



# WHERE NEXT FOR AUTONOMOUS VEHICLES?

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## Introduction

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Driverless cars are not just part of an imagined future street scene; they exist today. Yet it's an enormous leap from the prototypes being put through their paces under test conditions to a scenario where autonomous vehicles become a significant and accepted feature of our transport landscape.

So what are the issues we need to resolve in the near term? And whose responsibility is it to find the answers? To explore these questions we hosted senior leaders from a range of transport organisations to share and debate their perspectives with an invited audience.

This document summarises the discussions and seeks to identify those questions and the lead responsibilities for resolving them. The prizes for getting it right are significant – safer roads, less congestion, a thriving automotive sector in this country.

We welcome the energy and commitment of everyone who took part to help find the right way through.



With thanks to our speakers:

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**Neil Fulton**

Transport Systems Catapult

**Ben Plowden**

Transport for London

**Joe Greenwell**

Automotive Investment Organisation

**Ben Howard**

Association of British Insurers

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Director of  
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## The road user – a view from the driver's seat

Speaker's perspective: Steve Gooding

Autonomous vehicles have the potential for use in a range of settings: as part of a public transport system (as they already are on London's DLR), in a shared transport service (imagine an elaborate minicab company, where driverless vehicles can be summoned on demand), or sold under a traditional model of car ownership. So the first question today's motorists need to know is which of the above models they are being invited to buy into?

But for the travelling public to accept any of them, winning trust in the safety, security and reliability of the technology will be crucial.

### Debate:

Road safety is a key concern. Around five people die daily on UK roads with driver error a significant contributory factor in causing crashes. Removing driver error through the introduction of fully autonomous vehicles holds the prospect of huge safety gains. But transition to an autonomous system does not

look straightforward. How will a traffic mix of traditional, semi-autonomous and fully-autonomous vehicles work?

Autonomous vehicles might be far less prone to error than human drivers, but they are unlikely to be 100% failsafe. Public acceptance of, and confidence in, a new way of travelling will need to be built on what constitutes an acceptable level of safety and security. The public are likely to be less tolerant of incidents caused by technology failure in autonomous vehicles – witness the different expectations for rail and air travel compared to roads.

Where autonomous vehicles are intended for sale to individual owners, carmakers will need to take account of the wide range of factors that influence their customers' choices: price – to buy and to run, practicality – in terms of space and performance, and pride – a mix of aesthetics and comfort; the 'how will it look on my driveway?' test. Style and fashion will count for more if vehicles are to be privately owned



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than might be the case for the 'pod' prototypes being developed for the more taxi-like UK trials.

To fulfil the ambitions mooted for the driverless experience – such as the ability for people to work on the move – autonomy will need to come with a step change in ride quality, advanced suspension systems to level out the road, acceleration and braking that's smooth in all but the most extreme of circumstances.

**The issue for the road user is not one of finding an immediate fix to any of these issues, but demonstrating a willingness to engage with exploring the potential of autonomous vehicles to provide a better balance between the personal mobility we seek and the safety and congestion costs of our current model; even if that means the motorist as we think of them being written out of the script altogether.**

# The Technology Sector – from technological potential to commercial reality

Speaker's perspective: Neil Fulton

The technology underpinning fully autonomous vehicles is still some distance from commercialisation. Government support will be vital to its successful development in the UK, to help bridge the gap between bright thinking and viable commercial products. Hence the establishment of the catapult centres, including the Transport Systems Catapult, specifically charged with accelerating research and development in the field of intelligent mobility and developing UK assets to capitalise on the potential of the emerging technology.

The LUTZ Pathfinder project is one of the Catapult's highest profile initiatives. Three driverless pods are currently undergoing trials in Milton Keynes to help researchers understand how the public and vehicle occupants will interact with autonomous vehicles.

## Debate:

Alongside Government financial support, an effective regulatory framework will be needed to support on-going technological development, starting with a regulatory regime that allows for the testing of autonomous vehicles on public roads.

The UK currently enjoys a favourable environment, since, unlike most European countries, the UK is not a signatory to the Vienna Convention, which requires road vehicles to be under the control of a trained driver. But that advantage is time-limited. Hence, the Government has moved quickly to publish a code of practice covering the testing of automated vehicle technologies in public places, with the aim of making the UK the best place internationally to conduct trials of this kind, though the competition from overseas is stiff.

Managing the risk associated with developing innovative technologies like driverless cars is crucial to attracting investors. The Transport Systems Catapult makes it possible

for researchers and commercial backers to share the risk: it is funded through a mix of Government grants, university funding and funds from commercial investors. With risks shared, technology experts can get on with developing the systems – hardware and software – that will not only make autonomous vehicles a practical working proposition, but will also deliver the safety and security that users will demand.

While it could be argued that cyber security is an issue in every sector, the consequences of vehicles being hacked is more significant than most. Money being taken from a bank account is bad; however losing control of a vehicle travelling at speed is potentially life-threatening.

Designing an effective interface between the vehicle itself and the wider operating envelope of data and system protocols which inform the vehicle's 'decisions' will be critical, and will be all the more challenging for designers should different countries pursue different system architectures.



**Ongoing Government financial support and development of the right regulatory framework are needed to create the domestic environment in which the technology sector can address the technical and engineering challenges involved in making automated vehicles work, supported by mechanisms, as offered by the Catapult, for sharing risk. There is also a role for Government and industry to look across national borders and establish appropriate international protocols. Near term, the technological development will need to move on from proof of concept to the design of systems that will assure the safety and security of vehicles and their occupants.**

## The Highway Authority – an uncertain environment for investment decisions

Speaker's perspective: Ben Plowden



Among highways authorities, it's not uncommon for the term 'autonomous vehicles' to be used to refer variously to driverless cars, connected vehicles, urban traffic management, alternative power trains and shared transport services. Some of these elements often converge in innovative transport solutions – as in the Paris Autolib' electric, car-sharing service, for example – but they are, of course, all very different.

As highway authorities contemplate the arrival of autonomous vehicles in some or all of these roles, being clear about the terms used to articulate thinking will be vital.

Highway authorities face two key challenges. First, how far to go in facilitating and promoting the adoption of autonomous capability. Second, how best to 'future-proof' sizeable investment decisions on established technologies, such as advanced traffic controls, which could, in some scenarios, experience a dramatically curtailed shelf life.

### Debate:

Greater clarity would be welcome from Government and the public on how far they want highway authorities to go in promoting autonomous vehicles. Should public authorities take a passive stance, simply reacting to issues after they have become apparent? Is an 'actively responsive' approach the preferred route, with highway authorities developing public systems to keep pace with evolving technology? Or is society looking to highway authorities to create an infrastructure that proactively promotes the adoption of automated vehicles in a safe and optimised way?

If the latter is the preferred option, society will need to decide to what extent a centralised control system should be able to direct or even control the journeys of autonomous vehicles within its domain, and who is to be in charge of that system. Highway authorities such as TfL have invested in advanced traffic control technology and in the resource needed to manage day-to-day

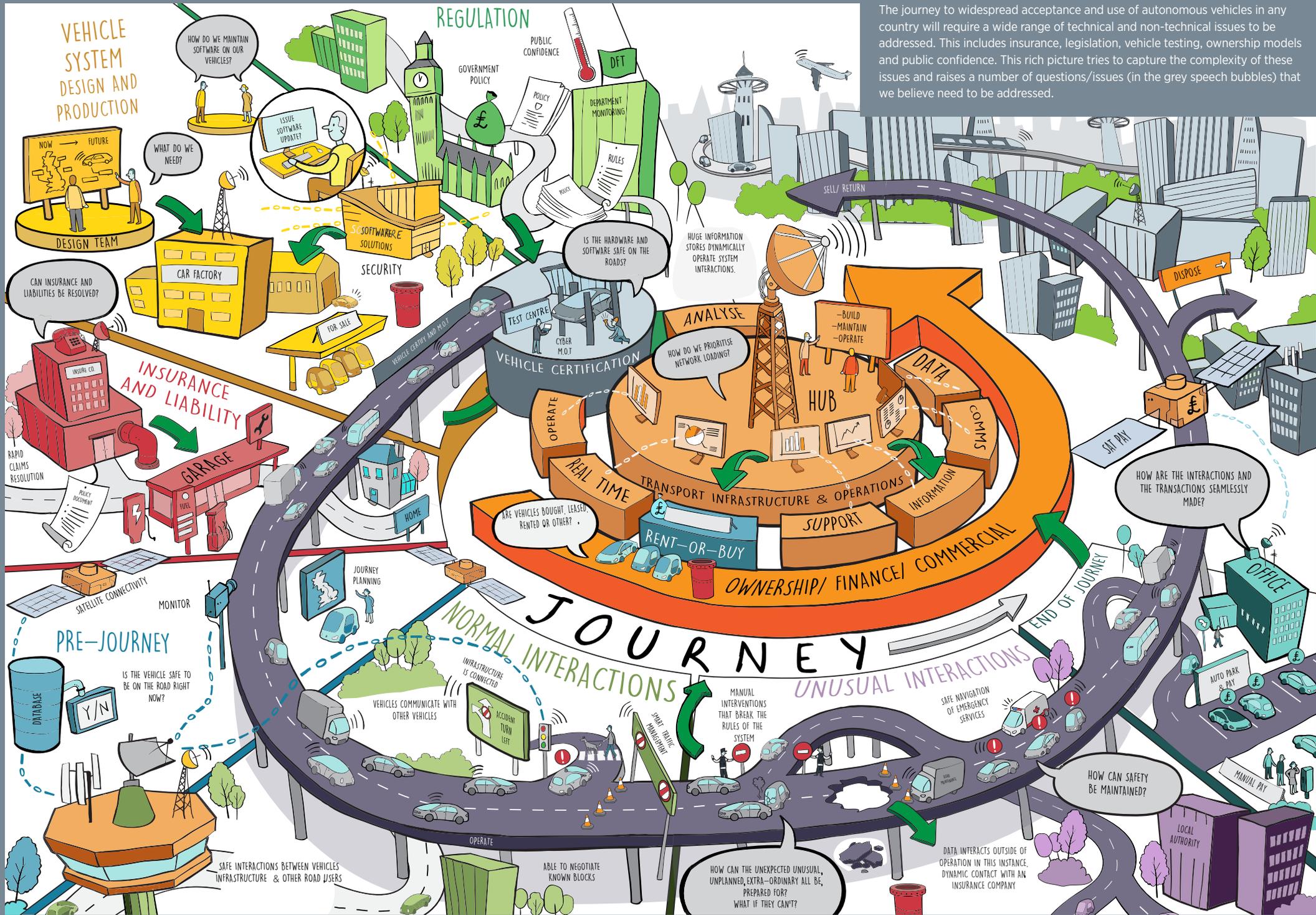
operations. Autonomous systems might have different resource consequences.

The question of who controls vehicle movements in real time is interesting. As motorists, we may be happy to follow a police officer's direction to change our route to avoid a serious incident – but how comfortable would we be about handing over control of our route to a master system, or about such a system holding detailed data on our second-by-second location?

Public authorities have a key decision to make – which technology to back. Autonomous vehicles are now evolving month-by-month and the development and delivery of major public infrastructure programmes would struggle to match this pace. Investing in an expensive technology solution that subsequently becomes obsolete represents a huge risk for public authorities. With substantial public funds at stake, when will be the right moment to make a decision on where to invest?

**In the absence of any other direction, individual local authorities will be deciding for themselves where they want to be positioned on the spectrum of openness to or active facilitators of autonomous vehicles. Shared working assumptions on the national and international trajectory towards autonomy could help provide a basis for near-term investment decisions. Looking slightly further ahead, local authorities need to be ready to engage with national government on the development of overarching system architecture and the specification of the highway authority's role within it.**

The journey to widespread acceptance and use of autonomous vehicles in any country will require a wide range of technical and non-technical issues to be addressed. This includes insurance, legislation, vehicle testing, ownership models and public confidence. This rich picture tries to capture the complexity of these issues and raises a number of questions/issues (in the grey speech bubbles) that we believe need to be addressed.



## The Automotive Industry – ready to seize the commercial opportunities

Speaker's perspective: Joe Greenwell

For the UK automotive industry, the development of autonomous vehicles represents massive disruption in a long established market where OEMs and Tier 1 and Tier 2 suppliers have occupied relatively fixed positions, with clearly understood routes to profit, for around 120 years. Now new challengers, with new ideas, new expertise and, crucially, new intellectual property, are on the scene. For the automotive industry the big question is: 'how can we continue to make a buck in this hugely disrupted market?'

The good news is that the UK industry is in a strong position to take advantage of the opportunities that this changing market brings. The industry has transformed over the last 10 years as politicians have re-engaged with the manufacturing and engineering sector. Government money is being committed through various agencies and the UK's many centres of excellence, including

MIRA and TRL, are collaborating to develop innovative vehicles and transport systems.

This is a positive story, but there are still plenty of questions the sector needs answering. The technical environment, for example, presents significant uncertainty. It's not yet clear what form the infrastructure technology will take. Who will develop the operating system that draws together the various strands of automated vehicle systems? Will there be a single system with a single owner, or will different organisations and businesses work collectively within one or competing frameworks?

The complexity of the technical issue is enormous – and too big for individual companies to manage alone. The high cost of developing technology solutions means companies need to come together as collaborators, which is already seeing OEMs working with the very businesses that are

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disrupting the automotive market. There are potentially lessons to be learned from the introduction of other disruptive technologies and business models, e.g. the introduction of mobile phones.

For automotive companies the challenge is to understand what intellectual property they will have in autonomous vehicles and to develop a business model that enables them to continue to make money in a new automotive landscape. That, in turn, begs interesting questions about the future model of vehicle ownership and the relationship between the automotive manufacturers and road users. Meantime, there is a further challenge in plotting how the future will unfurl: incrementally, through

the development of ever more sophisticated 'driver assist' technology that stops short of full autonomy, or with a 'big bang' jump into a brave new model.

**Automotive companies, individually, collectively, and in partnership with others, can make progress on vehicle design and technology. But it is hard to see how they could lead on developing the overarching framework into which their vehicles will fit. Whilst they need to be ready to engage in that work, in particular identifying the elements of that framework with which they need to dovetail their systems, they also need to be thinking through their own future business model.**

## The insurance industry – finding a straightforward solution to the liability puzzle

Speaker's perspective: Ben Howarth

With 90% of motor accidents due to driver error, the introduction of autonomous vehicles can be expected to cut the number of crashes, reduce the £27 million that UK insurers pay out on motor claims every day and deliver lower premiums for motorists. Already, there are 20% fewer collisions involving cars fitted with emergency braking systems and, as a result, the industry has cut premiums for vehicles fitted with this technology.

As insurers contemplate a scenario where it could be possible to 'drive' a partially autonomous vehicle on UK motorways within two years, they must address two key issues: transfer of liability and data management.

### Debate:

Initially, partial automation will require drivers to continue to monitor the system controlling the vehicle (and to be trained to do this). However, once the technology develops to a point where control of the vehicle is ceded completely the ownership of liability is set to change. Currently, liability rests firmly with the driver as the decision maker. But with fully autonomous vehicles that liability cannot attach to a person no longer in charge of the vehicle, instead it needs to pass to the system developer or manufacturer.

Work to pin down liability between insurers, in a way that results in the prompt settlement of legitimate claims and generates motor policies that make sense to consumers, is already work in progress for the insurance sector.

In future, it looks as if insurers will insure the vehicle, not the driver. Volvo has already

announced that it will accept full liability for collisions involving its driverless cars, and other manufacturers are expected to follow suit.

The data generated by intelligent vehicles presents both opportunities and challenges for insurers. On the one hand, data generated by a vehicle's control system will make it easier for insurers to understand exactly what happened in the event of a collision. Like improved safety, less fraud could deliver lower premiums for vehicle owners.

On the other hand, vehicle connectivity exposes both insured and insurer to the risk of cyberattack. At its most dangerous, this could involve criminals hacking vehicle control systems; at its most intrusive, it could involve the theft of sensitive data (such as vehicle location) which drivers will have shared in order to gain access to automated emergency response and vehicle recovery services.

Ultimately the cost of vehicle insurance should come down as vehicles become safer and have fewer collisions. However in the transition period between now and widespread autonomy there are a large number of unknowns for insurers, in particular about the effectiveness in everyday use of autonomous technology and systems. It would be unfortunate if these uncertainties crystallised into a higher perception of risk, with the consequent cost of higher premiums being borne by motorists.

**The question of liability is one which the insurance industry is well-placed to lead. Data management and data security raise broader questions, where insurers will need to be comfortable with the assurance architecture developed by others.**



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POLICY  
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## Government – the prize for UK plc – economic growth and inward investment

Speaker's perspective: Iain Forbes

Safer roads, new mobility choices for elderly people and those with disabilities, more effective transport systems for cities, faster journeys leading to greater productivity, and environmental benefits from better fuel efficiency – there are plenty of reasons for Government interest in autonomous vehicles. Overarching this is the growth and investment prize – the opportunity to drive growth and create wealth by positioning the UK at the forefront in the demonstration and deployment of autonomous vehicles.

To help realise the opportunities, the UK government has established a joint policy unit to co-ordinate the governmental approach to driverless cars and related technology; the Centre for Connected & Autonomous Vehicles - CCAV. The view from this organisation is that there are three key challenges to resolve: the legal framework; the management of data; and building public acceptance.

### Debate:

The UK's legal framework must keep pace with developments in technology. The UK framework must also fit with evolving international legislation in order to avoid hampering development and limiting opportunities. This is a task for CCAV to lead for the UK.

Autonomous systems will intensify issues that are already arising on data privacy and the commercialisation of data. Deciding who owns the data generated by users of autonomous vehicles, who has the right to access it and how it should be protected are among a suite of issues that require resolution. In part the answers will be driven by work to establish the architecture of the operating framework, but data captured by in-vehicle systems has to date been closely guarded by manufacturers, and that might need to change.

Autonomous vehicle technology will need to be robust to public pressure that could halt its development. Despite good progress in recent years, some 1,800 people still die on UK roads each year. With autonomous vehicles eliminating driver error there is the potential to reduce this figure dramatically – but mistrust of new technology could blind some to its potential. Government will need to work with the automotive industry both to shape the necessary assurance regimes and shape the communication that will be so vital to shaping public attitudes.

**There are some questions which fall naturally to Government, in the form of the CCAV, either in leading the development of solutions or in engaging on the international stage. CCAV also bears the responsibility for pulling all the various strands of activity together into a coherent programme so that all the relevant players can see what is expected of them and what they can expect in return.**



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## Stepping up a gear – drawing conclusions on the way ahead

Facilitator's summing up: Charlie Henderson

The technical development of autonomous vehicles is progressing such that within relatively few years a number of production cars capable of autonomous operation could appear on our roads. However, given the complexity and challenge of wider issues there is at least a risk that the framework is not yet in place to enable them to go driverless. A driver who is 'feet-off' and 'hands-off' might still need to be 'eyes-on' and 'brain-on', undermining many of the benefits of autonomy in taking driver-error out of the road safety equation.

### Conclusions:

Our workshop has helped crystallise a series of questions and suggested potential lead responsibilities:

- For the technology sector, to move beyond proof of concept trials to the design of systems that will assure the safety and security of vehicles and their occupants, including cyber threats
- For the insurance industry, to clarify the issue of liability
- For the automotive sector, to develop new models to support technological development and to consider their future business models

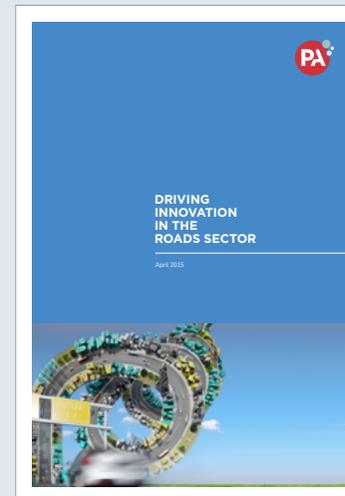
- For local highway authorities, to decide where they want to be positioned on the spectrum of openness to or active facilitators of autonomous vehicles and engage collectively on the working assumptions for the national and international trajectory towards autonomy to inform their near-term investment decisions
- For Government, to hold the ring on development of the national and international operating framework for autonomy, including the legislative and regulatory rules governing trials, the management, sharing and protection of data, including assurance protocols to guard against cyber-crime, and ensure effective communication with the travelling public
- Government, through CCAV, could also usefully pull these strands together into a single programme, with clear milestones and allocation of responsibilities

The good news is that there is no shortage of interest or energy going into finding solutions, and a welcome willingness to work collaboratively. And that has to be of benefit to current and future road users.

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PA are working with a range of stakeholders to further understand the issues and how to address them. Should you require further information please do not hesitate to contact [charlie.henderson@paconsulting.com](mailto:charlie.henderson@paconsulting.com).



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The RAC Foundation is a transport policy and research organisation which explores the economic, mobility, safety and environmental issues relating to roads and their users. The Foundation publishes independent and authoritative research with which it promotes informed debate and advocates policy in the interest of the responsible motorist.

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