Engineering the Future

The action forum for engineering

An Engineering the Future response to *Motoring of the Future*

Response to the House of Commons Transport Committee *Motoring of the Future* inquiry from Engineering the Future.

The development of the response was led by:

- **The Institution of Engineering and Technology**

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- BCS, The Chartered Institute for IT
- The Chartered Institution of Highways and Transportation
- The Institution of Chemical Engineers
- Institution of Civil Engineers
- The Institution of Mechanical Engineers
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Engineering the Future is a broad alliance of the engineering institutions and bodies which represent the UK's 450,000 professional engineers.

We provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy.

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Executive summary

- There is a need for an integrated transport strategy, across modes, nationally and at reasonable sub-national level. This strategy should be set in economic, social and environmental contexts to which motoring – and travel more generally – is a key factor.

- The future of motoring needs to be considered as part of the transport system as a whole. The lack of an integrated transport strategy for the UK creates barriers to a comprehensive discussion. A systems-view of mobility should be taken, including public road vehicles, pedestrians, cyclists and freight. These all need to be considered when looking at a coherent strategy for the future of UK roads in the context of the national transport system.

- In order to gauge a more comprehensive view of what motoring of the future will look like and what transport models and technologies will be dominant in the more distant future, there needs to be a clarification of the timeframe under consideration. This consultation, however, is looking at an unspecified future timeframe.

- The electrification of vehicles will require a massive shift in the shape and management of the electricity system of the future.

- New, technologically driven innovation, such as autonomous vehicles, may require an equally innovative approach to the regulatory, legal and ethical frameworks that govern them. We welcome the Department for Transport's recent call for evidence on the considerations that need to be made for the road-testing of autonomous vehicles.

- There needs to be recognition that the technological and behavioural changes likely to result from a shift towards autonomous vehicles will initiate new and differing demands being placed on the public infrastructure. Consideration needs to be given now to how responses to these demands will be funded and how the current models of funding the provision of transport infrastructure need to change.

- As well as considering the technical developments, research must be carried out in the social and behavioural issues of road use. Safety, security and resilience should be taken into consideration when looking at future models. This must include the cyber-security of digitally-enabled technologies.

- An efficient national road pricing system could represent one of the most effective and appropriate response to worsening congestion and reduced fuel duty and vehicle excise duty.

- The issues of fuel efficiency and alternative fuels need to be looked at in greater detail.

- New ownership models of vehicles (such as Zipcars) and the different types of use (urban, rural and inter-city) need to be considered.

Has the government articulated a clear strategy for motoring?

1. The UK lacks a coherent, integrated national transport strategy. Some elements of the transport system have had strategies determined for them but there is no clear national motoring strategy that sets out how private vehicles integrate with other transport modes both on the highways and other networks. Such a strategy would cover the automotive and related technology strategy ecosystem and overlap with strategies on infrastructure and industry.

2. There is a need for an integrated transport strategy, across modes, nationally and at reasonable sub-national levels. This strategy should be set in economic, social and environmental contexts to which motoring – and travel more generally – is a key factor. Transport and spatial planning should be better integrated, helped by collaborative planning by the Highways Agency and local authorities. Revisions also need to be made to the Digital Communications Infrastructure Strategy to ensure that it is able to adequately support smart transport.

3. The strategy needs to take account of wider trends in motoring and travel – such as more cars on the road but each making fewer trips with less cumulative mileage on urban roads, renaissance of rail, and differential travel costs (rising much faster on public transport).

4. Areas that need elaboration include:

    - use of ICT in cars for more effective connected cars

    - how cars meet the changing needs of an ageing population

    - new approaches to multi use roads – from pedestrians, cyclists, mobility scooters, powered two-wheels, cars, vans and lorries, special vehicles – and future proofing the highway infrastructure

    - compatibility with European and international standards for vehicles and roads, and the related research and standards (such as eCALL)

5. The strategy should also address the constraints on investment, planning and maintenance of (the majority of) local roads networks, and the contrast in the approach to the strategic and national networks, and take into consideration long-term capacity requirements.

6. There is considerable and growing activity around vehicle propulsion systems and autonomous driving; however, the strategy for these seems disjointed. Moreover, there does not appear to be much activity around land use planning and imagining what road space will be required for communities and places. In addition, there needs to be a clear reaction from the Government to EU (and global) initiatives on smart highways.

7. There is a lot more activity and strategy articulation on the vehicular side through the Automotive Council, the Transport Systems Catapult and initiatives on electric vehicles than there is on infrastructure or urban and transport planning. We see future intelligent infrastructure as a key tool in improving the management and operation of future transport. The success of the vehicular aspect is very welcome, and demonstrates the feasibility of a more coherent strategy that takes a systems approach.

How effective are the steps the government is taking to support technological development in motoring and what actions should it be taking to develop the necessary financial and legal frameworks?

8. The government is working to support technological development with Innovate UK (formerly the Technology Strategy Board) and the Advanced Propulsion Centre (APC). However, technological support is still highly fragmented and could be better linked within the UK. If better coordinated, UK developments in motoring could also be more effective in leveraging European initiatives and Horizon 2020 funding.

9. The government's reaction to the development of autonomous vehicles will be a good test of the current legal frameworks in place for new technologies, such as on liability and overlap with European and global legislation.

10. Underlying a clear strategy for motoring, there also needs to be an overview of the way in which this will be funded appropriately, including alternative ways to sustain tax revenue from motoring. Current funding models for national highways do not meet the requirements of the present network, particularly in terms of maintaining the local road network to an appropriate standard. As well as the most common solutions, there are some technical solutions that can be used to help create revised funding models (including road pricing).

11. Another financial framework to consider is the influence of engineering and technical innovation, if successful or adopted, on motoring taxation. There will be two major problems given the likelihood of more vehicles on the road but fewer of them powered by petrol or diesel. Congestion will worsen, and

important income from fuel duty and vehicle excise duty (VED) will decline. An efficient national road pricing system could represent one of the most effective and appropriate response to both challenges.

12. It is recognised that this option is counter to the government's previous position for the existing road network as stated in its Road Feasibility Study (2004) that considered it feasible but potentially costly and hindered by the inadequacies of available technology. Technology has moved on in the last decade to the point that it was worth re-evaluating this position, particularly in light of the seriousness of the congestion problem being faced in the near term. It is, however, also recognised that road pricing faces considerable public and political opposition and would need careful consideration were it ever to be introduced. Further discussion on this issue will be available in a forthcoming discussion paper from the Royal Academy of Engineering.

13. Future developments in motoring will need to bring together the technological aspects with understanding of the social, cultural, and political landscape.

14. Of course, the technology of motoring is not the only area where significant technological and societal changes are taking place. Motoring is affected by new technologies that influence travel more widely, such as internet shopping, remote working, high-quality teleconferencing or smart-ticketing.

How effective has the government been at setting its priorities for investment in research and development in motoring, and what further actions does it need to take?

15. The government is to be commended for working with Innovate UK, the APC, and the Catapults network to focus investment in research and development. However the integration between these and other organisations in the landscape is somewhat confused; they need to work together to support a common strategy. There also need to be staged strategies for the immediate future, and for 10 and 20 years' time.

16. Currently the investment priorities have been relatively positive. The challenge is, as the current technologies and ownership models are supplanted by new ones, we ensure the UK retains or expands its position, and that these strategies to relate to EU and global standards.

17. For example, in terms of roadside technologies (as opposed to vehicle technologies), there is a dilemma to be addressed in ensuring the UK fully integrates into EU standards whilst still retaining a technical lead by promoting the development of UK derived standards for Co-operative Vehicle Highway Systems, Universal Traffic Management Control or Urban Traffic Control. In addition to the consideration of European standards, vehicles are also part of a global market. International standards and technical requirements should also form part of the strategy.

18. Government needs to encourage consultants and manufacturers working on intelligent transport systems to engage in EU research platforms and consortia to ensure diffusion of UK thinking into EU standards-making.

19. The effectiveness of setting these priorities appears not to be well understood by the wider development community or on an international scale. Big data and pervasive sensing through the 'internet of things' in the right hands could also help identify and solve congestion on roads and we welcome local authorities opening up their transport data to third parties who can add innovation in this area.

20. Further feedback on the government's effectiveness on setting priorities needs to be gathered from the Automotive Council, the Transport Systems Catapult and the electric vehicle initiatives.

21. It would also be appropriate for the government to consider the wider aspects of motoring research involving the environment and other aspects. For example, 'smart vehicles' will surely not reach their full potential without some consideration of linked elements such as 'smart cities' and 'smart roads'.

Is it clear how current research and development in, for example, alternative fuels, safety systems or driver aids, will make a significant impact on mass-market vehicles by 2040, and how likely are changes that would make motoring of the future profoundly different from motoring today?

22. There will be a significant impact on mass-market vehicles by 2040, but it is very difficult to foresee exactly what that will be; a range of scenarios should therefore be envisaged. It is likely that there will be several technology types, according to the different needs which vehicles will meet. Given this level of uncertainty, the government and automotive industry needs to work with that uncertainty, both in terms of the pace of change, and the products that emerge from it.

23. There will also be a greater divergence between the needs of urban, intercity and rural users. Government should support social and technical research in the future, and avoid trying to 'pick winners' at this early stage. It is recommended that government begin scenario planning for likely changes in motoring of the future. The seminal Foresight Study on intelligent infrastructure for transport that was published in 2006 should be updated as its scenarios for technology adoption in transport are still valid now.

24. The issues of fuel efficiency and alternative fuels need to be looked at in greater detail. Conventional-fuel vehicles are getting more fuel-efficient all the time; encouraged and mandated by a range of measures. For example, the EU is encouraging low carbon vehicles with a system of punitive fines on Original Equipment Manufacturers (OEMs). This results in fewer CO_2

emissions; however, there is concern that, in some cases, there has been an increase in harmful emissions such as NO_x and Particulate Matter (PM), which are highly injurious to health. NO_x emissions remain the most difficult to reduce as there needs to be substantial reduction at ground level to affect atmospheric readings. Air pollution, to which vehicle emissions are a major contributor, is the second biggest UK public health hazard after smoking, resulting in more deaths in 2008 than obesity and alcohol abuse combined (COMEAP, 2010).

25. There are numerous 'alternative fuel vehicle' approaches, including electric, electric-hybrid, hydrogen, fly-wheels and compressed air. While most UK funding in this area has gone into electric vehicles and their necessary infrastructure, in our view a good investment – the other options should not be discounted at this stage as they may provide a better solution for some vehicle usage and requirements. Government could also support better urban traffic control technlogies and non-technical approaches such as driver guidance systems and driver training for reducing fuel consumption. There are currently some schemes on this, including through the Energy Saving Trust.

26. Vehicle technology is contingent on R&D in energy sources such as alternative fuels and decarbonising electricity. Therefore, future strategy for motoring needs to integrate with these other R&D strategies. It is recommended that an annual or biennial review of progress in both conventional and alternative-fuel technologies be commissioned to determine future changes, rather than just relying on a snapshot in 2014. These reviews would also help with scenario-planning, and should include reviews of well-to-tank pathways (the processes and steps necessary to turn a resource into a fuel and bring that fuel to a vehicle).

27. The situation in driver aids is very similar as there are currently various approaches to be considered, including exploring the potential of some level of assisted driving through to driverless cars for the elderly and disabled. We welcome the funding of the RCUK's Digital Economy Hubs programme in funding work in this area through the SiDE project (www.side.ac.uk/). A similarly diverse approach should be taken with funding, and a similar annual or biennial progress report commissioned.

28. These longer term discovery activities need more international focus from the UK and more concentrated investment that is not spread too thinly. Identifying UK centres of excellence for specialisms in longer-term research would help. There also needs to be greater involvement with UK car OEMs, component manufacturers, motorsports, automotive research or engineering firms (such as MIRA).

29. The electrification of vehicles needs a more joined up strategy between Transport, DECC, BIS and DCLG to assure effective implementation.

30. Autonomous vehicles will raise issues of safety, security (including cyber security) and resilience of networks in the future. Before large scale

deployment of such technologies, there are many immediate issues in safety to be addressed. Improving road design and driver competency would bring benefits for safety and potentially reduce congestion. Roads can be made safer through engineering solutions, from street furniture to sight lines to road markings. A roadmap from what we have now in terms of cooperative vehicles through all the stages of automation to fully driverless vehicles needs to be established as there is a concern that trying to move straight to driverless trials may not foster public understanding and support.

31. Given that the vast majority of motoring accidents are caused by driver errors, accident investigation can be improved with root causes found and published under a protective legal umbrella that encourages witnesses to be honest without risking self-incrimination.

32. Cultural attitudes to motoring and safety could be improved using policy informed by behavioural insights and economics. For example, safety regulation could be viewed through a 'user responsibility' lens rather than as punitive. There also needs to be a consideration of relicensing drivers to include a requirement of a minimum number of hours of tuition by a qualified instructor. Regular retesting of road drivers would also help improve safety.

33. The interaction between different highway users needs to be considered in future development of future policy. For example, the growing popularity of cycling, particularly in London, needs to be accompanied by awareness campaigns and training for all of the differing needs of highway users.

How might trends in motoring and patterns of vehicle ownership shape transport planning, policy making and provision?

34. This is a question that government should be leading on when evaluating its R&D spending. The trends in motoring are uncertain given the different technical, social, economic and legislative developments that may arise in the future. This uncertainty is also due to the lack of a national transport strategy. Planning and policy need to be shaped by a vision for the future quality of life, environmental concerns and sustainability in the UK.

35. For example, the development and use of automated and autonomous vehicles and issues related to these, including safety, insurance and land planning, are of great importance to the vehicle manufacturing industry as well as to infrastructure provision. It is recommended that this both technical and socio-economic trend is reviewed regularly by the government.

36. Current technology and commercial models of vehicle ownership will change as we move to a post fossil fuels ecosystem. However, it is still not clear what this will look like. It is also highly likely that the dominance of the major businesses currently operating in the sector will be challenged as vehicle provision changes to demand new and different technologies and

skills. The government needs to invest in R&D that will ensure the UK is best placed as these changes start to happen.

37. Uncertainty in the development of wider social, economic and technological factors creates uncertainty about future trends in motoring and vehicle ownership. Marking key trends through Foresight type studies would help to support wider discussion in the community. The bodies and organisations that have produced such research on key trends include the Automotive Council, LowCVP, Cenex, the Society of Motor Manufacturers & Traders and the All Party Parliamentary Motor Group.

Are current transport planning, policy making and provision taking likely future developments into account and how planning, policy making and provision might need to change in the future?

38. Current transport policy and planning is fragmented and gives little impression of the way in which the government's transport strategy will be focused in the future to shape or improve living in the UK in both rural and urban environments. In some cases, current transport planning – where it happens in a strategic sense – is not taking some important current developments into account, such as changes in car use and licence holding, and the decline in 'active travel' and the link with public health.

39. Although land use planning is increasingly recognising the need to consider all modes in major new developments, there still appears to be a strong desire to 'predict and provide' more road space as a reaction to new development. The government has the opportunity to lead and be innovative with the relationship between new housing developments and transport networks with an integrated transport and land use strategy that caters for long term increases in capacity.

40. Decisions and announcements on infrastructure are still closely contingent on political motivation, rather than being based on evidence. There needs to be more understanding of the overlap between regulation and political will, particularly where it related to the usage and personal freedoms of vehicle users.

41. There is also a general view that transport planning policy options have been rejected without detailed consideration. The most notable example of this is road pricing, where the technology has been available and in use in other countries for 10 to 20 years. Despite numerous studies, including on technologies, fiscal aspects and issues of public acceptability (including OBR 2011, IFS 2012, IPPR 2014 and various reports from the RAC Foundation such as RACF 2011 – and many similar reports in the US and world-wide), road pricing does not figure in current transport planning or policy discussions.

42. Transport planning and modelling also need to take into account the full range of vehicles, cyclists and pedestrians using roads in the future. For example, Engineering the Future and the Automotive Council are well placed to support this activity. However, for it to be effective, market trends need to be made visible to a wider community.

43. Developments in 'big data' will have a huge impact on a national transport strategy. The Transport Systems Catapult will need to coordinate with other Catapults, including the Connected Digital Economy Catapult, and with an open access digital strategy (especially GIS tools and online mapping), to support connected cars as well as more open innovation and use of 'big data', with appropriate cyber security measures. The digital strategy needs to link other modes of transport and to effectively support the rise of smart cities and the electrification of vehicles.

What evidence is there to show that the government is coordinating its policy making with other governments and the European Union to achieve joined-up transport outcomes and to establish universal standards?

44. Currently there is not a great deal of evidence. To take the road pricing example referred to above, the European Commission has been advocating and indeed encouraging widespread adoption of road pricing and standards for managing it (through the European Electronic Tolling System (EETS) standards); but road pricing in general and EETS in particular have not been adopted in the UK nor in other European countries.

45. The United Kingdom Roads Liaison group provides the basis for collaboration between road administrations in the United Kingdom. In turn, the World Roads Association provides the basis for collaboration between roads administrations across the world and gives the opportunity for the government to utilise the significant experience of the national highways sector in developing standards and achieving joined up transport outcomes.

46. DfT and national road authorities are often notable missing partners at key European meetings. This has been an issue for many years and can mean the UK misses out on many funding opportunities and the chance to fully influence the European agenda.

What role does the government have in ensuring that the UK has the necessary infrastructure—for example refueling networks or vehicle-to-infrastructure data networks—to facilitate motoring of the future?

47. It is the role of government to provide enabling measures, including investment and legislation, to support this area. In terms of infrastructure, although it is likely that the roll-out of such networks will be a commercial

undertaking (like the mobile networks), the UK government has an important role in funding R&D and ensuring that whatever EU and global standards systems are built to have a strong UK input. Government should still be aware that existing infrastructure, such as highways, need maintaining. In the future, it is likely that there will be multiple technologies and infrastructure networks, including electric cars, and different usages for rural and urban users. Government therefore needs to look at the future of motoring in phases, from maintenance to current networks to resilience of new networks and the opportunities this may bring.

48. Refueling policy should be government-led, and for electrification, although the policy may stimulate uptake, government needs to look very carefully at the barriers to this. The government has a role to coordinate on the security of the electricity supply to this infrastructure network.

49. A large scale electrification of the vehicle fleet will have profound impacts on the UK's electricity system, and, if electric transport becomes universal, could significantly affect the UK's electricity demand, both in terms of overall requirements and managing local demand at peak times. This will require major increases in the amount of generation needed and changes in how networks are developed and managed, particularly the smart grids needed to minimise the costs of expanding local electricity distribution networks. This problem is discussed in research carried out with Northern Power Grids (IEEE, 2013).

50. There are potential problems in the short term if clustering of electric vehicle charging occurs on a single distribution feeder (for example, if several people in the same street buy EVs). There may need to be a 'smart' system to prevent overloading. The My Electric Avenue project (www.myelectricavenue.info) is seeking to gain further insight into the nature and extent of this challenge through a real world trial.

51. It would be useful to gain clarity over the expected levels of vehicle electrification and of likely charging patterns, as this will assist in shaping the future development of the electricity infrastructure appropriately. The electricity system and wider energy system are facing unprecedented change over the next few decades as they respond to the challenges of decarbonisation while remaining affordable to consumers. Given that transport and motoring in particular are such a large component of the energy system, it is vital the two are considered in an integrated way.

What steps is the government taking to help UK business exploit new motoring technologies and whether there is scope for it to do more?

52. There are various steps that government can take, including:

- Ensure that the current and future workforce have the skills to innovate and support new motoring technologies

- Support the commercialisation of UK university research
- Liaise with the UK motorsport cluster on synergies
- More R&D spending and 'hothousing' to ensure that when new suppliers emerge to deliver the new technologies required, they are UK suppliers
- Encourage support for UK SMEs and start-ups, which can have a significant contribution to produce new technologies, with funding streams such as from Innovate UK
- Full commitment to the development of EU standards to ensure UK suppliers are able to compete effectively

53. Some of this is partially covered in the activities of Innovate UK and the BIS/Finance Birmingham AMSCI programme. There are also some partnerships between SMEs and academia. Productiv has taken new developments into production on a centralised site to ease the path to the marketplace for small OEMs (www.productivgroup.com).

54. The introduction of the Transport Systems Catapult is a good example of government support for UK business to exploit new motoring technologies. It is important to sustain this focus and add more centres of excellence that operate at real scale. It should be noted that the Transport Systems Catapult has a limited budget and requires more funding. Also, it does not necessarily have a remit to work with SMEs, which require support to produce and commercialise new technologies.

55. There also needs to be a climate that ensures that as big motoring companies continue to move into new technologies, they do it in the UK. There needs to be support to ensure the UK's already vibrant automotive sector is able to retool to meet the changing shape of the industry.

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