being deployed? If we can divide it into two chunks, one is road-based ones and the other is the others. Can you also tell us what progress you think is being made on looking at how a mixed economy would operate in the interim, where you might have a range of different levels of autonomy, including no autonomy or very little autonomy, all at the same time, and whether that, in fact, is practicable? Timescales, but also the practicability of that intervening period.

**Iain Forbes:** The question about timescales is a really good one and one which is debated quite a lot among the people working in this field. On road vehicles, it might make sense to split the answer into two. Developers are, broadly and very crudely, following two different paths to development. Some developers are seeking to add automation systems to existing vehicles, so building on technology which already exists in vehicles; they are seeking to, over time, increase the amount of work done by the vehicle as opposed to the driver. Those systems already exist, and we anticipate those getting more advanced over the next few years, and a lot of the work to devise a framework for that is done by my colleague Mr Yarnold and his team in Geneva.

The second area of development is an attempt to leapfrog that work to try to jump to fully autonomous vehicles, and some developers are more interested in that sort of technology. Initially, it looks like that technology is going to be deployed in constrained environments in certain areas with particular criteria—geofence is sometimes used as a term. Views about when that might hit the market in a serious way differ; some people are saying the 2020s, some are saying the 2050s. Making sure we have a strategy which is robust enough for a range of different scenarios is one of the things which is very important.

To take your question about the mixed fleet, this is another really important question for us. Understanding the impact of the technology on future road network performance is very important to help us make infrastructure plans for the future. We are still in the early stages of this but we have done some modelling on the effect of having different levels of connected and autonomous vehicles in the vehicle fleet over time, looking at the impact on particular areas, urban and intra-urban roads. For example, if there were a certain level of penetration of these vehicles at a traffic light, what would the impact be on traffic flows through that traffic light? It is still at a very early stage, I should stress, but we are keen to develop that work in future and build the evidence base over time. It is quite important to make sure that we, as I said, have a strategy which is robust for a range of scenarios, so that sort of work is very important for us in the future.

**Baroness Young of Old Scone:** If Audi introduce their A8 next year, are they going to get a licence to be allowed to use it?

**Ian Yarnold:** It depends on the level of technology. There is a huge amount of work going on now to ensure that there is an appropriate regime of regulation to ensure that the safety of self-steering systems is correctly accounted for. In automation there are three principle issues you have to deal with: throttle control, brake control and steering control. Throttle control—and you may be familiar with cruise control or advanced cruise control systems—has been with us for a while. Automated braking has been developed over the last 10 or 15 years and that is being regulated already, but the real challenge is self-steering systems because there is a huge amount of inputs to the process of steering a vehicle around an obstacle. That work is now moving forward in Geneva.

The UK is in a very good position in that because we chair the key global technical committee; my staff chair that group, so we are able to influence the way in which that work is being taken forward and the decisions being reached. There is a specific subgroup dealing with automatically commanded steering functions, which is led by Germany. They announced two years ago or so that they wanted to move this forward at a very rapid pace; we felt a more structured approach was appropriate, and we have been able to influence that to get the right controls in place. We have turned it into a structured further approach so that we can deal with the different technology levels and regulate those as we feel appropriate as those technologies come on. I am not exactly sure, because I do not think Audi have published exactly what their system will do, but it will have to comply with the regulations appropriate for when that vehicle is brought into the marketplace. We are an

important part of the process in making sure that that happens through a proper regulated process in the United Nations ECE. That is a parallel regulatory body to the EU.

**Q3 Lord Mair:** I should start by declaring an interest. I am chair of the Department for Transport's Science Advisory Council, a fellow of the Royal Academy of Engineering, a fellow of the Royal Society and a vice-president of the Institution of Civil Engineers. My question in relation to time-frame is about demonstration facilities, which are obviously all-important, particularly in the context of mixed vehicles: fully autonomous vehicles and what one might call more ordinary vehicles. In your view, is the scale of the currently planned demonstration facilities appropriate for what is going to be a huge market? Can you say a bit more about demonstration facilities?

**Iain Forbes:** Yes, of course. We have made a great start in the UK. The projects that we are running, which I know you will hear from later, are genuinely world-class and we frequently have people from other countries asking us for information about what is happening there. What is important is they are taking place in the real world. A crucial part of the development of this technology is allowing people to experience it: to get into the vehicles, to understand what it means for them and to think about how it might interrelate with the rest of their lives. For example, if you go to Greenwich in a few months you will be able to get into a self-driving pod, go round the peninsula and get a real sense, I think, of what that technology might offer you in future.

It is a great start. There are lots of countries around the world competing to be the world's testbed for driverless cars, so it is clear that more will need to be done to make sure the UK stays competitive. Over the summer we ran a call for evidence within industry to get views from some of the people developing the technology on what will be necessary, which we are currently sifting through at the moment and anticipate responding to soon. Some key messages were that it is not the case that we need to invest in vast new ground-up facilities; what we should do is build on what we have, including our regulatory system, which is one of the most open in the world. In the UK, unlike in some other countries, you can test anywhere, which is a real advantage for us when it comes to trying to understand what the technology will look like in the real world when people experience it. As we sift through the responses we might see that there are other things we need to invest in to try to make sure that we remain competitive, and that is certainly something that my team will look at closely over the next few weeks.

**Lord Mair:** Presumably, it is not just a question of testbed tracks.

**Iain Forbes:** Yes.

**Lord Mair:** Particularly in the context of cities and the urban environment, you need something rather more sophisticated, where the vehicles are being tested in what would be regarded as a real, urban situation with other things around—other vehicles, pedestrians, obstructions and all sorts of things. Is that what is being contemplated?

**Iain Forbes:** We need a range of different sorts of testing environments, everything from controlled environments—i.e. vehicle test tracks—through to real-world environments, as you describe: areas of towns and cities where these vehicles can be tested in the real world and in a safe way, all the way through to virtual environments too, so running systems on computers to see if they work. The piece of work on testing in the real world is hugely important because engaging the public in how this is taken forward is going to be one of the key ways in which you are going to succeed or fail. If people can see the benefit for them then that will speak to the ability of the technology to meet people’s needs. If they do not they will buy out and the technology will not succeed. The short answer is yes, we need real-world testing environments.

**Q4 Lord Fox:** I should declare an interest. I am employed by and have shares in GKN and I also have shares in Smiths Group, which may be active in this area. You introduced the topic of having a mixed technology environment where you have, normally, manual, semi-autonomous and autonomous vehicles in the same place. How much are you looking at the infrastructure needs? In the end, that may be the rate-determining step, if large investment is required to let this happen. In your view, what level of investment will be required in infrastructure and how are we validating that?

**Iain Forbes:** This is a very important question for the Department for Transport when we sit down to plan out what our infrastructure requirements are for the future. Predicting the future with any level of certainty is quite tough when people are following different development paths. I would say, though, certainly for the foreseeable future, it is likely that the vehicles will have to operate on the infrastructure that exists. As you mentioned, it is going to be a mixed environment and these and conventional vehicles will need to use it to anticipate getting value for money from those projects for quite a long way into the future.

At the same time, given the time horizon for infrastructure projects, we need to get a sense of what the potential scenarios of the future might look like and mean for infrastructure development. One way in which we do that is by having a look at different scenarios of the future and testing the strategy against all those scenarios to make sure it is still robust. It may well be that in future we might be able to run our infrastructure more efficiently if vehicles speak to infrastructure, and systems exist which allow safety to be implemented in a more efficient way. To properly determine that we will need to test in the real world, and one thing that the Department for Transport is doing is testing these sorts of technologies in real-world roads to get a sense of—

**Lord Fox:** So the Bristol/Greenwich-type tests will be testing that as well?

**Iain Forbes:** The key ones for those sorts of questions are the tests around Coventry, as part of the UK CITE project, and the “connected corridor”, a project the Department for Transport is leading on, between London and Dover, looking at a range of different communication technologies.

**Q5 Viscount Ridley:** Declaring the only interest which I think is of relevance, I am a

former non-executive director of PA Consulting, which is going to give evidence at some point. I would like you to try to speculate, if possible, about how we maximise the benefits from this technology while minimising the disbenefits. We can all see that there are potential benefits in terms of safety, environmental quality, lack of stacked/parked cars in towns, convenience, old people being able to get mobility back, people coming home from the pub late at night, et cetera. There are also possible disadvantages, including losses of jobs among drivers, making congestion worse because these things are ultra-cautious, et cetera. How do we go about working out how we maximise the former and minimise the latter?

**Iain Forbes:** I think you have done a good job of laying out some of the main benefits and potential disadvantages we think about when thinking about the technology. One of the key ways is to learn by doing. If you discuss a lot of this technology in the abstract, it is quite difficult to see how it is going to interact with the real-world environment. Our test programme is one of the core means by which we will explore those sorts of questions. We have a proposition that these vehicles are going to be more safe. When you put them in a real-world environment with appropriate protections around it, does that play out in a way which justifies the claim? Similarly with some potential disadvantages, we can identify some now but there might be others which crop up as and when we do the trialling. We can only operate step by step, I think; it is not possible to plan out the entire future from now and create the framework that is going to allow that to happen.

As part of our trial programme, one thing I would stress is the importance of public engagement. I am very excited about the technology; I think it has huge potential—I am quite a techy person and I quite like technology—and if we are going to see this improving people’s lives, having people touching it, feeling it and participating, participating in the projects is very important to allow that to happen.

**Ian Yarnold:** One of the key things of the trials programme is the behavioural study. There is a lot of work being done about how drivers engage with them and how motorists want to buy a vehicle or not, but from a Department for Transport point of view, we have to understand how these vehicles interact with the urban environment. There has been mention before about pedestrians and such like, and vulnerable road-users. One of the things we will be implementing—and we are part way through the pilot study, or scoping study—is to understand what we can learn from the trials that Iain has described within the four cities and to try to draw together the evidence so that we can make choices around where we go and what we do with these technologies. How do we maximise the benefits? We need to understand how people engage with driverless vehicles when they are being used in their local town or city, to help us make the right choices going forward. It is very easy to say “We know best” but we have to understand it in a way that the public can engage with and tell us what they think about it.

**Viscount Ridley:** Just to follow up on the point about public engagement, we have seen one survey saying that 52% of Brits think it is a great idea and another survey saying that 62% are scared by the prospect. Do we know what people really think about this?

**Iain Forbes:** You have to take all these surveys with a little pinch of salt. That famous saying by Henry Ford: if he had asked what people wanted they would have said a faster horse. People have not yet properly interacted with this technology, which is why the demonstration projects are so crucial and why, I think, within the departments our three-year programme is spending a fair amount of time scoping out the right questions and the right methodology. Like you, I read a survey every other week about what people think about driverless cars, and it is a different answer every time.

**Q6 Lord Hunt of Chesterton:** I wanted to follow up on your opening remark about the importance of networks. I was involved in setting one up for aeronautical research in the 1980s and it now still operates in Europe. You are exclusively using the word “UK” for your networks. Are these research industry networks European-wide, and will they continue to be European-wide?

**Iain Forbes:** The particular network I mentioned, the Robotics and Autonomous Systems Special Interest Group, was set up by Innovate UK and the knowledge transfer network, so a UK body primarily targeted at people doing work in the UK. I know the teams who do that speak very frequently to partners doing research in Europe. There is an awful lot of great work going on in Europe, and understanding what is happening and how we can be involved in that is going to be part of our job in the future. The particular body I mentioned earlier is a UK network.

**Lord Hunt of Chesterton:** I want to ask my proper question now. You keep saying there are no statistics. I went on one of these happy mornings when I had to learn about the driver’s manual because I had gone at 32 miles an hour—

**The Chairman:** We do not believe you.

**Lord Hunt of Chesterton:** The interesting point is that the person running it said that the biggest source of deaths on the road is in rural areas, where perhaps 2,000 people a year are killed. Therefore, the most important thing, as it were, is to get to these people after they have had a crash going round a bend in a leafy lane. This seems to me highly identifiable as a statistic and as a programme. Everyone is always talking about cities, but where people are being killed on the roads is not in cities. I wondered how that is reflected in your programme.

**Iain Forbes:** It is a good point to make, and it speaks to the need to have a look at where we can get the benefits that we are talking about, as opposed to talking in the abstract about road safety. The work I mentioned earlier, to add automation systems to vehicles, could potentially have a real impact there. Some developers are talking about putting a guardian angel around the driver to make sure, when they are driving, there is a system checking in to make sure, if it can help, it will do in future, which I am sure will have impact in rural areas as well as urban areas.

Having said that, I do not think it would be possible to direct all our focus on one particular area when so much is still to play for in how the technology might play out. It is certainly of real interest to us and we are definitely bearing it in mind when

thinking about the applications of the technology, but we are also keen to create enough space to allow people to innovate.

**Lord Hennessy of Nympsfield:** I have a question for Iain F, if I may. Your enthusiasm for all this is contagious and it is a very nice thing to see, but one always has to be careful of not overselling. Heaven knows how many transforming technologies we have been through, which of course in some cases have transformed lives. Behavioural studies intrigue me because human nature will not change, whatever the level of artificial intelligence, and the roads have always brought out the worst in some people. It is the Mr Toad syndrome. Ever since the days of the Deadwood stage people have been behaving badly on roads. They do now, and I am sure they will find a way of behaving badly in these things as well. There must be limits to the social psychology you are applying to all this. Do you not need buckets of scepticism applied here?

**Iain Forbes:** We certainly come at this with an air of healthy scepticism when it comes to some of the claims being made by some of the people developing the technology. The systems we are talking about will have to operate in a safety-critical environment, as current road vehicles do at the moment. I am very enthusiastic about the technology and its potential, but it will be important to have the right regulatory framework around that so that people can feel confident they will be operating safely and they are not at risk from the technology too. Part of the work which Iain and his team do is going through in scrupulous detail how these things will operate in the real world to make sure we can be comfortable with the way the technology operates. I do not know if you want to elaborate.

**Iain Yarnold:** Only on the social science side of things. There are different streams of work. Will people be able to misbehave in these vehicles? The answer to that is it depends how much control over the vehicle they have when they are in it. If we move to a fully automated vision then the expectation is that the person in the vehicle, and this may be a few years away, would have very limited control over the vehicle because they will not have any controls. During that period of transition we would have to think about how the driver interacts with the technology, and that is an interesting, large challenge. That is one set of issues.

A separate set of issues is how other road-users who are not in the vehicle engage with the vehicle. That is the subject of the separate behavioural research that I mentioned. We will, in effect, have researchers in various locations where those vehicles are being used engaging with people that are using the roads, walking, cycling—however they move around—to understand how they perceive this driverless technology being used in their locale. If it is used on a Friday will people not come out of their houses on a Friday because they are worried about it, for example? That might be a rather extreme observation but it might be that people avoid the particular roads where these vehicles are being used until they become more familiar with them. We need to understand that in terms of how we create an opportunity in the UK for the wider use of these vehicles. We are trying to take a measured approach to it to ensure that the public at large understand this technology, whether they are in the vehicle or outside the vehicle.

**Lord Maxton:** I am sure that I read over the weekend somewhere that the first autonomous cars on the roads would be anonymous to stop other road-users from deliberately trying to interfere with the way they operate. In other words, stepping out in front of one because they know it is an autonomous car to see whether it will stop or not. Are you taking that into account?

**Ian Yarnold:** I read the same article. You are right, there is the issue of the driverless car being too polite and will it ever make progress over pedestrian crossings, because there will always be someone close to the edge of a pedestrian crossing and the vehicle will be in this quandary of “Should I go or should I stop? Are they going to cross?” For those of us who are drivers, you handle that challenge daily when you move through an urban landscape. It is going to be a challenge. You are right that there is a risk that if an autonomous or driverless-type vehicle is painted red then people will test that and keep crossing in front of it to see whether it stops.

**Lord Maxton:** I also have a colleague who said to me that he was at a football match on Saturday and invited to the Chelsea/Arsenal game on Sunday, and he would never have made it in an autonomous vehicle because the autonomous vehicle would only drive at 70.

**Ian Yarnold:** I could not possibly comment.

**Lord Vallance of Tummel:** Can we take a quick look at this from a macro point of view? Sticking to motor vehicles for the time being, assuming all this works and this is going to be a great, big international marketplace, it is going to need big scale; it is going to need the usual control over standards, because if you win the standards game, you win the game, and so on and so forth. Where in the end-game of all this do you see UK plc sitting? What are we aiming to do? Are we aiming, at the end of the day, to manufacture these vehicles or have them manufactured in the UK, or are we providing systems to other manufacturers? If we are, who do we have in our sights? Can we take a macro view of it?

**Iain Forbes:** It is a very good question but a very tough one to answer, given the uncertainty in how the market is going to be taken forward. That terrible word “disruption” is used quite a lot about the future of the automotive sector. Senior figures in the sector think there is going to be an awful lot of change, not just to the technology but to business models as time goes by. People such as Mary Barra of GM think there will be more change in the next 10 years in the sector than there has been in the previous 50. Yes, there will be opportunities, perhaps in producing some of the component parts and systems for these vehicles; yes, there will be opportunities in manufacture too. But also, if we see more of a shift to providing these systems as a service rather than as products, there will be opportunities to explore there as well.

We cannot predict the future exactly but we can engage closely with industrial partners in the UK to get a sense from them about where they see the future value being, and that is what we do through the Automotive Council and through other bodies.

**Lord Fox:** By deft chairmanship, we were on the same tack, Lord Hunt, and it was

very much on that point. What you have described is the technological strategy. There does not seem to be any evidence of any sort of industrial strategy. I cannot believe, even though there is all this uncertainty, that Germany is not looking at this from the other end of the telescope and that the reason they are trying to accelerate things on their committee is that they believe they can take an industrial advantage by doing that. Where is the horsepower located that is having this discussion and developing this strategy for the United Kingdom? It is all very well having lots of collaborative things and working out lots of ways of deploying this technology if all we are doing is creating a market for everybody else to sell their services or their products. I do not see any evidence of that at the moment.

**Iain Forbes:** It is a very good challenge and a fair one. We do not want to produce lots of very excellent research and services which are hoovered up by other people to make money from. My team works very closely with the Transport Systems Catapult, which is one of the innovation agencies set up to try to steer efforts around particular challenges. They look at technology—it is an important part—but also at the value chain in future, how the future industry is likely to shape up and where the UK can play. They published a report called “The Traveller Needs and UK Capability Study” which gave an assessment of current levels of UK capability, which I think informed the Chair’s comments earlier about where we are strong.

The next step of the work for us is to take that initial bit of work and identify where we want to focus our efforts to make sure that we have a proper prioritised sense of how the UK can succeed in this area, which we will be doing with the Transport Systems Catapult and through our partners in the Automotive Council too.

**Q7 Baroness Neville-Jones:** I declare an interest as a member of the Council of the Engineering and Physical Sciences Research Council. These witnesses may not be entirely the right people to ask about the relationship with industry, but it seems to me that what you are doing should be linked with what I hope we will hear about the future of the industrial strategy. Could you say whether in fact there is a prospect that your team will be influential inside that strategy? Secondly, you say that the transport catapult is very important but, again, I would put it to you that it is essentially to do with the technical, technological and research side of the game; it is not to do with commercialisation, crossing the frontier between knowing how to do it and actually getting on and producing the vehicles and the road structure—indeed, I would say, the transport structures generally that are needed—which seems to me to be a much bigger programme. Could you both say something about that? How do you fit into that context?

**Iain Forbes:** On your first question about industrial strategy, the answer is yes, my team is engaging with the process of pulling that together. This is an area which is getting a fair amount of focus, given the potential for the UK genuinely to have a leading role in future. Obviously, that document is being worked on at the moment and we will be engaging with the process as it goes forward. Yes, is the answer; my team is heavily engaged in that.

Your comment about the catapult is a fair one too, but it is not the only means by which we are thinking about this. The sector council, the Automotive Council, is a key body for us in making sure that we, as government, are doing the right things to point our industry and our government efforts in the right direction. We can produce a report, which might be very interesting, but if we are not told by industry that it is going to be helpful for them then it is not going to get very far. We constantly validate the work we do with the council itself and the subgroups which look at technology and other services.

**Baroness Neville-Jones:** How does Innovate UK fit into your picture?

**Iain Forbes:** We work very closely with Innovate UK.

**Baroness Neville-Jones:** In what way?

**Iain Forbes:** They are the delivery partner for our research programme. We have over £100 million of government research which we work with Innovate UK to scope, and then they pull together the research competitions and the bids to make sure that the process is delivering value for the UK. We work in partnership around research.

**Lord Oxburgh:** My point has been covered.

**The Chairman:** We will move on to Lord Hunt. Would you like to declare an interest at this stage, Lord Hunt?

Q8 **Lord Hunt of Chesterton:** Yes. I am a fellow of the Royal Society, and I am director of a small environmental company and an NGO. One of the questions concerns the regulatory regime. As we heard from Ian Yarnold, you are doing this at a UN level, but there are also pretty strong EU regulations on that. My understanding from hobnobbing a bit with some civil servants is that many of the networks of Europe will, it is anticipated, continue although there may not be the funding we currently have in research. I would be interested in your comments on that.

**Iain Forbes:** Shall I give an overview and then pass to Ian for the international discussions? A regulatory forum is a hot topic for this particular subject, and creating the right framework is crucial. The UK has done a lot to set the pace in some respects around that work. A couple of years ago the Department for Transport did an audit, a review, of all the regulations which might relate to automated vehicle use and operation in the UK and found that there were very few barriers to doing tests in the UK. Later on, in July last year, we published a code of practice for the testing of autonomous vehicles, which a lot of people around the world have held up to be one of the best approaches to doing that. It could have been at that point that the department might have chosen to take a regulatory approach and set out in statute what the arrangement should be. Given the pace of change in technology the department decided to take forward a guidance document which could be adapted over time as the technology moves. That approach has been copied by countries around the world, which is encouraging to see. That is around testing.

On the wider framework around the sale and use of these vehicles, it is not going to be possible to sit down and plan out the framework for the moment; we are going to have to take a step-by-step approach, focusing on what we think to be near to market and what we think to be important to resolve now. We consulted over the summer on the first wave of regulatory reform relating to this area, which focused on motor insurance and some near-to-market technologies. We will be taking forward future waves in the next few years, engaging with people on the priorities to make sure that we are targeted at the right area. One of the key discussion forums for that is the forum that Ian and his team go to in Geneva. As Ian said earlier, the UK is very influential in determining the agenda for those.

**Lord Hunt of Chesterton:** Will you talk about Europe too?

**Ian Yarnold:** I was coming to that now. As you mentioned, all new vehicles coming on to the road in the UK and across the whole of the EU have to comply with European regulatory requirements. We cannot avoid that; it is a mandatory obligation. Those technical regulations are set both in the EU, in Brussels, and in the United Nations Economic Commission for Europe in Geneva. About six or seven years ago the European Union took the decision to move the setting of safety standards to the parallel group in Geneva. They retained the environmental standards in Brussels, so Brussels picks up the technical requirements from Geneva and brings them into the minimum requirements for vehicles entering the EU market. That is why when I talk about Geneva it is quite important to focus globally for setting technical requirements for new road vehicles. When I talk about “globally” I mean truly globally. There are two different approaches, and I can give you more information if you want it. There is one called type approval, there is another one called global technical regulations.

As I mentioned earlier, we are in a very good position, and have been for many years, in setting those standards. I chair the global harmonisation group and that is a shared chairmanship with Japan and the USA. It rotates every two years. I am the EU-nominated chairman on a two-yearly basis. I also chair the ITS—intelligent transport systems—automated driving group within that, and one of my team chairs the technical group of global experts. That brings in North America, one or two countries in South America, the Asian countries, Russia, all of Europe, South Africa and some northern African states as well. It has a very globally-based approach. That ensures we try to build in harmonisation at the origination of those regulations. I would not want to underestimate the challenge of that, especially when you are trying to deal with embedded approaches in those different territories, but we work hard to try to ensure that we bring together a collective approach. That is an important route for our understanding of where the technology is. I think someone mentioned earlier that there is a lot of protected interests, manufacturers guard their IPR very heavily to make sure they do not divulge anything. That networking allows us to understand exactly where they are on a bilateral basis, and you learn far more in those corridor conversations.

**Lord Hunt of Chesterton:** Presumably Nissan was quite pleased to hear this kind of remark.

**Ian Yarnold:** It would not be appropriate for me to comment on that, but it is a valuable source of knowledge, as we develop our regulations, to understand from different participants in the group; vehicle manufacturers, NGOs and trade bodies are there, along with a wide range of global governments. We are in an influential position, and have been for the last 35 years or so, in shaping that agenda and taking it forward from here.

**Lord Vallance of Tummel:** Picking up on what Lord Hunt said, it is great that we are in an influential position and we take the lead, and so on and so forth, but how does the UK take economic advantage of that, or is it philanthropic?

**Iain Forbes:** You have direct discussions with UK manufacturers but the ability to shape the agenda of a global standard-setting body allows us to target on things which we and companies in the UK care about. Ian and his team have gained that position because of their expertise and knowledge about what works in the real world. It also allows them to make sure that the items being discussed are ones of real relevance to the UK. That is not the only way in which we are going to succeed industrially; building up capability and making sure we have the right ecosystem in the UK is very important, but genuinely over the years I think we have been seen as very influential in setting standards which will determine the future of vehicle technology.

**Ian Yarnold:** There is a judgment call in that you have to be true to the principles of impartiality when you are setting these things, but at the same time you have to understand where the opportunity arises. Someone mentioned that Germany may have had a particular ambition about fast-tracking the steering regulation because it suited their industrial position. We felt that a more structured approach was needed to ensure we could implement a regulation that was fit for purpose rather than one that helped a particular advantage. I am sure that if we had the same approach another Government might have the same outlook and say, "Hang on a minute. Is this an intellectually robust technical regulation that delivers on a technical issue?" We always have to apply that balance.

**Viscount Ridley:** Mr Yarnold, from your chairing of this key committee in Geneva, as you say, you get a perspective on what is happening elsewhere in the world. Which country is most ahead in this technology? Which is going to do to this what Japan did to consumer electronics or America did to social media?

**Ian Yarnold:** I do not know if there is a straight answer to that. I cannot give you a name of a country. They all have strengths and weaknesses. As Iain has described, we established a year or two ago a clear commitment and leadership. When we published our code of practice we were seen as the global leaders in this area.

**Viscount Ridley:** It is possible we are the go-to country on this.

**Ian Yarnold:** That would be my impression of things, but of course, as I think you are alluding to, a number of other countries have some very advanced technology companies, and we are trying to establish ourselves as the best place to do the testing. As Iain has described, we have one of the most open regulatory structures in the world to allow that to happen. I had the opportunity to be in China talking

about the UK approach, in Shanghai at a big international conference earlier this year, and a number of manufacturers were very interested and impressed with the fact that we had taken the time and trouble to consider how we do things and how they can test vehicles in the UK, and at that time they felt they did not have the same approach locally to how they were producing and doing their technology development in China.

**Lord Oxburgh:** Let us say that people come here to test their vehicles. Is that going to be of significant economic benefit to the UK?

**Iain Forbes:** There are different types of testing and the type which might deliver the most benefit is development. If it proves tough to take forward testing in one particular country and you move your researchers and test teams out to another country to do the development, then you would probably need to buy some equipment and supplies from people in the area and you would probably need to have a relationship with a university to provide you with the skills you need to take it forward. The aim is to try to build that ecosystem, attract people here with the open regulatory environment and the contributions from government for research, and then build out from there to make sure we can take the industrial advantage too.

**Baroness Neville-Jones:** I can see there is a general advantage in providing a good environment for testing but where is the UK advantage in all that, as distinct from the advantage to everybody who can come along and use our facilities?

**Iain Forbes:** If we have a company which develops intellectual property around the control systems for the vehicles, that might end up being embedded into vehicles all around the world, in the same way, for example, as the ARM technology was embedded in mobile phones around the world. The areas in which the value is going to be are not exactly clear yet but we can see there is going to be a lot of interest in the control systems in some of the artificial intelligence-led work to create the way in which the machine interacts with its environment in future. We have strength and depth in universities in the UK in this field, which speaks to the ability for us to potentially take a leadership role here.

**Baroness Neville-Jones:** Are they intimately involved in these testing programmes?

**Iain Forbes:** Yes.

**Baroness Neville-Jones:** Is there an intellectual and commercial link?

**Iain Forbes:** For example, there is a spinout from Oxford University called Oxbotica, who have developed a control system which is being used in many of the UK trials, and we are aware they are frequently in conversation with companies around the world about licensing that service elsewhere.

**Q9 Lord Borwick:** Declaring my interests as chairman of the GATEway project advisory group, the Greenwich vehicle project, perhaps I may ask about the legal accountability for vehicles. There was a case in the papers yesterday about a 40-ton truck being driven by a guy using his mobile phone even though that is clearly against the current regulations—he was apparently photographed doing it. Any

vehicle thinking for itself is likely to be safer than that particular truck under those circumstances. Could you see in your regulations legal accountability requiring people to use autonomous braking systems?

**Iain Forbes:** This is a great question, and liability for autonomous vehicles is very much debated around the world. It is a very complex issue, which is probably worthwhile taking in parts. The first point to make is that the vehicles do not necessarily think in the terms we might think. They assess their environment and make decisions but they are not a sentient being. Ultimately, questions of liability within the UK will be for the courts, as they are now. They have experience of assessing liability across a range of different parties, as for conventional vehicles at the moment when there is an issue, both for criminal and civil liability. For example, if there was a crash because a car was faulty, the court may decide to hold the manufacturer of the vehicle liable for providing a faulty product under product liability laws.

Having said that, Government can provide some clarity and certainty where it is felt useful to do so, and we will explore that in our future waves of regulatory programmes. For example, as part of our code of practice, we have specified that a testing organisation is responsible for the safety of that vehicle. That might be relevant in a legal proceeding if there was an issue put before a court. We are also keen to make sure that, in future, if there is an issue, innocent third parties who might be affected by that crash, or whatever incident it was, are compensated quickly, which is why one of the first areas of focus for us in our regulatory programme is motor insurance and how we create the framework to make sure those conversations happen in a way in which ensures claims are paid quickly to people who are affected.

**Lord Hennessy of Nympsfield:** I should have declared an interest as a fellow of the British Academy. I am not quite sure in what way it is linked but I declare it just in case. Whatever the progress of artificial intelligence, robots on wheels are not going to be ideal witnesses in witness boxes in court cases, are they? How are you going to know? Are you going to have a black box, like an aircraft recorder, in each one of these things? For example, could it be a defence that its sensors were baffled by an extreme weather event? It all seems to me to be beyond A P Herbert's "Misleading Cases".

**Iain Forbes:** We recommend, as part of our code of practice, that manufacturers include a data recording device to make sure that that data is harvestable which could be useful, perhaps, in a court if there was a particular issue. Also there are discussions at international level about data recording devices, which I think could be relevant.

**Ian Yarnold:** Yes, coming back to the Geneva discussions, on the back of the work we did and the recommendations in our review of regulations we recognised that there needed to be some co-ordination on the issue of data recorders. We do not refer to them as "black boxes" because that is just a thing; we have to talk about the function of the device and what it would record. That discussion is at a very early stage but I anticipate that moving very quickly over the next year or so to move to

thinking about the information we need to collect, the frequency of collection and how long the vehicle has to store it for, for example, so that we have that opportunity to interrogate that information to understand the technology being used at the point when an incident occurred and who was in control of the vehicle if there is a switchover between a driver and a vehicle in that particular case.

**Lord Hennessy of Nympsfield:** Is the Government Legal Service helping you on this?

**Iain Forbes:** We have very close relationships with our lawyers. They work very closely on how we take the work forward. You probably have chats with your legal team—

**Lord Hennessy of Nympsfield:** What do they say? What do they tell you?

**Iain Yarnold:** The answer to the question is yes; we bring them in whenever we need to. At the moment it is a technical discussion about what we think are the parameters that we need to collect from a technical point of view based on our experience of the technology and the information we have seen required over the years on accident investigation, for example.

**Lord Hennessy of Nympsfield:** It will need primary legislation, will it not?

**Iain Yarnold:** Not for the vehicle to be fitted with the device because that would be a technical standardisation issue. That becomes more challenging when going back to your point about what you do with the data. From my point of view, it is a technical specification issue.

**Lord Hunt of Chesterton:** Would the cars talk to each other? If you have two cars going round a corner, they have not seen each other and they crash, as they do in north Devon where I have holidays—nobody cuts the trees—so the two black boxes will fight it out in the courts, will they?

**The Chairman:** We must move on because there is not going to be an answer to that one. I have Lords Cameron, Hunt and Fox. I am hoping we can complete this in three minutes because we are running out of time.

**Lord Cameron of Dillington:** My question was going to be on the black boxes but I notice that different brands seem to be accepting different liabilities, with Tesla the least liability and others saying they will accept liability. We had written evidence from the insurance companies saying that they want the Government to create an associated right of recovery allowing insurers to claim costs from manufacturers and other stakeholders, presumably having been proven by the black box. Are the Government going to introduce such an associated right of recovery, do you think?

**Iain Forbes:** We are looking into how the framework is going to operate in future including discussing that with the insurance industry and others. The point I would make about the statement you have made is that it is not really for the manufacturers to say where the liability lies; it will be for the courts to decide.

**Lord Cameron of Dillington:** I would accept that.

**Lord Hunt of Chesterton:** Do they have radios for the cars to, as it were, talk together?

**Iain Forbes:** Some manufacturers are very keen to develop cars that speak to each other using short-range radio communication. That is one path of development which is being pursued by manufacturers in Europe, the US and elsewhere. Some developers think they can achieve the benefits and develop systems without the need to speak to each other.

Q10 **Lord Fox:** Whether they are talking to each other or not, there will be tons of data. Who is going to own it?

**Iain Forbes:** We do not have the full answer to that yet. This is a new and emerging technology and it is going to require transparent discussions about these sorts of questions—

**Lord Fox:** Does this have moral value?

**Iain Forbes:** —including around informed consents, data privacy and security; a huge set of questions which are going to have to be worked through in future.

**The Chairman:** We have covered a lot of ground but we have run out of time, as we inevitably do. There are one or two points on which I think it would be helpful to have a follow-up note, if you would not mind. Maybe you have some other thoughts and might wish, in supplementary notes, to amplify your evidence. There was mention of a Cabinet Office co-ordinating committee. It would be interesting to know which departments are represented. We talked about work on modelling mixed fleets, and a note on that would be of great interest, if you could, and the M2 trial that was mentioned.

**Lord Hunt of Chesterton:** We did not have an answer to your and Lord Vallance's question on where is the company/economic dimension to developing in the UK.

**The Chairman:** If you read through the transcript, as you will, there may be other points you would wish to follow up on, and I have no doubt you will bear in mind Lord Hunt's point.

**Baroness Young of Old Scone:** Chairman, I forgot my interests.

**The Chairman:** You did indeed, and I was going to remind you.

**Baroness Young of Old Scone:** I should have said that I am chancellor of Cranfield University, which has a number of funded projects in the field of autonomous vehicles, with some of the funding coming from your money.

**The Chairman:** That completes all our declarations of interests. I thank our two witnesses for their very helpful start to our inquiry. As I say, you will get a transcript. Please make any alterations where the record is inaccurate. Once more, on behalf of the Committee, thank you for your help today.