



Science and Technology Committee

Oral evidence: [Government Horizon Scanning](#),
HC 703

Wednesday 20 November 2013

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Written evidence from witnesses:

- [Association of Chief Police Officers](#)
- [Intelligent Transport Systems UK](#)
- [Cranfield University's Centre for Environmental Risks and Futures](#)

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Members present: Andrew Miller (Chair); Jim Dowd; Stephen Metcalfe; Stephen Mosley; Pamela Nash; Sarah Newton; Graham Stringer; David Tredinnick

Questions 68-165

Witnesses: **Fiona Lickorish**, Head of the Institute for Environment, Health, Risks and Futures, Cranfield University, **Jessica Bland**, Technology Futures Analyst, Nesta, and **Marcus Morrell**, Senior Futures Analyst, Arup, gave evidence.

Q68 Chair: Welcome to our witnesses this morning. I would be grateful if you would introduce yourselves for the record.

Marcus Morrell: My name is Marcus Morrell. I am a futures consultant with Arup, a firm of design and engineering consultants.

Jessica Bland: I am Jessica Bland. I am a technology futures analyst at Nesta.

Fiona Lickorish: I am Fiona Lickorish. I am head of the Institute for Environment, Health, Risks and Futures at Cranfield university.

Q69 Chair: Thank you very much. It would be helpful, first of all, if you could tell us what recent involvement your organisations have had with the Government on horizon scanning.

Marcus Morrell: By way of a framework agreement for the provision of futures consulting services to the Department of Business, Innovation and Skills, we successfully bid for and won two projects over the last two to three years, both of which included a degree of horizon scanning. One was for the Foresight group under the Government Office

for Science. The other was for the horizon scanning centre in the delivery of a series of events for the FUSION cross-departmental membership group, with an interest in security and intelligence issues. The piece of work for the Foresight office was the design and delivery of a series of international workshops looking at “The Future of Manufacturing”. The outputs from that fed into the recent publication on “The Future of Manufacturing” by the Government Office for Science.

Jessica Bland: Our CEO at Nesta, Geoff Mulgan, was recently on the advisory group for the same “Future of Manufacturing” report. We have had less direct involvement. It is certainly not contractual in the way that Marcus has been. Nesta recently commissioned a series of papers looking at foresight and futures methodologies, including a forthcoming one comparing practices in Governments across nine different countries.

Fiona Lickorish: We undertake a range of horizon scanning and futures research for the Department for Environment, Food and Rural Affairs, and nine of their NDPBs and other organisations interested in environmental futures research. We do that under four work streams.

The first work stream is to look at horizon scanning and try to identify those emerging issues. The second work stream is about using risk-analysis tools to rank and help decision makers decide what the most important new and emerging issues are that they want to deal with. The third work stream is looking at larger-scale futures research around scenario building and so on. It is looking at the high-ranking issues that come out of the first two work streams. The fourth work stream is around training in capacity building and knowledge exchange for all of those organisations so that we present our outputs in a way that is informative, useful to them and so they understand the outputs of the work that we do.

Q70 Chair: For clarity, do the three of you approach Government with ideas, respond to initiatives from Government, or is it a bit of both?

Fiona Lickorish: For us it is both. We propose some ideas ourselves, coming out of our horizon scanning. We are also approached by the membership of the partnership for which we work for the items that they think are important to them.

Jessica Bland: As I said, our engagement is less immediate or functional. So most of that is us approaching them. For example, with some of Marcus’ colleagues at Arup, we created a provocative set of future Londoners. That led to some engagement with the new Future Cities project that Foresight are leading, but that was definitely led by us.

Q71 Chair: But you would feel comfortable in approaching in respect of any Department.

Jessica Bland: Yes. I know, because of our work on technology, Go-Science and BIS much more closely. I am sure if we thought that we had an issue or an important discussion to have with them—

Q72 Chair: Presumably, DCLG would be interested in your Cities initiative.

Jessica Bland: Yes, and other parts of Nesta interact directly with them.

Marcus Morrell: We have fairly limited experience of working directly with Government Departments. Our approach is through the contracting process. We respond to tenders that are put out by different Government Departments. As I say, our experience is really limited to work with Foresight and the horizon scanning centre in the last two or three years.

Q73 Chair: Finally, I want to flush out how you would like to see the process evolve and change. What are the real challenges in dealing with Government in horizon scanning projects?

Fiona Lickorish: The challenge for us, because we work with 10 organisations, is the different understanding and knowledge level of the people that we are working with. Some of the organisations we work with have long-standing programmes about forward-looking intelligence. Others are just beginning to do that kind of thinking, so they need a little bit more support.

We also have a challenge in the fact that a lot of the people that we work with often change their jobs quite quickly. We think that is both an advantage and a disadvantage. We have people who come to us and they get training. That is transferable to whatever job they then go on to do, but then obviously we have a new member of staff who comes in to take over their role and we need to work with them to get them to the same level of understanding. There are both challenges and opportunities in working with Government, and they are the main ones that we see.

Jessica Bland: Taking “The Future of Manufacturing” report as the recent example that I know most about, there is a distinction between the wider question that that report is trying to answer and the underlying research. It seems that good foresight or good futures or horizon scanning practice has to start from answering that question. We could look at that report as an example of where they got quite far with scenarios for 2050 for the UK’s manufacturing sector but maybe did not make big decisions or really point to the big opportunity costs of different kinds of policies in that area, though there may be a distinction between the policy questions that we need to answer and whether we are actually doing that with horizon scanning work and the quality of the methods underlined, which is less in dispute.

Marcus Morrell: From our perspective, we would have enjoyed more of a conversation around the wider objectives of the projects for which we won contracts to deliver. The framework agreement provided that opportunity but we had very little oversight of that wider conversation. We just came in to provide a very specific piece of work. A broader conversation about the objectives of the wider programme would have been more beneficial.

Q74 David Tredinnick: What are the key characteristics of high-quality horizon scanning?

Marcus Morrell: The approach has to be structured and systematic. There needs to be a good framework with which to build the analysis of the underlying trends and also an

appreciation for the systemic nature of the world around us and the fact that there are huge complexities and interconnectivities. We work with the STEEP framework, or STEEPLE, covering social technology, economic, environmental and political domains. It is really important to keep abreast of the trends across all those domains rather than have too much of a focus on technology, for example, or science.

The other characteristic is a high degree of collaboration. Quality desk research has to lead to lots of conversations with different multi-disciplinary perspectives and experts to enrich the findings. The communication piece is very important in communicating the results of the analysis in a clear way to a client or series of clients so that they can accessibly digest the material and findings. That is also critical.

David Tredinnick: It sounds pretty complicated.

Marcus Morrell: We live in a complicated world. It is hard enough understanding the current state, let alone projecting forward. A simple framework like STEEP is a very good start, with a high degree of collaboration and participation.

Fiona Lickorish: I would say a key characteristic is getting the research question at the beginning right. What is it that policy makers and decision makers really want to know about the future they might have to work and deliver in? We spend a lot of time with colleagues in Government with whom we work to say, “What is the real policy question? What is the real strategy question or delivery mechanism that you want this research to facilitate, underpin and help you in that thinking, in order to get your thinking right today so that it is flexible to deal with in any future that it might face?”

Q75 David Tredinnick: So it is harder to define the question than to define the answer.

Fiona Lickorish: I would say it is equally hard. That conversation has to go on throughout the whole of the project rather than being given a question and we then go away and do it. We have to have that discussion all the way through the work that we are undertaking for them.

Q76 David Tredinnick: When you look across Government Departments, do you think there is a difference in the way that different Government Departments approach horizon scanning and the priorities that they give it?

Jessica Bland: Having met some of the members of the network of heads of horizon scanning, which exist in a semi-formal sense at the moment, there seems to be some coalition within that group, a mutual understanding of what their role is and mutual discussion of some of the points we are discussing here today, about going back and clarifying the question being a key part of what they do. There is also a coalition of the kind of methods they find most useful for what they do. I found it almost heartening and maybe surprising that there was such symmetry in how they saw their role. However, it would seem that within their Departments they were sometimes performing a slightly isolated function. That integration departmentally could be strengthened.

Q77 David Tredinnick: Do you think all Government Departments should be responsible for their own horizon scanning?

Fiona Lickorish: I would add a little to what Jessica has said. There is a high level of agreement on the structure and organisation that is required to do cross-Government horizon scanning. Because different Departments have different specific objectives that they want to deliver, often they deliver them in the way that best helps their decision makers, but, as part of that discussion process that we have talked about, they are trying to bring in as many of their partners with an interest across Government who would have use for the outputs of the work that they do as much as possible.

Q78 David Tredinnick: Have the outputs of the horizon scanning work that your organisations have been involved in been made public? If not, why not?

Marcus Morrell: “The Future of Manufacturing” report has been made public. All the underlying evidence papers are also available over the internet. There are 37 evidence papers that underpin it; so this report has been made public. The outputs of the FUSION work that we have done have not been made public due to the classified nature of the discussions that took place during the events that we designed and delivered. For obvious reasons, those have not been made public under the Freedom of Information Act.

Jessica Bland: As with all Foresight reports, all the underlying evidence is made public. There may be a wider question about transparency here.

Q79 David Tredinnick: There is. What is the issue that you are thinking of around transparency?

Jessica Bland: There are things that perhaps could be done, such as summaries of those expert papers that are easier for policy makers to pick up and read quickly. Some of them are written in very technical language.

Q80 David Tredinnick: Are you saying that the language is confusing terminology, impenetrable and that really nobody takes any notice of the reports when they are published?

Jessica Bland: Not at all. People specifically in these fields, where you have done two years of study, are taking them very seriously.

Marcus Morrell: It is worth pointing out that there is a summary report, which is abridged and very clear, containing all the salient points.

Q81 Sarah Newton: It may help us all if we go into some specific examples. Perhaps we could start with Fiona Lickorish. Could you talk about the work that the Centre for Environmental Risks and Futures specifically does with DEFRA? Could you give us some examples of that work where you have seen an impact on DEFRA decision making?

Fiona Lickorish: Obviously, we work wider than DEFRA. It is their NDPBs as well and other arm's length bodies. We went into DEFRA itself. We ran a workshop for them,

thinking about the future of their evidence. They used that information to inform their evidence investment strategy development. That was a short piece of work that was done quite quickly for them to help them with a specific issue.

We have also written a piece on the future of noise for them. We ran workshops and interviewed experts on noise. We came to a collegiate discussion with those noise experts and the policy makers about some of the issues and implications of noise in the future.

For the Marine Management Organisation, we have done a set of scenarios for marine planning, which specifically fed into the marine planning guidance that they are developing. I can go on.

Q82 Sarah Newton: Those are interesting examples, so perhaps we could probe them a bit. What do you think was the benefit in each of those studies of an external organisation being involved rather than the organisation itself and people within the organisation just trying to tackle those issues alone?

Fiona Lickorish: The facilitation that we provide is very much under Chatham House Rules. We also do expert interviews with individuals, both in Government and outside, to talk about what they think the future of the particular issue is that we are thinking about. That is often anonymised so people can say the things that they might not wish to say in a workshop atmosphere but would like to have put into the discussion. I did not say this before, but I used to run the Horizon Scanning and Futures programme in DEFRA, so I have both internal and external expertise.

It is easier for an external person to ask those kinds of difficult questions and to probe a little bit further with senior managers than perhaps internal people can do. It is also easier for people to give an example of the things that make them feel uncomfortable. Lots of futures research makes people have an element of discomfort. It is often easier for an external person to pull out that elephant in the room and get it aired and talked about than somebody internally. It feels that it is implicit that everybody knows about it, but sometimes it needs to be laid on the table and discussed.

Q83 Sarah Newton: You are talking about a bigger talent pool to help the Department have a bigger source of expertise and to help them come to good decisions. We have had quite a lot of written evidence that says that the process itself can be very beneficial, even if the outcomes arrived at are not any different. That alludes to your point about the elephant in the room. Has it been your experience, having worked both inside and outside DEFRA, that the process itself is very beneficial to the Department?

Fiona Lickorish: It is beneficial to the Department and the stakeholders of the Department. What often happens is that the external stakeholders begin to understand the policy-making process far better. They understand the kinds of limitations under which Government are working. Government officials tend to understand a little bit more about the kinds of issues and problems that industry might be dealing with. That facilitation and open conversation is a great learning experience on both sides. If that can lead to some kind of collective agreement on what the actions might be—some of the actions might be in the gift of Government and some might be outside their control—and if we can get the

stakeholders together to decide what those actions might be and agree to take them forward, that can only be a good thing in helping Government and society.

Q84 Sarah Newton: I agree with you. Are you aware that any similar work to that which you have just described is happening in other Departments?

Fiona Lickorish: Yes. It is not quite in the same way that we do it, but other work is happening in other Departments. Often, they do not have embedded horizon scanning and futures teams, but when they identify an issue that they need to think about into the future they would put together a team to come in and deal with that issue.

Q85 Sarah Newton: Do you think that could be more advantageous, inasmuch as you have the line policy makers for the issue, as distinct from a separate group of people in the Department who are specifically dedicated to future planning and horizon scanning but not directly linked to the people whose day-in, day-out job it is to develop policy?

Fiona Lickorish: I would probably agree with that. External facilitation helps that, but, if you have particular issues, you should be bringing together those people who know about those issues, who know the policy area well, how that policy develops and how the different elements of the issues interact, so that you can get the best evidence possible to take forward when thinking about how you might act on those issues into the future.

Q86 Stephen Metcalfe: I would like to explore the role of the Government Office for Science in horizon scanning. From your experience, what do you think its strengths and weaknesses are in its approach?

Marcus Morrell: In terms of its strengths, the focus for the foresight function within the Government Office for Science is to have a longer-term focus, from 10 to 50 years out, which is much needed. The horizon scanning centre, from my experience, tends to focus on the shorter to medium-term horizon. Both are much needed and it makes sense that both have their particular focus.

From our experience, it has been a very fruitful collaboration with both sets of clients within Foresight and the horizon scanning centre. They have been very open to new ideas that we, from the private sector, have been able to bring to the table in terms of facilitation, workshop design and tools and techniques. They have been very open to our ideas, and that sense of collaboration has worked very well.

In terms of the weaknesses, I made the point earlier that we were brought in to deliver a very specific piece of work. It would have been positive to have had a broader conversation about the wider programme, interests and the needs of the end client. As a result of the way they parcel out work, there is limited opportunity for conversation to take place.

Jessica Bland: When it comes to having an advisory function within a Foresight report—one of those longer-term reports—from our CEO's perspective, there were three meetings he attended. That was almost the sum total of his engagement, with some papers in between. Those were very useful in terms of the presentation of evidence in the area that

was not already known to that group of both private and public sector leaders. That was a great point of discussion, but, perhaps, in following up the conclusions of the report and helping make some of the big decisions in the manufacturing sector that need to be made, there could be follow-on support that does not really exist or seem to exist for those reports at the moment.

Moreover, talking again about communication, that idea of a continuous dialogue between those people supplying horizon scanning and those people using it throughout a project cycle or even outside that project cycle could be improved as well.

Fiona Lickorish: I would say the advantages have been to get some really good examples of futures research out that everyone can see and that all Government Departments can use. They are high-level strategic pretty much all the time, but that means they can be used to facilitate those conversations. There is a wonderful toolkit of methods available, which is very good. It explains things in simple terms without too much of this futures language that can be difficult for people to understand. That has been a real advantage.

Sometimes, because they are located where they are in Government, they have been perhaps sidelined or the uptake of their outputs has not been as good as if they had been more centrally located in Government. That would be the main disadvantage I see.

The other disadvantage is probably around getting long-term engagement, as Jessica said. It is not just for the time of the project but afterwards, and what happens to the actions that were suggested in the work that they do. Who is taking those forward? Is anybody going back to see that they are being undertaken, and, therefore, also looking back to see what the impact of those documents has been?

Q87 Stephen Metcalfe: You talk about uptake, communication and dissemination of information. Do you think that the network of chief scientific advisers in Departments has a greater role in disseminating this information out to their Departments? How does it get out at the moment? Not as well as it could do, by the sound of it.

Fiona Lickorish: Yes, in one word; they do have a greater role. They are often part of the development of those larger-scale horizon scanning futures research documents, scenario building and so on. They are often part of the high-level stakeholder group that takes those forward. I know that, when I was working in DEFRA, both the late Professor Sir Howard Dalton and Robert Watson were real advocates of futures research and taking it forward. Bob Watson was an advocate of taking forward the national ecosystem assessment scenarios and really pushing those forward. They have a fantastic role. They understand the science and the long-term thinking. Yes, I do—that was a long way of saying yes, sorry.

Q88 Stephen Metcalfe: Does anyone else have a view on that?

Jessica Bland: That should not be at the removal of other senior stakeholders' role in that, particularly where there are policy-related recommendations in those reports. The chief scientists definitely have a champion role, but they are not the only people who are going to make those decisions or help make those decisions.

Marcus Morrell: I do not have a comment.

Q89 Stephen Metcalfe: But they could be more effective than they are at the moment.

Jessica Bland: I do not have immediate experience in the way that Fiona has.

Q90 Stephen Metcalfe: I want to talk a little bit about the quality of the work that the Foresight unit does and also about how that compares with the departmental work. What is your view on the quality of the Foresight unit?

Fiona Lickorish: This is going to sound strange. Sometimes I think the quality is too high. The science should be strong and everything else should be strong within the document, but it takes so long for those documents to be developed and put together that, sometimes, the policy agenda has moved on before they are published. There is a role for different levels of research and publication—from the short one workshop, where you get together the key stakeholders to deal with a particular and smaller-scale project that can give policy makers at least a heads-up about what might be coming in their direction, to those larger-scale pieces of work.

They are very expensive and time-consuming to do, both for the Foresight unit and the stakeholders who get involved in them. I would like to see an idea of looking at the issues that they have to face and the things that you want them to give you evidence on and say, “What is the best value approach to provide the evidence that is needed for decision makers to make the decisions that they need, now and into the future?”

Jessica Bland: There are examples of moves in that direction; for example, “The Future of Identity” report was much shorter. It was under a year rather than two-plus years in process. So there are moves in that direction and I would support those moves.

Marcus Morrell: It comes back to what Fiona was saying about understanding the question, what key policy area you are trying to address, and then making a call on how long that project should be and what the specific outputs should be to meet those needs.

Q91 Stephen Metcalfe: What I gather from that is that there are roles for all the different levels of horizon scanning. Some are at that high-level, too-good-a-quality horizon scanning, as long as you do not want it to be fleet of foot and want to use it some time in the near future. That leaves the role for departmental horizon scanning, which is still very important. Is that a fair summary? Both have a full role.

Fiona Lickorish: I would say that. Also, those Departments should be able to take the outputs of the horizon scanning unit and think about the implications of the findings in those reports for their specific policy areas.

Q92 Graham Stringer: I am perplexed by some of the terminology like “futures research”. Is horizon scanning a scientific activity? How do you research the future?

Fiona Lickorish: Horizon scanning for us is a specific methodology. It is a method that we use to identify those things that are emerging issues on the periphery of current thinking. We do not use the term “horizon scanning” to mean all different methods of futures research.

Q93 Chair: I am slightly confused about this, so let me ask this for clarity before you go on. What is the difference between horizon scanning and futures analysis? Is there a consistent use of terminology across Government?

Fiona Lickorish: There is an inconsistency of the use of the term “horizon scanning” between Government and external practitioners. External practitioners tend to use the term “horizon scanning” to mean a particular methodology, which I have just explained, whereas in Government the term is often used interchangeably with “futures analysis”, “foresight”, “forward-looking” and “intelligence”. It is all those kinds of terms that can lead to misunderstandings between practitioners and Government when they ask for horizon scanning, and that is not really what they are looking for.

Q94 Graham Stringer: So is it a scientific activity?

Fiona Lickorish: I would call it a social science activity.

Jessica Bland: There are parts of the methods or tools used for horizon scanning. If we want to talk about scientific activity, we should talk about foresight more generally. No doubt the use of modelling—whether that is geographic or political system modelling that scientists have expertise in—is part of that toolkit. In some senses, science has a role here, but to say there is a science of the future almost does not make sense because the future is essentially unknown.

Graham Stringer: That was really the point of my question.

Fiona Lickorish: I would agree with that. We use other elements of science and we try to pull those different elements of science using the STEEPLE or PESTLE analysis into thinking about the future in an holistic sense. It is about looking at whole systems rather than looking at individual elements of those systems. We are trying to look at whole systems and the interaction of different elements of those systems, and how they play out against one another.

Q95 Graham Stringer: Should scientific expertise be used in all horizon scanning, or are there particular areas where scientific expertise is of no use whatsoever? If there are those areas, can you tell us what they are?

Fiona Lickorish: If there are, I haven’t ever done them.

Q96 Graham Stringer: So science is useful in all of them. Do you think the Government Office for Science has a big enough role in the Government’s horizon scanning? We have slightly touched on that already, but do you think it should be more involved in horizon scanning?

Fiona Lickorish: Science itself?

Graham Stringer: The Government Office for Science.

Fiona Lickorish: Obviously, the horizon scanning unit and Foresight are located in the Government Office for Science. I do not know from personal experience how much they interact with the rest of the Government Office for Science.

Q97 Graham Stringer: You talked previously about using more quantitative methods. The Government Office for Science horizon scanning centre only uses two of the 26 quantitative methods that have been described in research papers. Does that surprise you? What recommendations would you make? Do you think they should be using more quantitative methods?

Fiona Lickorish: I think the use of quantitative methods should be relevant to the topic being investigated.

Q98 Graham Stringer: That is a circular answer, isn't it? I have a final question. I think we are agreed that it is not a scientific activity. Where have the greatest successes been for horizon scanning and futures analysis?

Jessica Bland: I would want to mention two examples: one in the UK and one not in the UK. One report that used mixed methods, both quantitative and qualitative modelling, was the flooding report a few years ago done by Foresight. That led to a set of scenarios 80 years in the future, which was a very ambitious thing to do. Those scenarios were not to say, "This is what the UK coastline will or will not look like" in that future; it gave a series of options, with the financial costs included of those options. It led to a doubling of the budget for protecting the UK coastline. There you saw a financial decision made by Government off the back of a set of scenarios, but they were well couched in the uncertainty that you must have over that 80-year timeline. There was a good use of method and humility about what that method could achieve. You had a clear policy outcome.

There are other forms of horizon scanning done by Governments outside the UK that are much more about wider citizen engagement processes. Foresight 2030 in Finland, which recently finished, had a series of regional meetings led by senior politicians. In much smaller countries this is sometimes easier to do. Those then led into a Prime Ministerial-led process that created a vision of sustainable Finland for the future. The same happened in Australia back in 2008.

Those processes are quite distinct. They are about building momentum behind a preferred future of what we want our country to look like. That is very different from the horizon scanning that we are talking about here today in the UK context. Maybe there are questions we could ask about why we are not doing that in the UK.

Q99 Graham Stringer: Isn't that just politics? Isn't that choosing to say, "We will invest in renewable energy and not fossil fuel?" Isn't it just a straightforward political decision and then putting posh words on top of it?

Jessica Bland: Possibly, but you are using the future as a more neutral space or a space where we see big challenges over the next 50 years in order to motivate that debate, even if it is not to say this is definitely the future we are going to be in.

Q100 Chair: I want to push a little further. I am not sure that you have explained how you measure success. In fact I am not even convinced that you can measure the success of something that is about the future. You have sort of explained to Graham what you think a successful project looks like, but you will never know, will you?

Fiona Lickorish: In some cases you do not know, but in other cases, such as the scenario I talked about with the Marine Management Organisation, we do know that they have had an influence on taking forward marine policy guidance. One of the things they wanted to think about was all the different things that were happening in marine areas and how they would weigh up the different impacts of the different types of development that were happening in marine areas.

Also, in the marine area some time ago—I cannot remember the exact date—DEFRA did some work with CEFAS looking at alternative futures for marine environment. We do know that that report was used in the EU thinking about the development of the Common Fisheries Policy. We do know that it is having influence on policy development. Perhaps what you are attempting to get at is where it has had an actual influence that has prevented an extreme event. Is that the kind of thing you are thinking about, rather than the impact on policy development? Sorry; I am now asking you a question. I am just trying to get clarification.

Q101 Chair: I am trying to understand how you measure the success of your input.

Fiona Lickorish: We measure it by asking the people we are doing the work for if it is useful to them. “Is it helping you in your decision making?”

Q102 Chair: Okay; so it is about aiding decision making and not necessarily planning the future.

Fiona Lickorish: It is aiding them to make the decisions about how they might act and react in the future.

Q103 Chair: Ms Bland, I am not entirely sure from your earlier response whether or not you think GO-Science use quantitative techniques.

Jessica Bland: I have not worked directly with them on quantitative techniques. I know that the Foresight unit within GO-Science have used modelling techniques—whether that is GDP modelling 50 years into the future for “The Future of Manufacturing” report or coastal mapping for the flooding report—but those are particular kinds of long-term models. There are other kinds of quantitative techniques for horizon scanning per se rather than this larger scenario development, where there are cutting-edge techniques that other countries, particularly the US, are looking at using the wide amount of data available from

the web as part of their scanning process. I am not sure but I do not think the UK uses those. Maybe that is somewhere to experiment in the future.

Q104 Pamela Nash: I want to move on to the Day review. Could each of you comment on how successful you think the implementation of the Day review has been? You all look overwhelmed with support.

Marcus Morrell: I have had very limited visibility into how that has been rolled out, so I cannot comment.

Jessica Bland: It feels like it is still at quite an early stage. I have met some of the people who were involved in the expanded Cabinet Secretariat. It seems that that senior level function will be useful. There may be question marks over whether the two-way process that the Day review points towards—so that ideas can come from the bottom up or the breadth of the civil service perhaps as well as from the new advisory group downwards—is really working yet. They have only had a few months.

Q105 Pamela Nash: Do you think this is a good idea? Are you concerned that it is not working or that it should not exist?

Jessica Bland: The central function is a great idea. It had existed to some extent before. The idea that you are bringing it more into central Government as opposed to a group of people with expertise that are sat within another Department does seem to make sense.

Fiona Lickorish: I think what is presented in the Day review on the organisational structure is useful. What I do not know and what is not included yet is what actions are going to be taken to take that forward. I will be interested to see what the actions are going to be before I can really comment on how successful or otherwise I think it has been.

Q106 Pamela Nash: Fiona, in CERF's submission there was an indication of concerns about horizon scanning practitioners also being expected to consider the policy implications of the findings. Could you tell us a bit more about that?

Fiona Lickorish: We are being asked more and more to come up with policy recommendations in the reports that we do. That is both a risk and an opportunity for us. There are opportunities for us to offer recommendations, but unless we are really feeding in and talking to those senior level politicians and civil servants, who understand the whole area of policy making and the issues that are going into that policy-making agenda, it is very difficult for us as outsiders to come up with what I think could be relevant and workable policy options. If we are going to do that—and we would be happy to help with that—we would need to feed into those senior level decision makers. At the moment, that is not as much of an option as possibly it would need to be for external people to offer those policy options. I know it is one of the things that has been mooted around the outsourcing of policy, but there really would need to be a change in the way that futures research practitioners interact with Government Departments and the level at which they interact to make that useful.

Q107 Pamela Nash: To be clear, you have already said that you are getting asked to make policy recommendations.

Fiona Lickorish: We are often being asked to identify the implications for policy on some of the futures pieces of work that we do.

Q108 Pamela Nash: Are there any other concerns about the recommendations or anything else that you think should have been in there? Are there any improvements to be made?

Jessica Bland: This is a small thing, but there might be a sense of missed opportunity in terms of experimenting with new forms of horizon scanning. We live in a world where more and more data in the most general sense is available. Government could play a role in experimenting and evaluating those kinds of new forms of horizon scanning. If you are going to have a central unit doing that kind of work, maybe that is the place to house that kind of experiment.

Marcus Morrell: I would like to know how the evidence base in the analysis and appraisal of underlying trends is being shared across different Departments and whether that will be done in isolation, or whether all Departments will have access to a central database of trends that they can then build on and use to understand the implications from their point of view.

Q109 Pamela Nash: You touched on this at the start, Jessica, but do you think it is right that the Cabinet Office has overall responsibility for this or should oversight be with GO-Science, or indeed anywhere else?

Fiona Lickorish: I think it should be with the Cabinet Office. I worked with the strategic horizons unit when it was in the Cabinet Office, and it appeared to have—this is no fault of the horizon scanning unit, Foresight—a lot more purchase across Government than what was currently available in GO-Science.

Jessica Bland: I am very pro the idea of a central function, especially in terms of expertise and growing expertise, but because I have not worked with a different system in the past I think it is too early to know.

Q110 Chair: Leading on from those questions of where it belongs and some of your earlier responses, it raises the concern in my mind that maybe you are telling us that there is not a proper sharing mechanism across Government for all Departments to benefit from the work that you are commissioned to do. Is that a fair comment?

Marcus Morrell: That is a concern of mine but I do not have much visibility into how that information is currently being shared.

Q111 Chair: You said for example, Mr Morrell, that there should perhaps be a database that all Departments could access so that when they are planning their work they can presumably refer to it. That seems to reflect a concern that maybe your work is ending up in a silo.

Marcus Morrell: That is a concern, but I cannot comment on to what degree that information is shared because I do not have that visibility.

Q112 Chair: Ms Lickorish, you have been on both sides of the fence and you have seen how the silo mechanisms operate. Do you think there is a better sharing mechanism now than perhaps when you started your career?

Fiona Lickorish: There is a better sharing mechanism now. Things like the SigmaScan were available to everybody. The sharing perhaps is not the difficulty. It is getting people to know where the stuff is that is being shared. That is possibly a role for Departments. All of our outputs, the horizon scanning and all the reports we do are on an open website. We do not have any confidentiality around the work we do. Everything is available for the public or anyone to look at. It is a searchable website, so anyone can see it.

I suspect there are only a few people who know about that. If people put “horizon scanning” into an internet search they would find it, but it might be easier if there was a sharing mechanism or at least a sharing protocol where all Departments, when they gathered information, put it into a central space, as Marcus was saying.

Q113 Chair: That equally applies to how decisions are taken about interpreting what the right policy ought to be. It needs to be driven not just by a single Department but holistically across Government. Is that essentially your case for planting it firmly in the Cabinet Office?

Fiona Lickorish: For transparency and also for collective action on policy making and the decisions that are taken in policy making, and possibly the delivery mechanisms that come out of those decisions, as much of that as possible that can be shared can only be useful in facilitating that conversation and those actions.

Chair: Thank you very much to all three of you for coming this morning. It has been very helpful.

Examination of Witnesses

Witnesses: **Professor Burkhard Schafer**, Professor of Computational Legal Theory, Edinburgh School of Law, **Professor Paul Newman**, Mobile Robotics Group, University of Oxford, **Dr Nick Reed**, Intelligent Transport Systems UK, and **Dr Graeme Smith**, Business Manager, Connected Services, Control and Electronics, Ricardo UK Ltd, gave evidence.

Q114 Chair: I welcome the second panel this morning and invite you to introduce yourselves.

Professor Schafer: I am Burkhard Schafer. I am currently director of the SCRIPT Centre for IT and IP law at the university of Edinburgh School of Law.

Dr Reed: I am Nick Reed. I am from the Transport Research Laboratory. I am here representing ITS UK—Intelligent Transport Systems UK. My work at the laboratory is focused on driver behaviour and now autonomous vehicles as well.

Dr Smith: My name is Graeme Smith. I am a business manager at Ricardo, which is an international engineering and technology consulting company working primarily in the automotive transport and energy sectors.

Professor Newman: My name is Paul Newman. I am the BP professor of information engineering at the university of Oxford. That gives me an interest in computer vision and machine intelligence. I also head up the Mobile Robotics Group, with a particular interest in autonomous self-driving cars.

Q115 Chair: I want to start off with autonomous vehicles and intelligent transport systems. I cannot remember who it was that said, “We wanted flying cars, instead we got 140 characters,” so perhaps foresight is not as good as it could be. What involvement do your organisations have, or have they had, in the development of autonomous vehicles and intelligent transport systems, first of all?

Professor Schafer: For us, we were able, thanks to a grant from the HRC, to run our own foresight forums, as we called them, which tried to anticipate emerging legal issues. One of the big things we identified generally was autonomous systems. Cars are just one example of autonomous systems. We looked generally at the legal challenges that these are going to present for us.

Dr Reed: In the 1960s TRL had a Citroen DS that would follow a cable that had been dug into the M4 for 16 km. That was designed to support drivers in their lane keeping. It was also thought it could support those with disabilities in their ability to drive a car. That technology was perhaps too soon, ahead of where the requirement for computers and sensors needed to be. We are getting to the point where the technology is ready.

In terms of what we currently do, it is about understanding how drivers engage with vehicles and respond to the level of responsibility between the control a driver has, compared with the control that the vehicle has and how drivers of other vehicles respond to the presence of highly automated vehicles on our roads as it affects the general transport network.

Dr Smith: As an engineer, my experience of autonomous vehicle systems goes back to 1991. I was working with Ford and Jaguar on adaptive cruise control, lane keeping and all these technologies that you are very familiar with today. I saw adaptive cruise control through to production with Jaguar in 1999.

Within Ricardo, we have had some recent experience on a European framework-funded programme on vehicle platooning. That took place with a Volvo car and Volvo truck in Sweden, where we demonstrated autonomous vehicles platooning on test tracks and motorways. Just last week, Ricardo won a DfT tender along with TRL as part of a consortium to look at a feasibility study of heavy goods vehicle platooning on UK motorways.

Professor Newman: We have built an autonomous car. It is called RobotCar. If you do a web search, you can find that. It is a LEAF built by Nissan. We took it from forecourt to autonomy in four months. It applies our robotic science. We are a robots group. We are about machines being able to move in their own environment. The key point about what

we have done is that it requires no infrastructure. Our stated goal is to try and enable autonomy very cheaply. Ideally, in the end, I think the autonomy package on a car should be about 100 bucks. That is what we should be going for. We are striving to produce technology that provides a path to that.

Q116 Chair: Leading on from that, the Nissan that you have developed does not rely on other forms of intelligent transport systems.

Professor Newman: Absolutely not.

Q117 Chair: It is totally self-standing.

Professor Newman: I think it is extremely important that you should not depend on anyone spending any money on the streets and the cities. We have already built them and they are really expensive. You need to be putting something else in and the car should be self-smart. If that infrastructure is there, knock yourself out and use it; great. I do not think we should be saying that intelligent cars require massive investment or co-ordination. I think you should start an arms race between the car companies to hire the best engineers to be the smartest they can. Like we compete on CO₂ per kilometre—or mile now—we should be competing on miles autonomous. That would be part of the advertising just because the cars are independently smart, like all machines will be.

Q118 Chair: Do the other organisations concur with that view?

Dr Reed: To enable a vehicle to drive itself in all situations, then you do need that independence. There are probably additional benefits to which Paul alluded. If you have that co-ordination available, where the system can inform a vehicle of congestion ahead and plot an alternative route, then there are incremental benefits available with that communication.

Dr Smith: I certainly think that is an end goal. There may be other steps on the way there that would require some localised infrastructure. For example, having autonomous vehicles in a controlled environment such as a retirement community might be more feasible in the short term. You might be able to use some localised sensors to accelerate their technology and make things happen there more quickly.

Professor Schafer: From a legal perspective, that vision takes away quite a substantial set of thorny legal problems. Net neutrality is a debate. We have the internet. If on our streets a Google car only drives on Google-maintained infrastructure and a Yahoo car only on Yahoo infrastructure, then obviously for competition law and liability law you get a whole new set of problems. That solution would facilitate things quite tremendously on the legal side.

Q119 Chair: I have probably been driving longer than anybody else in this room.

Jim Dowd: That is because you are so slow, Chair.

Chair: Yes. I also had a track licence at one stage. In my lifetime, cars have changed from being very hard things to drive. Nobody these days learns how to double declutch or even start their car with a handle at the front. The cars nearly drive themselves. In fact, when I first did the test, 95% was about the car and 5% was about awareness. Now it is the reverse of that—it is all about awareness on the road. The cars virtually drive themselves. So what is the real advantage of moving from cars as they are now to a genuinely autonomous vehicle?

Professor Newman: The obvious thing is that you are probably not very good at driving. Forgive me for saying that.

Chair: I will tell this to the Institute of Advanced Motoring and see what they say.

Professor Newman: I am going to take a bet. Let me generalise “you” to “people”, just to try and desensitise that. We do maim; we do kill; we do waste time; we do pollute; and we do consume—

Jim Dowd: Is this your mission statement?

Professor Newman: I am not part of that. We do do these things. The car has evolved from a bloke on a horse slowly and then to a wagon. If we were to start now and say, “Right, we are going to take large amounts of land, flatten it, put tarmac on it, paint lines on it, put a lot of laws about it, and now we have got to think what the vehicle is that would work on it,” it would not be a car. There is a lot of stuff that has evolved and we have ended up in local minima that we might want to rethink.

The big difference for me is that, yes, you can imagine it would be safer. If it’s not safe, we wouldn’t be using them. So we can probably take that as a given. It is a driver.

Another one is time. We are very pushed for time and that is not going to get any better. I sit in traffic jams and I wonder what I am doing with my life at those points. Why am I wasting my life sitting in a traffic jam? You are in control of the car. You have to pay attention. Why can’t the car say to you, “For these 500 metres I’ve got it covered, and your insurance just reduced by 9p because I bid for you and you can do something”? Why must we say for all time that, when in that box, you can do nothing else but drive? That does not seem like a very sensible use of time. Computers are going to change it. Computers have changed so much for society, and yet not at all for transport and cars. That is going to come. That is safety.

There is mobility. We say all kinds of things. We say, “Yes, you can drive a car so long as you are a super person and you’ve got all your faculties; you have not had epilepsy; you haven’t just had major surgery; and you are not getting very old.” All the places where we say, “I am sorry, we need to look after you,” we say, “Actually, your world is going to shrink because to get in a car you have to have all these faculties.” Yet when I am old that is when I want to keep going out.

There are lots of arguments why we should do it. There is cost and pollution. A large amount of pollution is because of inappropriate accelerations on the road. Cars can do a better job. We kill, we maim and we waste time. We have shrinking worlds just when it needs to go the other way. I think technology in cars can help.

Dr Smith: You mentioned autonomous vehicles. It is probably important to realise that different people have different understandings of what you mean by autonomous vehicles. For some people it is the complete driverless car that does not have an occupant, but there are different levels and different ways of getting there. For example, just at the moment a lot of manufacturers are introducing autonomous emergency braking systems. These are braking systems on today's cars. They are already in production. They deploy at the very last second or microseconds to prevent or mitigate an accident. The idea is to try and improve safety and reduce collision force. So there are already different levels of autonomous systems on our vehicles today. To answer your question, the return you get from it depends on what level of autonomy you have.

Certainly, in the first instances, we will see improvements in road safety. Volvo had a vision that by 2020 they would have zero accidents or zero fatalities with their vehicles. They are already putting technology behind that and implementing emergency braking in all of their vehicles. We will see through autonomous vehicles that there are lots of opportunities to reduce congestion and CO₂. Through the heavy goods vehicle platooning-type work that is going on in various places, we will be able to reduce transportation haulage costs. We will see a back-to-back reduction in CO₂ emissions and on cost as well. There are some short-term benefits from all of this.

In the longer term I very much subscribe to Paul's views. There is an opportunity here to change society, the way we get from A to B and the way we think about getting from A to B.

Dr Reed: I would add to that. There is a pressure on space. If we can move more vehicles with the same amount of infrastructure we already have available, there is a big benefit. From a personal perspective, I have been doing research for a number of years on driver distraction. I can prove how impairing it is to use your phone when driving, yet we still see it going on all the time. I do not think there has been a marked decrease as a result of that research in the number of people using their phones when driving. Why not allow people to use their phones and let the car take control for that period of time? Everybody would benefit.

My final point is that the UK has done very well in terms of the level of fatalities on the roads. There are still too many obviously, but we lead the world in having the lowest number of fatalities on the road. There are diminishing benefits in increasing the strength of vehicles to improve their crash integrity. If we can work to reduce the risk of those collisions happening in the first place, that is where we will get the next big improvement in crash reduction.

Professor Schafer: I have to declare an interest here, I suppose. I do not have a driver's licence. I failed all driving tests abysmally, and eventually my instructor pleaded with me, "Please give it up because otherwise I will give up being a driving instructor and I have a family to sustain." I am exactly the sort of person that you do not want on your road in a traditional car, but, if these autonomous cars come along, there might be a chance for me—and not just for me, but also for people with all sorts of disabilities or with an access problem and for the elderly with reduced reaction times. One important benefit for me would be to widen the range of people who will be mobile again or for the first time.

Secondly, there will be environmental benefits and the possibility that more than one person uses the car, because it can automatically drive itself home or is available for other purposes. There would also be a great opportunity, as has already been said, for the reduction of accidents and fatalities.

Chair: We can move on to David Tredinnick. You have convinced me that getting old is the big disadvantage.

Q120 David Tredinnick: To continue the digression for a moment, Professor Newman was talking about time. My recollection is that the famous jazz musician Dizzy Gillespie said that the most valuable thing any person can give anyone else is their time. That is something to think about there.

What role has Foresight's 2006 report on "Intelligent Infrastructure" played in preparing the UK for the introduction of autonomous road vehicles and intelligent transport systems?

Professor Newman: Honestly? I had not read it before you asked me to come here. We were just progressing because we knew this was a thing that was going to come. Of course my model is that you do not need to prepare much at all; it is going to happen.

Q121 David Tredinnick: The second question I have is, has the report had little lasting impact? As you have not read it at all, it has clearly had no impact.

Professor Newman: But that is not to say that the Government have not been staggeringly helpful. I have to say that the DFT have. If this report, that I did not read and did not know about, helped the DFT to have a good attitude when I phoned them up and said, "Listen, I would like to do some research with self-driving cars on our roads," and they responded by saying, "Let's talk," and it primed them for that, then it has been a big success. I am not privy to it if that is what happened.

Q122 David Tredinnick: Have any of your colleagues on the panel had any cognisance of this report?

Dr Reed: The sense from ITS UK was that, as you said, the report was welcomed at the time and was read with interest but that it did not have the lasting impact they would have liked to have seen.

Q123 David Tredinnick: Setting that report aside, what role have the Government played in identifying and taking steps to resolve the policy issues posed by autonomous road vehicles and ITS?

Dr Reed: I would think the fact that Mobile Robotics Group have been able to progress their research on the roads and the fact that DFT have commissioned Ricardo and TRL to look into road trains as a form of automated vehicles suggests that there is an openness to see this technology develop in the UK and for the UK to take a leadership position in it.

Professor Newman: I can speak a little bit about my experience of working with the DFT. We have engaged in a pilot with them, such that DFT are interested in understanding what opportunities self-driving vehicles, smart vehicles and cars that can drive some of the people some of the time in some of the places—and that is a really important phrase to remember—might mean. It is not that I could just tell them on the phone. We are engaged with them and they can come and visit. We can tell them the technology we are using, why it is different from other people's technology, where it is similar to other technology and what that trajectory is. It is very much a partnership; it is not that they have set us free. We are trying to keep them very much involved in what is going on. Let's be clear—we are all about curating the UK IP here and having the DFT help do that is very important. It is about curating UK IP. It does not have to happen just in California.

Professor Schafer: I read the report before I was invited to and I have read most of the other Foresight reports as a consumer. They tell me about things that might happen and they generate interesting research questions for me, which per se then force me to think about what it means for the legal system. I did not find in the reports typically a great focus on the legal analysis as part of them, so for me it is not so much finding out things that are already happening in my area, but they do generate new and interesting questions from the research.

Dr Smith: First of all, Ricardo contributed to the 2006 report, and we were also peripherally involved in the Automotive Council's Intelligent Mobility report just released. My experience of them is that they are really frameworks to hang discussions around normally. Most of our work is with commercial clients; they are good to build frameworks around. We do have a series of our own technology roll-outs within Ricardo that we prefer to use, which are very much more focused on specific technologies and deployment.

I would say that the Foresight report was a good start. There seems to have been not a lot of progress made in the meantime in terms of some of the policy issues. There are quite a few policy issues around autonomous vehicles that need to be addressed. For example, we have already talked about different levels of autonomy. Different countries have established frameworks that they can talk about. NHTSA has a framework. The German organisation BAST has a framework about different levels of autonomy. We are still struggling to make sure we are talking about the same level of autonomy and the same subject. There were things that were flagged in that report that do not seem to have been particularly followed up on.

Q124 David Tredinnick: One more question, if I may. What do you hope the new Transport Systems Catapult will achieve?

Professor Newman: My understanding is that that has been instrumental in setting up the Milton Keynes autonomous pods project. We are very much involved in that. The technology that we have running on our autonomous car will also be running on those pods. That is absolutely fantastic because that is a different domain. We are all about applying the same tech in different domains. That is a great place to trial. There is some funding there, which solves one of the big problems we have as a university—and we will talk about that in a moment maybe—of doing something, being a repository for know-how and taking this from TRL3, which is where you might expect a research group to end, and

helping us get that through to technology readiness level 6 or 7, such that it becomes credible for very large organisations to start working with us, licensing and taking it forward into the domains that they know. In that sense already, we win.

Dr Smith: I hope it will help stimulate not just the technology but also the other enablers that we need to make autonomous vehicles a reality: for example, understanding some of the policy and infrastructure questions, if there are some; understanding what the medium-term road map is that enables us to get to fully autonomous vehicles.

Dr Reed: Progressing the legal issues but also engaging with industry, so bringing in the OEMs—the vehicle manufacturers who will need to support this and will need to contribute to the system that develops.

Q125 Stephen Metcalfe: Professor Newman, I love your vision. I have signed up and I want to buy one. Tell me where I can get it. But I am a little concerned that when I tip up at my insurance broker they are going to say, “Ah, we have a whole load of problems here.” Is the legal and accident liability insurance framework going to delay the commercialisation of this technology when it does become ready? How responsive are the Government to addressing that?

Professor Schafer: If you look at the international debate, which is slightly further ahead than in the UK, then we do, indeed, find two almost contradictory fears. One comes primarily from the US. They fear that the new technology will initially create a huge amount of litigation because people will try the limits. Something is going to go wrong all the time; it is just in the nature of things. Some people might try to get money out of this through litigation. There is a fear that litigation might kill the industry in its infancy and that, therefore, adjustments are needed.

We find very different concerns primarily in continental Europe, where people fear there might suddenly be liability gaps occurring where victims cannot get redress because the software people say, “Well, it was none the less the driver. He did something wrong by interfering in ways he shouldn’t have,” and the driver says, “No. I trusted my vehicle and it was not me who did it.” There is a fear that gaps will be created in the liability protection.

Both of these models are possible. How plausible they are is very difficult to anticipate. An incremental approach is not the worst thing. My fear would be rather that the uncertainty delays investment. There are real issues with it that need massive changes in the law, but the mere perception that they might be needed might delay investment.

Q126 Chair: I want to push you a little further on that. Some of the technologies that exist today could give rise to complications about liability. Take, for example, an automatic tyre sensor. Was the under-inflation of the tyre the fault of the software or the car designer—or should the car driver have ignored the fact that he has this convenience tool and have tested the tyre himself? Has there been any litigation on issues like that?

Professor Schafer: It is very limited. That is the reason why I think some of the worst-case scenarios being presented, calling for a more or less wholesale reform of liability law,

are probably premature given what technology is likely to do. We have lots of experience with very complex manufactured products, where liability was always distributed and a mixture of the insurance industry together with common-sense case law by and large was able to deal with these things in the past. Depending on just how autonomous the technology is going to be obviously affects this issue. Quite a lot of them can be taken care of within the existing framework with relatively small adjustments.

Dr Smith: In Sweden, there are a number of insurance companies now that will now offer lower premiums if you have a Volvo fitted with autonomous emergency braking. There is a lot of evidence to suggest that those vehicles are involved in less fatal collisions and less collisions totally. Legislation aside, the insurance industry is recognising that these vehicles are less risky to insure, if you like.

Q127 Stephen Metcalfe: There is a range of technology being discussed here from useful things such as anti-lock brakes and moving on to totally autonomous vehicles. There has to come a point at which the driver stops being legally in control. There must be a legal definition of when the driver is in control. If the driver is no longer in control, who is, and therefore who is responsible for that vehicle moving along a road?

Dr Smith: There are these different levels of technology that we refer to. Taking ABS as an example, that is a system where, when the driver applies the brake, the ABS system takes it off and puts it back on. You already have a system there taking some level of control from the driver. ABS, traction control and adaptive cruise control are all recognised as having net benefits rather than disbenefits, and so they have been accepted. It is likely that you will need different levels of regulation depending on the level of autonomy. There is a point at which these things could conceivably take complete control from the driver and start to make decisions. One could say they are better decisions, but they are still questionable decisions by some people. There will need to be some regulation that defines and bands it.

Q128 Stephen Metcalfe: From a legal perspective, at what point does the driver cease to be in control of that vehicle?

Professor Schafer: That is a very good question. In the past, you are absolutely right that our whole legal system takes as its starting point that humans make plans, have intentions and mental states. Quite a lot of legal consequences are attached to the way we subjectively plan our behaviour and then act on it. Quite a lot of the vocabulary that the law developed to deal with these things does not quite fit in an environment where these decisions are taken away from us. That has led some people to propose these very far-ranging changes, generally in robotics, right to the point that some people suggest that they should be given legal personality just like companies do as a legal fiction. I find that very premature, to put it very mildly. It seems to me that the language of the law rather than sometimes its content is not a perfect fit. It might be that we should reformulate it rather than necessarily change the content.

That is the right moment for me to lose my English, isn't it? Very often, in the airport, I rely on these conveyor belt things to get me from one place to the other and I simply stand on them. If something goes wrong, it is a classic product liability problem. We do not

suddenly start to think, “Oh, did this machine make a decision that harmed the customer in some way?” We don’t; we just take it as a normal part of our environment. As we get more accustomed to these machines making decisions with us, the novelty disappears and we see behind it very traditional and classic legal problems, which might just need a slightly different way of expressing things.

Professor Newman: I violently agree with you.

Stephen Metcalfe: Violently.

Professor Newman: A big yes. I think it is really important that we think of these things as just tools. They are not thinking machines; they are just tools. Think then also as a blend, from where we are now to where we will get, pointing in the direction of cars in the end—in the end—driving us most of the time in most of the places. It will not start like that. Think about a creep of technology and that is how it will be sold. I do not see any day soon a sudden change where, on Wednesday, there were cars with steering wheels and, on Thursday, you didn’t need the steering wheel. It is going to be very, very gradual. We will bring the insurance companies with us, or they might start pulling us because it will be better. Technology offers options. If the options are good for people, they will buy it, which means more engineers get hired and you will get good salaries for the best engineers. You will get an arms race, you compete and the cars get better.

There is one other aspect of this about insurance. Don’t forget these cars will be seeing and doing some understanding a lot of the time before they are in control themselves. For insurance, there is a complete audit. You know if you ever have a ding with your car there is that picture that you draw at the bottom of your insurance form. There was only one thing that happened. Why are there so many interpretations of it? The cars will say, “This actually is what happened. There isn’t any ambiguity here. Here is the complete recording of everything that happened running up to that accident in all the cars.” In that way it gives insurance companies a very good way to say, “Here is the thing that went wrong; what are we going to do about that then?”

We are also very accomplished as a species in being engineers, building complex things, figuring out how often they go wrong and the number of times they do not go wrong, and getting comfort from that ratio. I do not see what is different about cars that drive themselves some of the time. I do not see what is special about that that transcends all the engineering expertise we have put in—for example, making sure we have confidence about the stickiness of wings on to the sides of fuselages. I cannot prove it but I can test it. I cannot prove that that engine is going to perform for all those hours, but I can test it and I get comfort from its reliability. The same will be true from smart cars. It will come because we blend into that future world. I am talking about the direction in which we are pointing. There is a long distance to go in that way, but on that way we will bring people with us. The computing in these cars will help address some of these questions.

Q129 Stephen Metcalfe: So for the time being, as long as there is someone who is deemed to be legally in control of the car, the legal framework we have got will do.

Professor Newman: That is how we can go on the roads now.

Q130 Stephen Metcalfe: There was talk about changing article 8 of the Vienna Convention, which says that the driver has to be in control at all times. We do not need to worry too much about that at the moment. Let's get on and develop the engineering challenges and take the insurance companies with us. That is kind of the way you think it could work.

Professor Schafer: There is a lot to be said for incremental approaches, especially in a common law system like ours where we can rely on past experience. We have a huge array of problem-solving methods stored there in our history and very often premature legal change interrupts that type of adjustment. I do not think the convention is a major problem, especially not as long as, again incrementally, there is someone in charge. My greatest fear with the convention would be a very indirect one. We have already discussed the international dimension—that different countries are developing their own standards. This could potentially be used by some countries to say, “We will not allow your type of car, and we are allowed to do that even under GATT rules because we think it is in contravention of the convention.” That would be my greatest worry for that international instrument—that it could result in a market fragmentation, where, say, UK cars do not get licensed in other countries because they come with a different interpretation of the convention.

Stephen Metcalfe: So I cannot pick one up next week; never mind.

Professor Newman: But you can sit in one next week.

Q131 Graham Stringer: I was in Detroit 10 years ago and I drove a hydrogen-based car. I went in an autonomous car that could get into traffic jams. Both Ford and General Motors told us that both technologies would be common in 10 years' time, but they are not. How long do you think it will take to overcome these legislative barriers to technical and legal standards?

Professor Newman: I am afraid I can only comment on how long it would take to overcome the technical side of it. There is an existence proof that you can do half a million miles now if you want to spend that kind of money. The Google car has driven hundreds of thousands of miles around California very well. It is expensive at the moment but there is an existence proof that it is possible. The question now is maturing that technology such that it becomes cheaper, very easy to use, embedded and diverse. That is the challenge we have now. At the moment the Google car uses a big 3D spinning laser on the roof. I am sure they are working on doing that with computer vision, absolutely—that is what we are trying to do as well—and making that cheaper. That becomes very hard.

You can engineer the problems away by putting expensive sensors on it—existence proof. You can do good programming—existence proof again that you can do this—and you can interact on the road. Now, the challenge is building these things very cheaply. I think that is going to take quite a long time. It is going to take many, many years, such that you can get autonomy for 100 bucks where you can say, when you are buying a new car, “Yes, I'll have the air conditioner, the Bose speakers and the autonomy package.” It is going to take a while.

This kind of autonomy is going to occur in other vehicles long before that. With freight imports it is already happening. In factories, Amazon bought Kiva, which is similar mobile autonomy kind of stuff. It is nothing like as complicated as cars, but you will see mobile autonomy occurring in many domains of commerce first. It will be bleeding into cars and some of the car tech will go either way. Cars are interesting because they have to be so cheap, whereas there are other domains such as mining where you can have a really expensive machine and you will pay quite a lot of money for the autonomy package because it is going to save you a lot of money when the machine is expensive anyway. You need to think not just about cars but about autonomy and smart in moving stuff. It is not just people on the road, but goods, freight, imports and ships. It is all this kind of stuff. You will start to get some sense for what mobile autonomy means.

The legal framework will appear in many of these things. How do you have ships driving themselves round harbours? Maybe that is something you really want and maybe you are really good at that, but what is the law for that? You are not just going to see it in transport.

Do you see what I didn't answer? I get asked this all the time. To when? To when the car drives itself completely by itself or to when the car drives you some of the time?

Q132 Graham Stringer: To a point when Stephen can go and buy his car that is going to drive itself and the extra gizmo is only going to cost £100 even maybe—not dollars.

Professor Newman: You could buy a Ford Focus tomorrow that will park itself in a parking space. That has not answered your question. How long before it could go round a multi-storey car park? Three or four years maybe. I am trying to answer your question by saying there is not a time to which I can point and say, "There, you have got yourself a driving car." It is always going to be the car saying, "I can't drive this bit."

Q133 Graham Stringer: I can see the incremental approach, and often technology develops better when it is incremental rather than when it is a huge leap forward. I just want to get an idea. Ford and GM told us it would be 10 years, 10 years ago: they were wrong. Is it the next 10 years or the next 25 years before Stephen can buy that car?

Professor Newman: Some car manufacturers are coming out and saying there will be autonomy in 2020. That is what we are hearing now. I think there will be some autonomy in 2020, but it will not be driving you all the time in all the places. Yes, I would be surprised in 2020 if we are not seeing a direct line from the Ford Focus thing there.

Do I think in 2020 that the average person will be able to press a button in their car and say, "Drive me to work," and it will do the whole thing? No, I really don't, not by 2020. Do I think it will be driving me some of the time by 2020, such that it is a substantive thing and I will say, "I am pleased I bought that car that did that," yes, I can imagine that in some high-end models? The Mercedes S-Class at the moment is starting to look pretty slick in that sense. It is a very high-end car but it is getting better.

Q134 Graham Stringer: Are the legislative changes that need to take place going to slow it down even more? What changes need to be made—we have partly covered that—and how long will it take?

Professor Schafer: There are a couple of minor technical adjustments. Very often that is updating the language of the law to achieve the same results in the new environment. It is a sort of technology-neutral approach, which is not very exciting intellectually for us academics, but it simply needs going through quite a lot of technical legislation, seeing if the words fit and helping with that.

As I said, the liability part of it will have to be experienced incrementally, as uncomfortable as that sometimes is. There will be problems. I am not totally buying into quite the optimistic version we have had. I think there will be new forms of accidents. Then the problem will be that in the old car that would not have happened. We will have fewer accidents statistically speaking, which is great, but you are the individual victim here because we did something new and something different. That will obviously be a political question, a policy question and also a legal question where the law has to keep up with things.

I do not think that at this point in time it would be helpful to start major legislative reform. It would probably cause more uncertainty than certainty; it would deter investment rather than enable it. The examples of successful technology legislation, I am sorry to say, are few and far between anyway. I do not think that at this point there is a need to facilitate things through massive intervention. It is probably going to be slightly more on the technical aspects.

However, one thing where long-term thoughts have to be developed right now relates to something that Professor Newman gave us as a positive side, which was that our car can tell on us when we have an accident. “It was him who did it by taking over the wheel.” These cars will produce and store quite a lot of information about us.

Chair: We are going to cover that in a moment.

Professor Schafer: That would be one of the areas where I feel probably the need for reform is the most pressing and potentially the greatest.

Q135 Graham Stringer: What I keep trying to get at is the schedule—the timetable. When will this happen by?

Dr Smith: Some of it will be required earlier. Again, we seem to be talking about this final vision of what this final autonomous vehicle will be like. If we take something that is going to be much closer to term such as heavy goods vehicle platooning, the technology of that has already been demonstrated. We have already shown it on a test track with a mix of cars and trucks in a platoon. The difference between a platoon and a completely autonomous vehicle is that you will typically have a lead vehicle that has a professional, trained driver and then a series of following vehicles that are autonomous and effectively follow in the footsteps of the lead vehicle.

If you think about platooning for heavy goods vehicles, there is an economic business case for that. You can get fuel efficiencies of about 20% for the vehicles in the platoon. If you are spending £100,000 a year on fuel, being able to save 20% is a big return.

An area of regulation that could be addressed would be drivers' hours. At the moment drivers are regulated through tachograph law to drive a certain amount of time. When a driver is in a platoon and is not touching the controls, and there is a lead driver of that platoon, does that count as his working day? Is it time off or a rest period? Is there a way to re-evaluate the tachograph laws so that we can effectively extend the working day of that vehicle? I think there are some regulations that we will be pushing up against, and 2018 or 2019 might be the time frame by which we would start to see some level of platooning on roads. There would need to be some regulation and consideration around that. Technically, it is feasible today.

Q136 Stephen Mosley: I was interested in the area of data protection and privacy. Before I move on to that, I want to ask something about security. We can all imagine a nightmare vision, basically, where malware gets into one of the heavy goods vehicles to stop the brakes if the vehicle goes over 60 mph. You have been talking about aircraft and ships. What are the risks associated with security in terms of malware, hacking and cyber-security? Has there been any consideration of that?

Dr Smith: Yes, there has been quite a bit. There has been quite a bit of scaremongering about it as well and people philosophising about what might happen. If you look at today's vehicles, a lot of them have electric steering and electronic management systems. They have electronic commands to the braking system. Technically, you could hack in to any vehicle today. So the vehicle of the future is really no different from the vehicle of today. I do not see that there is any increased risk. As security improves, I am sure the systems in the vehicle will improve as well. If you are talking about the level of encryption you would have, I would say, "Do you trust your bank account?" That is the level of encryption that you would expect to see on these types of channels.

Q137 Stephen Mosley: But, with respect, if someone hacks into your bank account you lose money. If someone stops your brakes working at 80 mph, you—and quite a number of other people—could be dead.

Dr Smith: True. That depends on what level of connectivity you have to the vehicle and how you architect that. Part of the answer is what are the principles of secure design; how do you look at how you architect the vehicle; can you communicate to the vehicle from the outside world? Paul's work is on completely autonomous vehicles that are not necessarily connected, so there is not a channel to hack the car in that situation.

Professor Newman: Do you worry about traffic lights being hacked into?

Q138 Stephen Mosley: I guess not, but when I approach a junction I keep an eye open as to what is happening on the road. If I am approaching a green light and there are people going across it in the other direction, then I slow down and think, "What is going on here? Perhaps the traffic lights aren't working." If it is a totally autonomous vehicle, I am snoozing in the

back seat and the automated vehicle sees a green light and goes straight through it, then it is a different matter, isn't it?

Professor Newman: I think that is right. This is not a concern specific to smart cars. We are going to see this in many endeavours within our society. The great thing about transport is that it will be able to leverage many of the other accomplishments in other areas. I do not think we specifically need to worry about it here. There is a general issue about devices working on our behalf which have software that runs them. That is a generic thing we should be talking about. It is not specifically about cars.

How might I engineer that problem away? You can have two independent systems. You can have a degree of introspection in these cars so that, if it does not look right, it is how we run it. If the whole time the machine is in a persistent state of self-doubt and 100 times a second it thinks that everything has gone wrong and everything has to assuage it of those doubts, you would have to be an extremely accomplished person to completely re-engineer that whole system. That possibility is there and you need to deal with it, as we need to do it in elevators.

Q139 Chair: I must say that the first time I ever drove a drive-by-wire car I found it very disconcerting and yet I have just flown to the venue by a plane that flew by wire. It is an interesting bit of psychology.

Professor Newman: Trust is an important part here. How you get people's trust in these products is going to be interesting. It is not necessarily an engineering issue.

Professor Schafer: I agree. As I mentioned before, sometimes the law has to respond to perceptions of risk rather than real risk. Law can play a role in creating trust by telling you that you are going to be covered for whatever might go wrong, either by getting damages if you suffer harm or by not being held liable if something goes wrong. There is potentially a role for law in helping to create that degree of trust.

We obviously have to worry about malicious attacks. Being a lawyer makes you very cynical about the world. There will be new forms of crime; I am pretty certain of that; there always will be. To a certain extent, again, it will depend on how this works out in practice. At the moment if you have a car, there is already quite a lot of intelligence in it, but it is nothing that you as a normal driver play around with. You do not reprogram your brake system as a normal driver. I can easily imagine a future where people are able to download lots of interesting gadgets from their provider. The car honks every morning for the driver of the car, just like one of those irritating ringtones; that might be an additional feature I can download. As soon as we give the user, the customer, that amount of freedom to add on small pieces of software developed by third parties to customise that experience, the possibility of malicious attacks that exploit that channel are also going to increase. That is definitely one of the things to keep an eye on.

Q140 Stephen Mosley: I want to turn to something slightly different, which is the area you touched on about privacy. Yes, the car might report if you have an accident, but it might also report if you are going to visit your mistress in another town or something like that. Has any consideration been given to privacy concerns?

Professor Schafer: Or it might check your expenses claim against the amount of driving that your car did. It is a real concern because the car is so central in so many people's lives. The amount of time we spend in our cars and the importance of them in organising our social life is very crucial information about us. It tracks where we are, what we are doing and potentially with whom we are as well. That is a potential issue for me. I do not think it has been analysed in any specifically systematic way.

It might be too short-sighted to look specifically at the car. This is simply one of these features of intelligent autonomous environments that apply to autonomous cars just as much as it does to autonomous care robots that look after our health, for instance, or intelligent houses that take some of our functions from us. They will collect quite significant amounts of information that allows very personal inferences about us and our behaviour. It therefore needs to be addressed.

Q141 Stephen Mosley: From a legislative point of view, data protection laws are different even across the EU. By their very nature, cars move and go over borders. How would you cope with a situation where, for instance, a car from Germany, which has completely different data protection laws from here, travels across national borders?

Professor Schafer: Indeed. That is one of the problems that go beyond, as you rightly say, the competence of any national Government, which needs international co-ordination. In Europe, we are supposed to be governed by the Data Protection Directive. There is an assumption that our data protection laws are different but equivalent in their outcomes. I doubt very much that that is the case. You can easily imagine one country insisting that their manufacturers observe data minimisation at the point of engineering so that the data is not collected in the first place, whereas other countries might say, "No, we are quite happy that you collect that data if it improves the performance of the car. You are just supposed to encrypt it very carefully."

As soon as you get these different approaches, which both try to interpret the same legislative framework, you can easily see problems if these cars then move or are sold across borders. That needs to be addressed on a supranational level.

Q142 Stephen Mosley: I have a question following on from that. In terms of accident investigation and so on, the police or the authorities are going to have to have access to this data. If it is all encrypted, they would have no access. How would that work? Sometimes these accidents might be caused by manufacturer error—a coding problem or software errors, which might be the manufacturer's fault. It would not really be appropriate for the police to have to go to the manufacturer and say, "Can you tell us why this car"—

Professor Newman: Would it be the police who did that? My understanding is that a case would be brought and then legal rights would be sought to get access to that data. That is how it would work. The police would not be doing this. Here is a thing; it went wrong; someone may have misbehaved and it gets tried. During the court proceedings data then gets released. It can be confidential.

Q143 Stephen Mosley: The police would have to do an investigation and they would need access to the data in order to do that before they decide to—

Professor Newman: Why would that need to be any different? There has still been an accident. What is different? It is just that one of the cars was autonomous. Someone is at fault so something has gone wrong. You could have an accident with two people, and one says, “It was his fault,” and the other says, “No, it was his fault.”

Q144 Chair: You are presenting a case, in the extreme example of a death, that there ought automatically to be a charge of death by driving and then have that tried.

Professor Newman: Oh, I see; you would not know whether you would need to say it was a fault case. That is right.

Q145 Chair: It is an interesting argument that some of the road safety organisations will enter into with today’s technology.

Professor Schafer: Obviously, it need not be in the context of a criminal trial. It could simply be me suing the driver or the manufacturer of the car that just injured me. We already know that at present e-discovery and getting necessary data for trial is increasing the costs of litigation quite tremendously. It would be another concern that relatively straightforward accident litigation becomes rather expensive because elaborate methods have to be taken to secure or get access to that data and then to analyse it. Potentially at least, there is a huge amount of data created, and to find the legally relevant part requires different types of skills. There could be increased costs for litigation, which is ultimately undesirable.

Stephen Mosley: Every answer seems to generate about five more questions.

Q146 Sarah Newton: We have discovered a lot of barriers this morning to overcome. I would like to end up with the weakest link, if you like, which is us humans. The AA recently found that only 38% of its members believe that science and technology would enable these driverless cars to be as safe as when they are driving a car. Is that typical of public attitude studies of which you are aware?

Dr Reed: That particular survey is of a particular group; it is of AA members. The questions will have been phrased in a certain way that might not have presented what it means to be driven in a way that was even-handed. There was a question, “I enjoy driving too much to ever want a self-driving car.” The members were asked to agree with that statement. The answer was that the majority agreed with that statement. I think you would get a very different answer if you phrased that question a different way to say, “Would you like a car that for some of the time, and for the parts of driving you do not enjoy, drives itself?” It is useful to do those kinds of surveys to understand public opinion towards these things, but it has to be tempered because it is not always easy to convey the reality of what the technology might provide in a survey that probably lasted five minutes.

Q147 Sarah Newton: I agree with you because you are looking at hypothetical situations that very few people would have experienced. Where we have had vehicles that have an autonomous element to them, and understanding that there are different sorts of technologies, what has been the feedback of the people who have been asked to drive them—other than the engineers who have created them, who are obviously going to be very enthusiastic about their creations?

Dr Smith: When I was involved with Jaguar in the late 1990s and we launched adaptive cruise control, the feeling was very much that the driving pleasure of the day was such that people would not want that sort of technology. That was very much the attitude of people. As we went into some focus groups, particularly among some of the older Jaguar drivers, they were adamantly against the technology but they drove it. Once they had driven the technology of adaptive cruise control, they realised that in certain traffic situations it helped them but it did not take control away from them. I saw their attitudes completely flip. It was just a case of becoming familiar with what the technology would do. More than just reading it, it is getting behind the wheel and driving it. They found out how it could improve their driving experience rather than detracting from it. I found there was a switch point in education that changed the attitude of many people towards assistance.

Q148 Sarah Newton: Does anyone else have other evidence of more properly constructed surveys, as far as you can, that do not lead people to answer questions, or any other research where humans—regular people, not engineers—have driven vehicles and their experience, other than what we have heard this morning?

Professor Schafer: Not specific to cars, but there are general studies on risk perception. One of the themes that come out is that people will always have a higher perception of risk if they feel they are not in control. That does not necessarily match the factual situation or the statistics. It is just the feeling that they have to trust someone else, which immediately increases their perception of risk.

I remember a colleague of mine who became a chain smoker during BSE. She was very worried about someone feeding her something over which she had no control, but as long as she created the much more massive risk for herself she was fine with that. That was always very iconic for me. I know that most of the studies bear that out. As soon as we feel that we are not in control, we exaggerate the risk. That will definitely be a psychological problem. Again, the law might play a very limited role in alleviating that perception. It will also partly be a human interface issue. How can we recreate a feeling of being in control even though the car is doing quite a lot of the stuff itself?

Q149 Sarah Newton: Given that these vehicles are not going to develop unless there is a market for them, and if humans do not really want this and do not perceive the benefits that clearly you do, we are not going to get very far with this technology. It will be a very niche product without a degree of public support and public buying. Who is responsible for communicating the benefits as have been communicated today and overcoming the barriers so that a market can be created?

Dr Smith: It is the beneficiaries. If we wanted to increase the utilisation of road space in the UK by employing this technology, having people travel more closely together more

safely, perhaps that is a Government responsibility. If you would like to promote the sales and usage of cars, then I guess it would be the car company. If you would like to have trucks that could platoon and save you lots of fuel in your haulage company, then you would promote it from that perspective. There are many different areas of society that would benefit from this and they will undoubtedly promote different elements for their own purposes.

Q150 Sarah Newton: I agree. There is a whole range of stakeholders who could have a real interest in increasing public awareness. What more could the Government be doing to enable that sort of dialogue across the stakeholders in our society who could potentially benefit from this technology?

Professor Schafer: From my perspective, I think back to the very early days of the car. I think we used to have someone with a red flag running in front of it and warning people of this dangerous machine approaching. Today that might look ridiculous to us, given how slow these cars were by and large, but it definitely helped to create public acceptance of this machine. People felt that someone had thought about it and was doing something about it. It might not have been the most efficient way of doing something but it had a very high visibility; it had a very high symbolic value. There is a role for the Government, and Foresight is an aspect of that in order to demonstrate, “Yes, we have thought about this and we are not driven into developments over which we do not have control. Where we feel there is a need to reassure the public, if need be through legislation, then these steps have been taken.”

Dr Reed: I would say that, in addition to supporting any legal questions, it is the research case to prove the benefits and then communicating the outcomes of that research.

Dr Smith: I would say that some stakeholder consultation and public discussion is required. As part of the DFT work that Ricardo and TRL are doing for the heavy goods vehicle platooning, there is a stakeholder consultation phase. We will sit with a lot of stakeholders—for example, the police, roadside assistance companies, insurance companies and the DFT—and we will take their input on their concerns and the challenges they see for the technology and any legal and liability issues. We will put together a framework of how we will research those.

Gathering input around concerns and challenges is the very first stage, and coming back and reassuring people that all their concerns have been taken into account in the final design and implementation of the system is the next phase. I see it as part of a continual discussion, but, without gathering input from all the right stakeholders in the first place, we won’t get to the point of talking about the benefits because we will always be talking about what the challenges and barriers are.

Professor Newman: My point is simple and it is a cautionary note. The best thing you can do is to help expectation management. Everyone thinks that this is coming next year because there is so much hype about it. The truth is that it is coming, but it is not coming next year. I worry about a real fizz of excitement about driverless cars because they are possible, but they are not coming yet. It is a bit of a technological let-down, but it is coming. We need to think about how we sustain our involvement and excitement about this over the years—this relates to your question—that progresses us to better cars. If we

keep that going in the UK but do not get involved in the first few years and say, “Wow, that was great,” and then sit back, someone else will come past us and say, “Okay, now we have really landed it; thank you very much”—and it is not here. Could we please make it happen here this time?

Q151 Jim Dowd: I would say to Professor Schafer that, according to the most authoritative source of information on planet Earth, namely, the programme QI on television, the red flag was a myth. It was never required in front of cars.

Professor Schafer: I would never dare to challenge the authority of QI, and I stand corrected.

Q152 Jim Dowd: I want to discuss infrastructure, but before that you reminded me of something, Dr Smith. I have a car that is now 12 years old. I have had it from new. It is a marvellous machine. It has cruise control. I doubt that I have used that twice in all those 12 years. Although the technology can do things, it does not necessarily mean that people want it or use it. I very rarely get out of London, but generally Britain’s roads are far too congested even on motorways for cruise control to be an effective tool. Is that true?

Dr Smith: Cruise control is a great example. In the US it is very widely used because there are lots of open roads. It has a very different infrastructure from that of the UK. There is less traffic and there are big expanses of space. It is certainly very different from Europe. When we were working on adaptive cruise control, certainly the people in Europe did not really understand its benefits or why you might need to even adapt to cruise control. We found that things like adaptive cruise control were significantly better in the UK. I frequently drive up and down the M11 and M1 with adaptive cruise control on all the way. I do not touch the pedals because I do not have to. Whereas cruise control may not have been useful with the UK’s infrastructure, something like adaptive cruise control is inherently useful.

Q153 Jim Dowd: Now I will go on to the main substance of my question, which is about infrastructure. What are the infrastructure needs for autonomous road vehicles? I am talking about the public highway network.

Professor Newman: Well, none. I think that would be a smart thing to try and aim for. I really believe that we should not try to build stuff to support self-driving vehicles, because you will never get it right, the technology will always go faster and you will have built something that is out of date because you cannot judge what it is going to do. I really strongly believe that.

There are some places where you might put infrastructure in, such as ports, but cities are complicated enough. There is enough infrastructure there and we should strive for cars doing it by themselves. This is a subtle point. I am saying that if you wanted to do it you can, but don’t think that you have to do it so you can get the cars. The car companies will just skirt around that if they do not like the way it is done. You would have to agree on how you do it with all countries and you are in all kinds of woe at this point.

There are things like vehicle-to-vehicle, vehicle-to-eye and vehicle-to-infrastructure. There are things for data sharing. I suspect that is probably just going to use the 4G networks. We are building that infrastructure anyway, just like we built the roads. I would strongly say there is an existence proof that you do not need it. There are half a million miles of autonomous driving in California—I think those numbers are right—with nothing special being done. That is what we should strive for.

Q154 Jim Dowd: That rather renders most of my other questions redundant.

Professor Newman: That is my view.

Q155 Jim Dowd: I was going to ask, “How much would it cost?” If the answer is nothing to start with, then even I can work that out.

Professor Newman: The real cost is that you have built the roads and the cars already. You have built the cities and made the laws. That is the real cost. It is a good job because you have already made the investment. We should now be saying, “How do we make the cars smarter by running the right text file on them?” It is a piece of software; it is a text file. We just have to find the right text file.

Q156 Jim Dowd: Governments like things that cost nothing; they are very fond of them. Basically, you are saying that there is no role for Government, central or local. It is all irrelevant for autonomous vehicles.

Professor Newman: I am saying that you do not have to do it. I do not believe it should be a necessity. That is what I am telling you.

Q157 Jim Dowd: But you are also saying that that is the optimum solution. Why would you adopt a sub-optimal one that costs money?

Professor Newman: Because you could get to some of the places earlier if you did want to invest in infrastructure. If you did want to instrument the roads and put smart traffic lights up that radio out what the traffic lights are doing if you are autonomous—“You should go now”—if you did want to spend that money, you will get there quicker and you will have some other benefits. I am saying that there is a spectrum. You have a surface you can move on here, but you just don’t have to.

Q158 Jim Dowd: Who should be making that choice?

Professor Newman: Choice of what—that you do all of this?

Jim Dowd: Whether you have infrastructure.

Professor Newman: I guess you guys get to do the spending—so you.

Q159 Jim Dowd: You mean whoever invests in the infrastructure should make the decision.

Professor Newman: Yes, but it is going to be the Government because they are your roads.

Q160 Jim Dowd: Is there not an interest in those making autonomous cars?

Professor Newman: They are going to try and do it by themselves independently of everyone. They are going to go for the infrastructure.

Q161 Jim Dowd: Is it not a chicken and egg situation, rather like the issue of unleaded petrol? The public did not want to move to unleaded petrol. The biggest boost was, of course, the taxation policy. But, of course, you needed the stations. People were very reluctant to use unleaded originally because they did not know where they were going to get the next tankful from.

Professor Newman: This is a grey area and we could spend hours here. There are some things about cars where you would like to have a better experience in the car such as knowing more about the road, what the traffic is like around the corner and what the road surfaces are like. There are all these kinds of things. We already have communications with vehicles so there are definite things you could do that would make it better.

That is an excellent question. Who should make that decision? I would take a pinch point in two years and see where the car manufacturers have got to, and then again in three years. I would not think about building big infrastructures. You may need to do some instrumentation and then take a view. It is not clear on the “self-drivingness”—the navigation—that you would want anyone to spend anything on infrastructure. You then as a Government would be saying, “This infrastructure will make these cars safe because we have put that infrastructure down there.” That is a decision you should think about.

Dr Smith: It is worth while considering. So far we have talked about self-existing autonomous vehicles as a bubble, if you like. That helps you to some extent, but, if what you wanted to do was reduce congestion on the roads and close up the gaps between the vehicles by having the vehicles start to communicate with each other, you might be in the area where you might consider an express lane for these types of co-operatively working autonomous vehicles. You could have an express lane for vehicles that have the technology that lets them travel safely just a few feet apart. They are all talking to each other so if there is sudden braking two miles down the road everybody starts braking at the same time to reduce accidents. There might well be some level of infrastructure on that perspective.

Equally, if you had that level of autonomy, you might want to think about your road traffic control system. If one motorway is closed, and you know you have a platoon or a convoy of vehicles all following each other and you know where they are all destined for, maybe you can start to intelligently reroute them. That level of infrastructure investment may be worth while. It is certainly worth considering in the context of autonomous vehicles. There are certainly some infrastructure investments that could be considered around just the stand-alone autonomous vehicles and how they co-exist with each other for optimum benefit.

The wider issue is that anything you do there would have to be interoperable with other countries. It could not just be a UK initiative, but they are certainly areas we should be thinking about.

Q162 Jim Dowd: You mentioned the phenomenon of the phantom traffic jam there. Apparently, the wave it causes moves against the flow of traffic at 12 mph.

Dr Smith: That is right.

Jim Dowd: I got that from a recent broadcast of QI, amazingly. Thank you; I've finished.

Graham Stringer: Are you on a commission?

Q163 Chair: It seems to me that you are arguing that some of the technology issues would need to be established by a high degree of collaboration across the industry to avoid the kind of mess we or the Americans were in 15 years ago with mobile telephony. It would be rather inconvenient, especially in Europe, if individual nations ended up with disparate standards. That is probably best done by the industry itself.

There are other issues. I know Professor Newman will agree with me here. In the UK we have some incredibly talented engineers. It would be really great for Britain to take a lead in the application of these technologies. It seems to me that that needs a regulatory lead to overcome the kinds of problems that Professor Schafer quite legitimately raised. Do you see that lead coming? Do you see the foresight process helping with that? If you do not, what would you like Government to be doing to provide that lead to help British engineering?

Professor Newman: Do you really want to know what I think Government should do to help on this—straight up? From my perspective—and these gentlemen will have different views—universities are extremely amazing places. They get teaching done—yes, of course—and they get research done. They also need to be a repository of know-how. Imagine if I was Google and you had to refresh your work force every three years. That is what we have to do. We should be training graduate and undergraduate students to go into industry, absolutely, but if we have this research agenda—and we have got something here—my biggest problem is strategic planning to keep a small group of people to accumulate this knowledge so that we can really bring this stuff through and we do not stick at the “Best Paper in the Universe” prize. We should not stop at papers, but we actually do it and take it through so that we can work with people like you to say, “Look, we have something here and it really goes.”

We need some sort of scheme with some sort of planning where it is not just basic research grants. The university needs some small amount of money that allows me to strategically plan and say, “These three people are really important and we are going to take this forward to the next step over the next couple of years.” It is really important, and the single thing that stresses me with a group of about 30 or 35 is a complete turnover. You have to keep retraining. No company can work like that, yet I am trying to curate UK IP and bring this through past the research papers. We really do know how to do it. We can do demos on the road. That is my single biggest thing. If the Government were to fix one thing, it would be to think of some way to help universities who want to do research,

teaching and be a sovereign capability or repository of know-how to do stuff. That is an arm that is missing at the moment.

Q164 Chair: Putting the same question to you, Dr Smith, 20 years ago in Ricardo I saw a hybrid engine for trucks that never got used because at the time it was argued that there was not the right leadership from Government. Does the same argument apply in industry? Does there need to be some regulatory lead?

Dr Smith: You will have seen that for trucks and different types of vehicles there have been all sorts of different power trends. Different car makers and truck manufacturers have gone in their own direction. From a regulatory perspective, I think there does need to be a regulatory lead to help focus the direction of the technology and the way we design the manned machine interfaces in the cars.

As to your original question about whether the foresight initiative is providing sufficiently, I am afraid I am not sufficiently familiar with that to comment.

Q165 Chair: Dr Reed, do you have any views in terms of TRL's role?

Dr Reed: On the regulatory side, we could do nothing and there would be the risk that other nations would take a lead and overtake us in this area. The current situation is where the Government are permissive. I think that is a good thing. They are allowing progress in this area. The next step beyond that is to be proactive—to set the agenda and challenge the industry and research communities to respond to that challenge. There are things like the Vision Zero ambition in Sweden that Dr Smith has already mentioned. That is one area where the Swedish companies are now aiming to achieve that vision. That could be an approach.

Chair: Gentlemen, thank you very much for an interesting session.