Handling uncertainty in transport planning and decision making

Report of a roundtable discussion held in London on 20 July 2018

Professor Glenn Lyons

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Summary

In the 1700s, the French philosopher Voltaire reportedly said "*Uncertainty is an uncomfortable position. But certainty is an absurd one*." The transport sector is becoming increasingly alive to how uncertain the future is. There is significant (or 'deep') uncertainty about the extent to which existing trends, relationships, technologies, economic and social forces, preferences and constraints will carry into the future. Uncomfortable though it may be, there is a need in our transport planning and decision making to avoid absurdity and address this. This report reflects the insights gained from a roundtable workshop in London convened to discuss the matter.

For some, absurdity concerns the continuation of a longstanding norm in transport planning of appraising future prospects through a reliance on being able to judge what the *most likely* future is or, in forecasting terms, what the *central projection* can be considered to be (with management of uncertainty through some form of error band either side of this). Such approaches no longer command a professional or public consensus. The notion of 'most likely' is either being challenged or a divergence of views exists over which type of future can be deemed most likely.

Orthodox notions of predicting the future are giving way to scenario planning in which *multiple alternative scenarios* – substantially different pictures of what course of events might unfold - are entertained. One of the challenges here is in judging whether the true extent of uncertainty is being accounted for, distinguishing between *probable* (likely to happen), *plausible* (could happen) and *possible* (might happen) futures. Views are subjective (and further coloured by opinion on *preferable* (desirable) futures). This can appear uncomfortable compared to the illusion of a well-defined most likely future that frames the decision making task. Yet the act of embracing and accommodating rather than concealing uncertainty holds the prospect of better supporting and informing decision making.

The following proposition emerges for an approach that may be especially well suited to the early strategic planning and optioneering stages of the policymaking process. Set against a wish to fulfil a high level vision, the aim is to consider the implications of different courses of policy action in the face of multiple plausible futures. Does a course of action align with the vision in each plausible future considered or does it align well in some and not in others? The intention is *to reconcile risk and yield*. The best course of policy action for one assumed future may give high yield in relation to the vision but may also carry a high risk of misalignment or even failure in other plausible futures. Meanwhile, a course of action which has reasonable alignment across multiple futures may offer a lower (but acceptable) yield but with lower risk.

As becomes apparent from the considerations above, the handling of uncertainty is a *wicked problem* that is inherently insoluble. It is wicked in the sense that it concerns: (i) divergence in views, understanding and values across stakeholders; (ii) knowledge gaps and a lack of 'evidence'; and (iii) needing to deal with complex relationships between multiple considerations. This should not imply policymaking paralysis if progress can be made as outlined above in terms of embracing and accommodating uncertainty.

In critically examining how uncertainty has been, and continues to be, handled in mainstream transport planning practice and exploring the prospects for changing this, the following key issues emerged through the roundtable discussion:

Transport planning inertia – Well established approaches, procedures and norms can conspire against developing and adopting new approaches that may be better able to handle uncertainty but which are unfamiliar and potentially challenging to communicate. Acknowledging uncertainty can have connotations of poor confidence and conviction in decisions being made – for example in the context of public inquiries.

Learning by doing – The application of new approaches should be strongly encouraged, with a 'learning by doing' philosophy where experiences of those new approaches and the lessons learned are shared with others. Continued dialogue of the sort fostered by the roundtable is important. Guidance should be seen as an accompaniment to this evolutionary approach and as something which itself must be flexible and evolving. The growing signs of transport authorities wishing to take account of deep uncertainty in their decision making are to be welcomed.

Closing down uncertainty – To avoid decision making paralysis, the exposure or *opening out* of uncertainty through scenario planning needs to be followed by an appropriate process of *closing down*. Closing down refers to how the exposed uncertainty is then accounted for in informing and enabling decision making. Closing down can take the form of concealing, reducing or accommodating uncertainty and distinguishing between them is important. Uncertainty may be *concealed* by reversion to focusing upon a most likely future. It may be *reduced* through better monitoring and understanding of change taking place or through greater effort to control the shaping of the future. *Accommodation* of uncertainty (as outlined above) involves making sense of what to do in decision making terms with the uncertainty that has been exposed.

Analytical fitness for purpose – Especially in the face of finite time and resources, it is important that the analytical approach supporting each stage in the policymaking process is fit for purpose. There is a risk that emphasis is currently being put in the wrong place in terms of analytical effort and rigour. Heavyweight modelling tools may be used to address a small number of scenarios when, particularly at the earlier stages in the policymaking process, simpler (though not to infer less robust) analytical tools can be more effective in exploring the uncertainty space of plausible futures and enabling dialogue and development of views of actors in the process.

Communication is key – The analytical tools will only ever be a part of the wider *process* of examining and interpreting the uncertainty faced. It is important that the actors involved in that process - from the analysts to the decision makers themselves - are enabled rather than confused by how the tools are used and their results conveyed. There is a balance to be struck between the breadth and depth of examination of the uncertainty space. There is also a need to recognise the place of both 'narrative' and 'numbers' in order to ensure effective engagement with actors and to communicate the credibility of, and insights from, scenarios analysis.

Guidance and leadership – The current existence of guidance for appraisal, including the handling of uncertainty, may intend to provide latitude for interpretation rather than 'rules' to be complied with. However, this is not always how guidance is treated in practice. As approaches to handling uncertainty are evolved, it will be particularly important that accompanying guidance is enabling

rather than constraining. This may require that practitioners are guided on how to use the guidance (with a role for case studies). Leadership will also be critical within organisations in providing staff with appropriate direction, mandate and agency to address uncertainty.

Resources and expertise - We may be facing a perfect storm in transport planning: greater uncertainty over the future at a time of depleted resources and capabilities to address business as usual, let alone the handling of uncertainty. One means of starting to address this would be to consider how available resources can be redistributed across the transport planning and decision making process alongside seeking to reconsider the makeup of experts required to handle uncertainty and communicate it to decision makers. Handling uncertainty must become integral to mainstream practice rather than a bolt-on to it, with the latter risking being misaligned and ignored.

Handling uncertainty in transport planning and decision making

Part 1 – setting the scene

Introduction

On 20 July 2018 a roundtable meeting was convened in London involving a number of key UK commentators on handling the uncertainty faced by the transport sector. The event was organised and facilitated by Glenn Lyons, Mott MacDonald Professor of Future Mobility at UWE Bristol. This report captures an account of key issues addressed by the roundtable discussion. The event took place under Chatham House Rule and hence no remarks are attributed to individuals who attended. However, invited written 'on-the-record' comments provided by some of the participants (and by further individuals who were unable to attend but contributed in absentia) are included (with their permission) as Appendix 1.

While the future has always been uncertain, the uncertainty currently ahead is widely recognised to be 'deep' with a number of dynamics at play in terms of social, technological, economic, environmental and political drivers.

Approaches to transport planning and analysis in past decades have been framed by an era of car dependence and an ever-present trend of growth in road traffic. The tools and processes that have evolved to support decision making have not ignored a need to handle uncertainty. However, in light of the nature and extent of uncertainty about the future that now exists, their sufficiency is being challenged.

Scenario planning is receiving more attention as part of an appetite to further evolve how we handle uncertainty. The proposition has been put forward that instead of reactive policymaking that is vulnerable to policy failure due to unanticipated change (predict and provide), we need proactive policymaking that helps guard against policy failure through adaptability to unanticipated change (decide and provide). However, charting a course through this territory is highly challenging for the parties involved.

This roundtable event was intended to allow those involved to share their experiences and views. This report is intended to share more widely the insights gained in the interests of advancing collective understanding and practice.

Background

This section sets out briefly some of the developments leading up to the roundtable.

In 2014, the New Zealand Ministry of Transport undertook a major national study to examine future uncertainty in travel demand against the backdrop of a 10-year period of near zero growth in total road traffic and at a time when the Government was set to invest $10bn over the coming 10 years in roads[1].

The study was informed by the emerging phenomenon of 'peak car'[2] and by the proposition that we may be in the midst of a fundamental transition away from the regime of automobility towards a new future mobility regime[3]. Its centrepiece was a scenario planning exercise that developed four plausible futures for New Zealand in 2042. An Excel-based spreadsheet model was also developed to produce quantitative estimates of per cent change in total car traffic (2014 to 2042) in each of the scenarios[4]. Change in total vehicle distance travelled ranged from an increase of 35 per cent to a *decrease* of 53 per cent.

Crucially, the study went beyond exposing uncertainty in this way to consider what the implications were in terms of how to handle uncertainty in, and with what consequences for, transport planning and decision making[5]. Two contrasting policymaking pathways were outlined, as shown below:

regime compliant	regime testing
predicted and practical outlooks	plausible and preferred outlooks
transport – economy coupling	access – economy coupling
weak planning	strong planning
concealed uncertainty	exposed uncertainty
justified decisions	guided decisions
benefit-cost analysis	real options analysis
predict and provide	decide and provide

[1] Lyons, G., Davidson, C., Forster, T., Sage, I., McSaveney, J., MacDonald, E., Morgan, A. and Kole, A. (2014). *Future Demand: How could or should our transport system evolve in order to support mobility in the future?* Final Report. New Zealand Ministry of Transport, Wellington, New Zealand. https://www.transport.govt.nz/multi-modal/keystrategiesandplans/strategic-policy-programme/future-demand/

[2] Lyons, G. and Goodwin, P. (2014). *Grow, peak or plateau – the outlook for car travel. Report of a roundtable discussion in London on 20 May 2014*, New Zealand Ministry of Transport, July. https://www.transport.govt.nz/multi-modal/keystrategiesandplans/strategic-policy-programme/future-demand/

[3] Lyons, G. (2015). Transport's Digital Age Transition. *Journal of Transport and Land Use*, 8(2), 1-19. https://www.jtlu.org/index.php/jtlu/article/view/751

[4] https://www.transport.govt.nz/multi-modal/keystrategiesandplans/strategic-policy-programme/future-demand/

[5] Lyons, G. and Davidson, C. (2016). Guidance for transport planning and policymaking in the face of an uncertain future. *Transportation Research Part A: Policy and Practice*, 88, 104-116. http://dx.doi.org/10.1016/j.tra.2016.03.012

Portrayed as a simplified learning aid, one pathway suggests elements that would, together, reflect an approach to decision making that would be compliant with the current regime (in which adherence to trends and the nature of the world we have known pushes policy). Meanwhile the other pathway brings into question the nature of the world as we have known it and vision pulls policy decisions).

This work sparked interest back in the UK. The Chartered Institution of Highways & Transportation undertook a national workshop-based study (CIHT FUTURES) with 200 of its members to explore their views on future uncertainty and the relative merits of regime compliance (predict and provide) and regime testing (decide and provide)[6].

This proved very timely for Transport for Greater Manchester which at the time of participating in CIHT FUTURES was at the outset of developing its 2040 transport strategy[7]. The strategy adopts a vision-led approach aligned with regime testing[8]. Inspired by CIHT FUTURES engagement, Transport Scotland, in embarking upon the development of a revised National Transport Strategy[9], determined that it should ensure its vision-led approach embraces uncertainty. As a result, it has commissioned from Systra and UWE Bristol the development of a scenario-planning process and tool that can test the appropriateness of alternative policy measures for fulfilment of its vision in the face of multiple plausible future scenarios[10].

In 2015 the Department for Transport, for the first time in the history of its series of national road traffic forecasting exercises, engaged with scenario testing beyond (only) sensitivity testing of a central projection of future road traffic[11]. The movement away from reference to a 'most likely' future scenario to a set of plausible future scenarios in the face of uncertainty should be seen as significant. There is a continuation of this approach in its 2018 road traffic forecasts, the report for which was published after the roundtable and just before this roundtable report[12].

The National Infrastructure Commission (NIC) was set up in 2015 with one of its main tasks being to undertake a national infrastructure assessment during each Parliament[13]. The need to handle uncertainty has been strongly recognised by the NIC and in its 2018 National Infrastructure Assessment published immediately before the roundtable[14] it sets out recommendations to Government that "have been designed to stand the test of time, and to be robust to a variety of scenarios".

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[6] Lyons, G. (2016). *Uncertainty Ahead: Which Way Forward For Transport?* Final Report from the CIHT FUTURES Initiative, Chartered Institution of Highways & Transportation, August, London. https://www.ciht.org.uk/knowledge-resource-centre/resources/futures/

[7] https://www.tfgm.com/2040

[8] See talking head commentary here from Nicola Kane (Head of Strategic Planning and Research, TfGM): https://www.ciht.org.uk/knowledge-resource-centre/resources/futures/futures-inspirations/

[9] https://www.transport.gov.scot/our-approach/strategy/national-transport-strategy/

[10] Lyons, G., Cragg, S. and Neil, M. (2018). Embracing uncertainty and shaping transport for Scotland's future. *Proc. European Transport Conference*, Dublin, 10-12 October.

[11] https://www.gov.uk/government/publications/road-traffic-forecasts-2015

[12] https://www.gov.uk/government/publications/road-traffic-forecasts-2018

[13] https://www.nic.org.uk/

[14] https://www.nic.org.uk/assessment/national-infrastructure-assessment/

Further significant reports have recently been published that underline that travel preferences and behaviours and in turn travel demand itself appear to be subject to some important dynamics of change.

The Commission on Travel Demand gathered submissions of evidence from across the UK concerning changing travel demand[15]. Insights from this 2018 report include the following: 16 per cent fewer trips than in the mid-1990s; a 20 per cent reduction in commuter trips per person per week since the 1990s; a 30 per cent decrease in physical shopping trips over the past decade coinciding with the rise in on-line shopping; and traffic levels having reduced in major cities, while on the motorway network there has been significant traffic growth (with van traffic growing at 5 per cent per year). The DfT commissioned work published in 2017[16] that sought to better understand the decline in trip rates noted above and to model trip rate changes between 2002 and 2012. Depending upon trip purpose, between 0 per cent and 13 per cent of observed trends could be explained by model variables beyond 'year'. This highlights the substantial challenge in making sense of the travel behaviour dynamics being observed. Earlier this year the DfT published a report examining evidence on young people's travel behaviour[17] exposing what appear to be structural and lasting changes to behaviour. The report observes, for instance, that "29% of all 17-20 year olds had a full driving licence in 2014 compared to 48% in 1992/94".

In June 2018, informed by its Joint Analysis Development Panel[18], the DfT published a consultation document for its transport appraisal and modelling strategy (with a closing date of 15 October 2018)[19]. Within this, the DfT sets out five key themes and priorities, one of which is reflecting uncertainty over the future of travel. Its consultation questions centre upon: what the priorities should be for improving understanding and treatment of uncertainty in modelling and appraisal; and what the main challenges are to adopting a more sophisticated approach to uncertainty in business cases and how to overcome them.

It should be noted that while the DfT's Transport Analysis Guidance (WebTAG)[20] is applicable in England, Scottish Transport Analysis Guidance (Scot-TAG)[21] and Welsh Transport Appraisal Guidance (WelTAG)[22] apply for transport interventions promoted or funded by the Scottish and Welsh Governments respectively. Where WebTAG is referred to within this report the reader

[15] Marsden, G. et al. (2018) *All Change? The future of travel demand and the implications for policy and planning*, First Report of the Commission on Travel Demand. http://www.demand.ac.uk/wp-content/uploads/2018/04/FutureTravel_report_final.pdf

[16] DfT (2017). *Provision of travel trends analysis and forecasting model research*. Analysis and Developer Report, prepared by AECOM and Imperial College London for the Department for Transport, November. https://www.gov.uk/government/publications/trip-rates-research-for-a-range-of-journey-types

[17] Chatterjee, K. Chatterjee, K., Goodwin, P., Schwanen, T., Clark, B., Jain, J., Melia, S., Middleton, J., Plyushteva, A., Ricci, M., Santos, G. and Stokes, G. (2018). *Young People's Travel – What's Changed and Why? Review and Analysis*. Report to Department for Transport. UWE Bristol, UK. https://www.gov.uk/government/publications/young-peoples-travel-whats-changed-and-why

[18] https://www.gov.uk/government/groups/transport-appraisal-and-strategic-modelling-division#joint-analysis-development-panel

[19] https://www.gov.uk/government/consultations/transport-appraisal-and-modelling-strategy-informing-future-investment-decisions

[20] https://www.gov.uk/guidance/transport-analysis-guidance-webtag

[21] https://www.transport.gov.scot/our-approach/industry-guidance/scottish-transport-analysis-guide-scot-tag/

[22] https://beta.gov.wales/welsh-transport-appraisal-guidance-weltag

should be mindful that the point being made may either be broadly applicable across all three or more specifically relevant to WebTAG.

To summarise this background section of the report, the transport sector is becoming increasingly alive to the sense of change and uncertainty being faced and recognises a need to respond to such changing circumstances in transport planning and decision making. At the same time, established approaches (regime compliance) are deeply entrenched while new approaches are either embryonic or not yet widely applied. Indeed some approaches exist largely in the academic literature and may not yet have seen their application within the transport sector (even if there is application in other sectors). A case in point is that of Robust Decision Making as a scenario planning based approach to handling uncertainty that was put forward by the RAND Corporation in the early 2000s[23].

In light of the above it seemed timely to convene a roundtable to explore the matter of handling uncertainty in some detail.

Key questions for the roundtable

The following four questions were addressed in preparation for, and at, the roundtable on 20 July:

1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?

2. In terms of **closing down**[24] uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?

3. In terms of **analytical robustness**[25] (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?

4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?

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[23] Lempert, R.J., Groves, D.G., Popper, S.W. and Bankes, S.C. (2006). A General, Analytic Method for Generating Robust Strategies and Narrative Scenarios. *Management Science*, 52(4), 514-528. https://doi.org/10.1287/mnsc.1050.0472

[24] Opening out and closing down uncertainty are terms that Glenn Lyons and Greg Marsden have set out in the following paper: Lyons, G. and Marsden, G. (2018). Opening out and closing down uncertainty in transport planning – purpose, procedures and people. *Proc. 50th Universities Transport Study Group Annual Conference*, London, 3-5 January.
'Opening out' concerns exposing the nature and extent of uncertainty faced (as opposed to ignoring or concealing the extent). Meanwhile 'closing down' should not be misunderstood to mean narrowing down the extent of uncertainty again but rather adopting an approach to decision making that accommodates the uncertainty whilst avoiding paralysis.

[25] Lyons, G. (2018). Is Transport Planning Fit for Purpose? *Proc. of the 16th Annual Transport Practitioners Meeting*, 5-6 July, Oxford. http://eprints.uwe.ac.uk/36973

Participation

Roundtable participants; from left to right: Glenn Lyons, Tim Jones, Charlene Rohr, Adam Jones, Mark Ledbury, Lilli Matson, Sarah Rae, Alice Crossley, Alison Irvine, Julian Laidler and Stephen Cragg

Event attendance was by invitation only, and the following individuals participated:

- *Stephen Cragg*, Senior Modeller, Transport Scotland
- *Alice Crossley*, Head of Performance Analysis and Modelling, Highways England
- *Alison Irvine*, Director of Transport Strategy and Analysis, Transport Scotland
- *Adam Jones*, Strategic Forecasting Lead, Department for Transport
- *Tim Jones*, Programme Director, Future Agenda
- *Julian Laidler*, Senior Transport Strategy Officer, Transport for Greater Manchester
- *Mark Ledbury*, Head of Transport Appraisal and Strategic Modelling, Department for Transport
- *Glenn Lyons*, Mott MacDonald Professor of Future Mobility, UWE Bristol
- *Lilli Matson*, Director of Transport Strategy, Transport for London
- *Sarah Rae*, Head of Modelling and Analysis Team, National Infrastructure Commission
- *Charlene Rohr*, Senior Research Leader, RAND Corporation

Further invited individuals were unable to attend but in absentia contributed written responses to the four questions above (included in Appendix 1):

- *Helen Bowkett*, Senior Technical Director, Arcadis
- *Phil Goodwin*, Emeritus Professor of Transport Policy, UCL and UWE Bristol
- *Patrick Harris*, Founder, thoughtengine
- *Greg Marsden*, Professor of Transport Governance, University of Leeds
- *Tom van Vuren*, Divisional Director, Mott MacDonald

All those individuals named above had the opportunity to comment on the earlier draft version of this report and suggest amendments. Their generous input of time and insight is very gratefully acknowledged. Responsibility for the content of this report as a record of the exercise and any matters of accuracy rests with its author.

The event was held at the Chartered Institution of Highways & Transportation and hosted by Sue Percy, CIHT Chief Executive.

Part 2 – record of roundtable discussions

In this main part of the report, the key themes that arose during the discussion are set out. This is not intended to be a synopsis. For the reader in a hurry, please refer to the Summary. It is instead a thorough account of the detail of the discussion that took place, intended to be of value to those taking a close interest in the matter of handling uncertainty.

Introductory insights

Participants each gave introductory remarks regarding the topic and their initial observations. The following points emerged:

- *A wicked problem and the importance of communication* - Until it is engaged with, uncertainty may appear relatively straightforward to contemplate. Once engagement begins it becomes clear that it constitutes a wicked problem. 'Wicked' reflects that it is marked by: divergence in views, understanding and values across the actors involved; it faces knowledge gaps and a lack of 'evidence'; and it has to deal with complex relationships between multiple considerations. In turn the primacy and challenge of being able to effectively communicate uncertainty and communicate how it is being handled becomes apparent. Communication relates to decision makers, senior officials and the public. There is a risk of 'uncertainty push back' with analysts expected to 'resolve' uncertainty and provide the answer. Beyond what should be expected of transport analysts in handling uncertainty, this raises the question of what should be expected of decision makers?
- *How analysis can inform decision making* - Of heightened interest and importance beyond the development of modelling and forecasting techniques is *how* they are used to inform and support decision making. How can a policy path be plotted that supports a higher level vision and which minimises risks to policy effectiveness relating to alternative plausible future states of the world? There is a need to avoid policy action becoming paralysed by the uncertainty exposed through scenario planning. Importance should shift from notions of optimal decision making to decision making that is seen to be *robust* to the future uncertainty faced. In short, "what's the best way through this maze?"
- *Different inter-related timescales regarding uncertainty* - There are different timescales faced when handling uncertainty. A transport strategy may have a 25-year timescale. Yet within this there could be a succession of 5-year business planning cycles. The latter tend to demand greater confidence in the plans and their outcomes while the former offers (or appears to offer) scope for adaptation to changing circumstances over the period. Business planning and its response to uncertainty can lead to conservatism and this may have opportunity costs in relation to responding robustly with regard to the longer term. Does a succession of five-yearly business planning cycles of itself constitute adaptive planning with regard to a longer-term vision and the handling of uncertainty? Major capital investments in particular are more prone to the need to have accommodated uncertainty if there is to be confidence in the longer-term returns on such investments, allied to a higher-level vision.
- *The nature of appropriate analytical approaches* - Breadth versus depth and qualitative versus quantitative approaches are important considerations when it comes to examining multiple

potential future states. Is it more appropriate to analyse a much greater number of future scenarios in limited detail or to target a small number of future scenarios that are analysed in more detail? Are simpler models more useful than more complex models because they offer more scope, perhaps, for exploring alternative possibilities? Simpler models may offer an agility as part of a wider process of handling uncertainty – a chance to 'rapidly prototype' combinations of policy measures and future plausible states of the world.

- *The importance of engagement and diversity of views* - The future is unknown. To suggest otherwise is misguided. By engaging as many informed views from different perspectives as possible there is greater prospect of achieving a better-informed position from which to support decision making.
- *Evolving the approach to handling uncertainty* - A current challenge in handling uncertainty is: (i) a reliance on existing proven tools and techniques in transport analysis; and (ii) limited timescales within which to appropriately address uncertainty through augmenting such tools and techniques with further analytical approaches. Over time there is the prospect of 'learning while doing' and being able to improve approaches and develop new approaches (including those which reach beyond (only) the transport sector). Nevertheless, more immediately there is a risk of being relatively ill-equipped to handle uncertainty and reverting to incremental planning cycles where the risks of 'going wrong' can appear lower. For improved and new approaches to gain traction and uptake it would be helpful for case studies of their application to be shared, with particular emphasis on how decision makers have been able to act upon the analytical advice concerning handling uncertainty.

The following sections reflect the issues and insights that emerged from addressing the four questions posed for the roundtable.

In terms of opening out uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?

This question gave rise to three main themes emerging: (i) handling uncertainty as a wicked problem (with matters of interpretation a central consideration); (ii) inertia associated with established transport planning and decision making; and (iii) learning by doing as a means to making progress with handling uncertainty.

Handling uncertainty as a wicked problem

It is not always easy to appreciate that handling uncertainty – or more particularly handling *deep* uncertainty – extends beyond being a complex problem. Handling deep uncertainty amounts to a *wicked* problem[26]. Coming to terms with the idea that handling uncertainty is not a *soluble* problem with an optimal outcome or one that lends itself to rigid procedural steps and guidance in terms of analysis can help avoid a sense of dissatisfaction with attempts to address it. Nevertheless, coming to terms with handling uncertainty being a wicked problem may itself be far from straightforward.

What is handling uncertainty seeking to achieve?

Part of being able to embrace the *extent* of uncertainty being faced concerns having a clear understanding of the purpose of embracing uncertainty. There is an emerging viewpoint that this purpose should concern being able to make decisions that are robust to multiple futures. It is about having a vision or strategy and being able to demonstrate that a particular decision concerning a policy measure or investment will move developments towards that vision, irrespective of whatever wider contextual developments are unfolding. Factors affecting how the future unfolds are both endogenous and exogenous. The decision maker exercises some control over shaping the future; but at the same time that future is also shaped by forces beyond the (direct) control of the decision maker. This can be a conundrum in terms of using scenario planning to explore the future. On the one hand, a scenario can depict the future that is sought, with steps then mapped out of how to get there. On the other hand, a scenario can depict one of many plausible futures within which a vision or strategy is striving to be fulfilled.

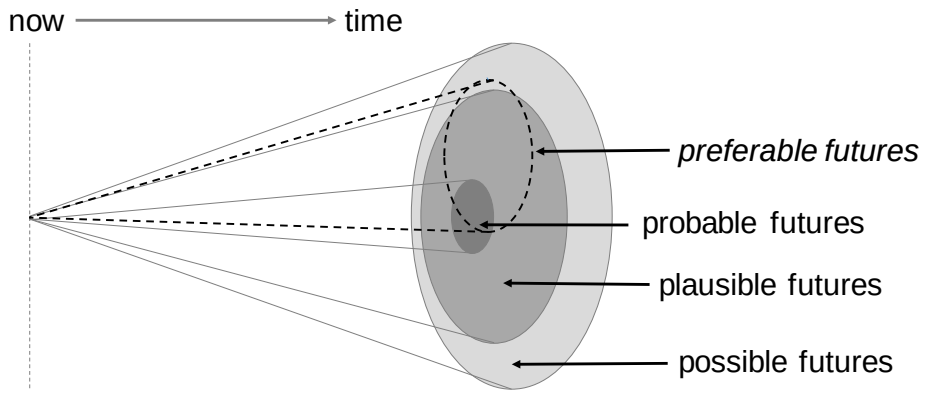
In some cases the purpose of decision making is to address the need to move into the unknown towards a desirable future state or set of outcomes in the longer term. This is achieved by being able to make choices between a number of policy and investment options in the shorter term that are likely to prove effective across a wide number of alternative futures such that regret over what might prove to be an ill-judged decision can be minimised. There are, however, complications in a hedge-betting approach which seeks to ensure a positive return on a decision in different futures. It can lead to conservatism and distinctly suboptimal outcomes – were the notion of a truly optimal outcome even to be appropriate. From an analytical perspective, handling uncertainty

[26] See Head, B. (2010). Evidence-based policy: principles and requirements. In Strengthening evidence based policy in the Australian federation. Volume 1: Proceedings, Roundtable Proceedings, Productivity Commission, Canberra, 13-26. Available at: https://www.pc.gov.au/research/supporting/strengthening-evidence/roundtable-proceedings-volume1.pdf

becomes a matter of being able to advise the decision maker that they are making a robust decision – one that will likely not be optimal for any given future state but rather will prove to be a good decision in the face of multiple (perhaps extreme) future states. In this sense, given the uncertainty faced it could be considered the best or most appropriate decision to take – one that sets the right direction of travel in relation to the higher level strategy or vision.

Subjectivity, perception and ambiguity

Opening out uncertainty is a subjective undertaking. The 'futures cone' shown below [27] is a helpful *conceptual* means of distinguishing between probable (likely to happen), plausible (could happen) and possible (might happen) futures. However, in practice not only is there the question of which of these types of futures should be planned for but also the question over how one distinguishes between futures that are probable, plausible and possible. Different individuals will have different opinions on this – something that opening out uncertainty through scenario planning has to contend with. Scenario planning itself is typically a participatory process involving the opinions of those taking part. The selection of participants and the knowledge, experiences and prejudices they have will influence the scenario planning and its outcomes. How can one know whether scenario planning has been too conservative or too extreme in relation to the futures cone? How can one know whether a scenario planning exercise has been done well or not so well when being presented with its results? These are challenges in relation to the notion of *appropriately* opening out uncertainty.



Such matters of perception and ambiguity apply to the existing handling of uncertainty within the Department for Transport's WebTAG. WebTAG is seen by some to be a straightjacket within which transport analysis is fitted while others recognise its function as a source of *guidance* within which flexibility of interpretation and application resides. It is acknowledged that, while the extent of WebTAG guidance is considerable, there is by comparison very little published about how the guidance is (or can be) interpreted and applied in practice in the course of supporting decision making[28]. This may well be a barrier to more innovative approaches emerging. In relation to opening out uncertainty in scheme appraisal, *sensitivity analysis* is the focus of WebTAG[29]. Even

[27] See https://thevoroscope.com/2017/02/24/the-futures-cone-use-and-history/
[28] This is something identified in the DfT's consultation on its transport appraisal and modelling strategy.
[29] TAG Unit M4 forecasting and uncertainty. See https://www.gov.uk/government/publications/webtag-tag-unit-m4-forecasting-and-uncertainty-may-2018

amongst those participating in the roundtable discussion, there was a lack of clear consensus on the interpretation of sensitivity analysis and the extent of its value in handling deep uncertainty.

One view is as follows. Sensitivity testing was never intended to cope with plausible, let alone possible, futures and instead is limited in its appropriateness to the realms of handing probable futures. The premise of sensitivity testing is that a central (most likely) case exists around which variations are tested. This becomes seen as the reference case that is principally drawn to the attention of decision makers. This cannot be deemed helpful in terms of opening out deep uncertainty. Sensitivity testing is founded upon an extrapolation of trends that have been seen historically and then adjusting variables associated with such trends. This contrasts with scenario planning where very different (counter trend) states of the world are (also) contemplated (for example in relation to connected autonomous vehicles).

An alternative view is also offered. Interpretation of sensitivity analysis for handling uncertainty depends upon what sensitivity analysis itself is understood to mean. Models are tools to illustrate what might happen in the future as a consequence of different input assumptions and/or assumptions about relationships between variables. It is the *way* in which these tools are applied that determines the nature and extent of handling uncertainty. Exploring changes to a reference case might highlight that the reference case is very sensitive to its underlying assumptions. This in turn could lead to alternative reference cases being considered. Thus sensitivity analysis is a tool that is neither inherently fit or unfit for the purpose of handling uncertainty but whose fitness for purpose depends upon how and when it is used.

Inertia associated with established transport planning and decision making

Quite understandably, there are established ways of doing things in transport analysis including the nature and extent to which uncertainty is addressed. Established approaches give rise to norms and expectations in the practice of transport planning and decision making that can become entrenched. These can be difficult to change giving rise to a sense of inertia faced by any new approaches to handling uncertainty.

Making the case in the incumbent transport planning regime

Investment decisions are not directly based upon the benefit-cost ration (BCR) of a scheme but are based upon a value for money case (poor, low, medium, high, very high) alongside four other cases: strategic fit, commercial viability, financial affordability and deliverability. Nevertheless, this is not how things are often perceived with an assumed primacy of the BCR in governing the outcome of an appraisal. Even if WebTAG does not say as much, its interpretation or portrayal in rank and file transport planning and policymaking tends to be as such. A good deal of transport planning culminates in a public enquiry examining the proposed investment. It is suggested that emphasising uncertainty in such a forum is not welcome (and indeed could even lead to further legal challenge).

The following analogy is offered between a public enquiry and a court case. In a court case, while the defendant's legal team may want to emphasise uncertainty (and hence doubt), the team for the prosecution is seeking to prove the case against the defendant and to do so through

emphasising certainty. The proponent of a major transport scheme could be seen to be in a similar position to the prosecution. Their case has to be made convincingly and to introduce uncertainty would be to introduce doubt into the case being made. Similarly the perception is that when DfT makes a case to the Treasury for investment, it is better placed to convey confidence in the return on investment estimates rather than to suggest a range of outcomes from the proposed investment, dependent upon how future uncertainty plays out. In practice, the Treasury in some respects does have a willingness to engage in consideration of *outcome ranges* – moreso perhaps than is commonly understood. For example, Monte Carlo analysis was employed in supporting the business case for HS2. Scenarios analysis was considered in the case of the Airports Commission's examination of options for new capacity provision for UK aviation. At the same time, it is recognised that in some instances the making of public statements about major investment can create pressures to be able to offer a definitive figure on return on investment.

Messaging by politicians versus back-office requirements

It was recognised that in politicians making their case publicly for investment, they may well not centre upon value for money and BCRs but instead focus upon outcomes of relevance to the public and to business, for instance in heralding creation of new jobs, reducing waiting times for hospital treatment or the building of new homes. Nevertheless, there would remain an imperative to 'get the wiring behind it correct' so that a politician is able to confidently make such claims. This would involve persuading other bodies and government departments of the merits of the investment wherein the economic case and an inclination towards concealing uncertainty may well exist.

Inertia that prevents uncertainty from being embraced more convincingly is significant. This relates back to the uncomfortable nature of dealing with the wicked problem of uncertainty. Acknowledging uncertainty has connotations of poor confidence and conviction in decision making and associated problems for how decisions are able to be communicated. In such a setting it can be considered (too) bold and risky to break with the norms and established practices of transport planning and to pioneer more strongly embracing and exposing uncertainty. It would be easier to engage decision makers and the public in issues of deep uncertainty if there was a clear route for coming to a decision off the back of understanding that uncertainty.

Learning by doing as a means to making progress with handling uncertainty

A wicked problem coupled with inertia associated with established approaches can create a hesitancy around applying and sharing experiences of new approaches until their efficacy and robustness can be demonstrated. This risks stifling innovation and progress in transport planning at the very time that this may be needed if transport planning is to remain fit for purpose.

Getting it right

As noted earlier, the subjective nature of scenario planning exercises can raise questions over how one distinguishes between a well-run and not so well-run exercise. Development of scenarios is a challenging undertaking that is as much an art as a science. Scenarios can be pitched at too broad a level such that they lose relevance; they can be (considered by some to be) too extreme or not

extreme enough. Scenarios can risk becoming too inward looking in relation to transport and fail to accommodate the wider array of drivers of change that may *indirectly* affect the transport system's use. The National Infrastructure Commission's remit affords it the opportunity and indeed obligation to look more widely but this does not mean that to do so is straightforward. How should uncertainty be handled at different *levels* of decision making from strategic planning through to scheme options and on to scheme design options (such as how many escalators to have at a station or how long the platforms should be)? Such considerations and more besides could suggest real challenges in knowing how best to proceed.

Just do it

It would seem premature to expect that definitive guidance should be made available in relation to how to 'get it right' (though this should not preclude the development of guidance that can be evolved over time as experience of handling uncertainty accumulates). Instead it is suggested that we should 'just do it' – proceed with undertaking to make best endeavours to go through the process of opening out uncertainty and learn from the process of doing so. Importantly, if real progress is to be made, we need knowledge-sharing regarding: lessons learnt; strengths and weaknesses of exercises undertaken; and opportunities for emulating and improving upon completed exercises.

We should not lose sight of the fact that opening out uncertainty is as much about *opening minds* of the analysts, decision makers and stakeholders as it is about producing a suitable set of future scenarios. It is about engendering a new mindset of robust decision making whereby there is confidence in having stress tested the suitability of a proposed measure or scheme against alternative futures.

Just doing it may not be straightforward – especially in a live transport planning and decision making environment where there are also political realities to contend with. However, there appear to be growing instances of transport authorities wishing to engage in opening out uncertainty, particularly at an early stage in the policymaking pathway. This is something to be celebrated, promoted and shared. It is also important to make the most of what we already have. It may be recognised that our existing models are not particularly well placed to address future mobility dimensions such as technology-driven innovation but this should not preclude examining scenarios – however crude – within the bounds of the models' capabilities in the interests of helping expose uncertainty and open minds to the plausibility of different futures.

In terms of closing down uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?

The notion of *closing down* uncertainty may be ambiguous as a concept. In the question above framing the discussion, it is described as 'making sense of the plurality of futures for the purposes of informing targeted policymaking action'. Crucially this is not, or should not be, about simply reversing the process of opening out uncertainty by concealing it. However, this can happen in the face of potential paralysis due to the extent of uncertainty exposed through opening out. The discussion distinguished between: (i) concealing uncertainty; (ii) reducing uncertainty; and (iii) accommodating uncertainty (the latter having already been identified as part of the overall handling of uncertainty in the section above). As noted previously, handling uncertainty is a wicked problem and it is difficult if not impossible, even in the fullness of time, to be entirely clear on whether or not closing down uncertainty has been done in an appropriate way with regard to making a robust decision in the face of multiple plausible futures that could play out.

Concealing uncertainty

Inadequate opening out

It can be suggested that if the process of opening out uncertainty has been limited or inadequate then a degree of the uncertainty faced remains concealed. Earlier consideration of the appropriateness of sensitivity testing for opening out is a case in point. In relation to road traffic forecasts, for example, it is difficult to judge whether or not a range of forecasts reflects a sufficient exposure of uncertainty. That such forecasts have only ever indicated varying degrees of *growth* in total road traffic could suggest that some uncertainty remains concealed, particularly in the light of the phenomenon of peak car seen in the early years of this millennium[30]. Faced with a range of degrees of projected growth, closing down of uncertainty could then be in the form of a reasonable assumption that provision of further highway capacity makes sense in order to accommodate growth, albeit with uncertainty in its magnitude.

Undoing the opening out

Concealing uncertainty may also come from human judgement and associated biases in relation to making sense of the results of opening out uncertainty whereby an inclination towards inferring varying degrees of likelihood of different scenarios may arise. For instance, from a set of plausible scenarios identified through opening out, some may be judged to be probable while other plausible scenarios are judged only possible. This type of behaviour can be observed in futures discussions where people will cite examples from the past to support their views on the likelihood of future change or pace of change coming to pass. For example, one may be inclined to make the case for the probability of rapid uptake of driverless cars on the basis of comparison with the adoption of smart phones in society. On the other hand, one could argue for little or much slower

[30] It should be noted that the Department for Transport's 2015 Road Traffic Forecasts did include a scenario of declining trip rates.

uptake of driverless cars on the basis of comparison with the lack of adoption of 3D television technology in spite of its availability.

Reducing uncertainty

One interpretation of closing down uncertainty is the act of narrowing down a large number of plausible future scenarios to a much smaller subset in order to make the process of policy testing against scenarios more manageable. This might be considered a form of concealing uncertainty *if* it were the case that through narrowing down, the diversity of plausible futures was not well represented. On the other hand, if the diversity is preserved it could be considered a pragmatic means of reducing uncertainty in order to assist in the process of informed decision making.

Judgements over declining uncertainty

Another interpretation of reducing uncertainty is where 'reducing' is an adjective – in other words, uncertainty itself is reducing or at least *is judged to be*[31]. This can relate to the importance of monitoring trends over time from which greater confidence in new directions of development into the future may arise. For instance, there has been a 25 per cent growth in cycling traffic in the last 10 years in the UK. When allied to declining driving licence holding amongst younger people, heightened awareness of public health, the emergence of cycle share schemes and of e-bikes, this could be taken to suggest a growing confidence in active travel being a prominent feature in urban areas of the future – in contrast to how this might have been viewed only a few years ago.

Crucial in this regard – and with some difficulty in the distinction between *concealing* and *reducing* uncertainty – is the matter of judgement over changing levels of uncertainty. As has been said by the science fiction writer William Gibson, 'the future is already here its just not evenly distributed'. In other words, there are signals of the future to be seen in the present – the challenge is having confidence in being able to spot those signals and act upon them. Kodak is notable for its slow transition from photographic film to digital photography[32] in spite of the signals being there. More relevant to transport might be the changes being seen regarding private hire vehicles with the rise of Uber. The numbers of journeys concerned against total travel may be relatively small but with significant change over a short period of time. At what point might one judge this to be a sign of things to come and infer greater confidence or certainty in this? Such deliberations are a reminder that handling uncertainty is far from an exact science and relies upon matters of judgement amongst the actors involved.

Acting to reduce uncertainty

'Reducing' may also be a verb in terms of reducing uncertainty – in other words, taking steps to reduce uncertainty. In theory, a government could mandate and legislate for strict controls over motor vehicles and their use to the extent that the advent of driverless cars, regardless of the technology readiness and rate of adoption, does not spell deep uncertainty but is 'contained'

[31] It could be questioned whether or not the assertion that we are in much more uncertain times is itself valid – might it not (at least in part) be that we are getting better at exposing and making sense of uncertainty which might give the impression that it is now greater than in the past?

[32] https://en.wikipedia.org/wiki/Kodak

within strict governance frameworks. In short, an interventionist approach by government in the market could exercise much more control over the shape of the future, thus reducing uncertainty. There may be other means within the public sector of acting to reduce uncertainty. A particular example is that of land use and transport. Future housing stock could be considered an exogenous and uncertain driver affecting the transport sector in terms of transport analysis in the handling of uncertainty. Yet to a significant degree, future housing stock is a responsibility of another arm of government in terms of its nature, extent and distribution. Could greater co-ordination between different parts of government internalise some of the drivers of change? Could this hold the prospect of exercising more control over that change or at least rendering aspects of change more rather than less certain? This may be an avenue to explore. It risks being seen as 'command and control'. Instead it can be viewed as a form of *co-ordination* that fosters discussions that can help in the collective capability of handling uncertainty. This may become even more important (albeit more challenging) in the face of devolution.

Accommodating uncertainty

At one extreme there may be little or no uncertainty of relevance if the decision making authority is in (near) total control of shaping the future. At the other extreme that authority may be entirely at the mercy of external and uncertain forces beyond its control. The likely reality will be somewhere in between. Once uncertainty has been exposed and is no longer concealed and cannot be reduced, the decision making process must act in a way so as to *accommodate* the uncertainty.

Having a vision

Whether in qualitative or in more analytical and quantitative terms, the notion of *robust* decision making in the face of uncertainty seems compelling: the opportunity to apply some degree of stress testing to particular measures and policy paths in terms of how their outcomes – in relation to an overall vision for the future desired - may be affected by uncertain driving forces. With the vision or overall goal as a beacon, the policymaking process can iterate and narrow down decision making options to a point of general comfort and consensus amongst the actors involved regarding a tenable strategy. The uncertainty is not removed (or even diminished) but the process has been cognisant of the uncertainty and in this sense the outcome decisions have been 'informed'. Such a vision-led approach in principle can encourage more attention to optioneering – exploring multiply ways in which a course might be set towards realising the longer term vision.

For instance, if the vision involves the goal of a zero carbon future then, with a least regrets approach in mind, does one bank upon a large-scale transfer to electric, connected autonomous vehicles realising the vision or upon promotion of walking and cycling – or upon some combination of the two? Considering such different means to achieve the same end and how they may be affected by uncertainty could lead to a healthy process of debate, iteration and convergence (where open-mindedness has been prioritised in a way that can accommodate differences of opinion about the uncertainty in question). Norway's zero growth objective for passenger car

traffic in urban areas[33] may be a case in point where the vision acts as a catalyst. It should remain clear that having a vision does not itself dispel the need to account for uncertainty in terms of developing policy actions and investments that can move towards realisation of the vision in the face of external drivers of change.

A mixed economy

It can be suggested that where decision making involves a 'mixed economy' in terms of different means of providing mobility and accessibility, it may be easier to have confidence in weathering uncertainty by having a *package* of measures and investments. While different elements of a package may perform more or less well in the face of different plausible future scenarios, there may be greater likelihood that the package as a whole performs robustly across different plausible future scenarios. In this context, handling uncertainty for Network Rail or Highways England may be more challenging than for the likes of TfL, TfGM and Transport Scotland with the latter organisations having greater span across modes and means of providing accessibility.

Adaptive planning

Real Options Analysis is identified in the regime testing policymaking pathway in Part 1. This typically involves considering higher up-front investment in infrastructure schemes so as to put in place the *option* of doing something in the future, should conditions dictate. For example, with HS2, investment options exist in relation to station design to be able to accommodate the prospect of demand forecasts underestimating out-turn future demand; or underestimates of the number of conventional trains stopping at high-speed rail stations. Faced with the plausibility of being in a future position of needing greater station capacity, and the significant disruption and costs this would entail, it may be a prudent investment to enhance the station design now to either have greater capacity than the forecast need or to have the later option to incorporate that capacity if required.

Such approaches do give rise again to the matter of communicating uncertainty and communicating how it is being handled. Increased up-front investment could be construed in the media as wasteful use of public money in creating white elephants. On the other hand, decision makers may risk downstream criticism for short-sightedness if uncertainty is poorly handled and some degree of real-options thinking has not been applied. In the former case, the politicians involved would be in office. In the latter the original decision makers may no longer be in office. Politics is therefore never far away where difficult decisions relating to uncertainty are being made.

Major infrastructure investments may be contrasted with more incremental developments or with policies and measures that can be adjusted over time. In such cases there is more scope for *adaptability* over time. This calls for continuous or regular *monitoring* of trends in relevant drivers of change associated with uncertainty with a readiness and agency to adapt or change policy measures and investments according to the latest insights. This holds the prospect of maintaining

[33] https://www.ntp.dep.no/English/_attachment/1525049/binary/1132766?_ts=1571e02a3c0

a robustness of response to uncertainty and continuing to steer a suitable course towards the longer term vision (which itself may be subject to revision).

Adaptive *thinking* may also play its part with *reframing* being a form of closing down uncertainty. Some years ago, Shell was considering the big issues being faced by society in the coming 30 years, one of which was water. For a company known for drilling holes for oil this was not seen as an issue it could engage with. However, with a realisation that Shell was in the business of moving liquids with its oil pipelines came an understanding that it could be well-positioned to play a part in addressing the issue. Similarly for the transport sector, reframing from 'increasing mobility' to 'improving access' could introduce new dynamics into the decision making process.

In terms of analytical robustness (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?

We have evolved a way of thinking about transport analysis over half a century and more. There are expectations and norms around robustness of analysis that may appear immutable. Yet faced with the (new) circumstances of handling deep uncertainty it seems entirely appropriate to question the notion of *analytical robustness*. There is subjectivity in opening up uncertainty in relation to how scenarios are identified and characterised. There is a value laden approach to vision-led policymaking and handling of uncertainty. Given such developments, can established analytical techniques be seen in the same light regarding their robustness? The key themes in the discussion prompted by this question were: (i) fitness for purpose (appropriateness of analysis for supporting the decision making process); (ii) guidance and leadership (providing people with the appropriate direction, mandate and agency to address uncertainty); and (iii) quantitative breadth and qualitative depth (the relative merits of analysis that is broad or deep and of 'narrative' and 'numbers').

Fitness for purpose

Perhaps central to the notion of robustness is a need for the analytical approach being employed to be fit for purpose.

Putting emphasis in the right place

In this sense, the importance of robustness at the early stages of the policymaking process, where high level optioneering is being considered, should be recognised. There is a risk that this is overlooked in the face of the characteristically more detailed and complex analysis that can take place further downstream at stages of scheme selection and scheme design. This gives rise to a *proportionality* concern in the overall process of analysis. There is a risk that emphasis is being put in the wrong place in terms of analytical effort and rigour.

Robustness then is not necessarily characterised by 'analytical might' but instead by whether it *appropriately* supports the decision making process in seeking ultimately to secure effective outcomes. There is a need to determine what the right tools for the job are for the stage in the process being addressed. Complex and expensive modelling tools may very well not be appropriate to employ at an early stage in the decision making process when many factors and options are under consideration. Not only do they involve long run times but they operate with a level of detail that does not befit the nature of input information available with which they are fed. Simpler (though not to infer less robust) analytical tools can be more effective in enabling dialogue and development of views amongst actors in the decision making process at this earlier stage. A scenario planning process is more appropriate for early stage optioneering whereas sensitivity testing may be more suited to scrutinising shortlisted measures and schemes downstream in the process (notwithstanding the earlier point regarding what is meant by sensitivity testing).

Heavyweight tools

In some respects the transport sector risks being encumbered by the legacy of its established modelling tools. It is suggested that there is a tradition in transport of using uniquely complex quantitative tools which originated from a time when their purpose was to work out the routing of cars through a fixed highway network. As the problems to be addressed have become more complex, there has been a tendency to add 'bolt-ons' to that basic network based model, culminating in a hugely complex and difficult modelling process.

Large scale strategic transport models still have their place – perhaps particularly in being able to examine how policy packages may perform and whether particular elements work in harmony with others in terms of their consequences for the overall system. Nevertheless, in the face of uncertainty, there remains a need to be alert to the prospect that analytical complexity and detail may not equate to analytical robustness in terms of the extent of insights offered into the decision making process with a high risk of false precision.

Rules of the game

From a somewhat different perspective on fitness for purpose, a concern is raised that public authorities can be distracted from attempts to sensibly apply the right analytical approaches for given stages in the policymaking process and the handling of uncertainty. Such distraction comes from funding initiatives from central government wherein the task becomes one of trying to secure funding which requires that the 'rules of the game' are followed. This can result in contortions that try and reconcile misalignment between what is best suited for fulfilment of a strategy or vision in the face of uncertainty and what is best suited for winning the funding on offer. It is also suggested that perverse incentives for analysis are created by the way funding is allocated – 'encouraging lots and lots of money to be spent on very sophisticated modelling chasing a BCR' - rather than investing analytical resource where it may be most needed which is at the earlier stage in the decision making process where uncertainty is being exposed and optioneering is taking place.

Guidance and leadership

Guidance on handling uncertainty

There is limited (formal) guidance on handling uncertainty in relation to some of the approaches and issues considered in this report. For instance, how many scenarios should be considered in opening out uncertainty and in what level of detail and using what process for their development? How should closing down uncertainty be addressed and using what tools? Lack of guidance is in part because we are at the early stages of considering new approaches to handling uncertainty in transport planning and decision making. For example, Robust Decision Making (RDM) as an approach to handling uncertainty conceived by RAND some years ago has been applied to decision making regarding climate change, water infrastructure and energy requirements. However, it has never been applied (at scale) in transport. Meanwhile, at the time of writing, Transport Scotland's trailblazing approach to applying similar principles to RDM to inform its National Transport Strategy remains a work in progress whose effectiveness and lessons learnt are yet to be revealed.

It would seem important to be harnessing insights from such approaches and offering at least outline guidance on approaches to handling uncertainty that can be adapted and enriched over time as experience accumulates.

Guidance on the guidance and being capable of using it

At the same time, there is a need for further development of capability, skills and the application of leadership in organisations faced with handling uncertainty. It is suggested that at present, in some instances, analysis resides in engineering-based environments in which people are naturally inclined to gravitate towards complex numerical modelling. Analysts need to have the ability to address uncertainty in an appropriate (robust) way and the mandate and confidence to do so. A greater breadth of skills and experience needs to be achieved alongside being able to ensure fitness for purpose in handling uncertainty – something that extends beyond complex numerical modelling. As noted earlier, DfT already recognises the challenge of ensuring its WebTAG guidance is appropriately used and now sees merit in providing more case study material regarding its application and outcomes. In relation to new approaches and new guidance concerning handling uncertainty, there is likely still to be a need for, in effect, *guidance on how to use the guidance*.

Quantitative breadth and qualitative depth

In handling uncertainty through the use of scenarios there are different approaches in relation to how many scenarios are considered, in what detail they are considered and the role of quantitative and qualitative analysis and communication. The value or appropriateness of different approaches can vary at different stages in the policymaking process from strategy to programme to scheme to detailed design.

Tight and deep

Having a number of important and uncertain drivers of change to account for can lead to a substantial number of combinations of how those drivers could collectively play out. However, not all combinations would make sense in terms of internal consistency and plausibility and some combinations may suggest similar outcome states. There are also pragmatic considerations regarding how many scenarios can be addressed within the time and analytical resource available. Taken together, this can lead to and perhaps warrant the selection of a (relatively) small subset of combinations as being reflective of the uncertainty space of plausible futures.

Most classically, (qualitative) scenario planning considers two 'critical uncertainties' resulting in four plausible future scenarios. There is nothing to preclude more scenarios being considered and this can sometimes be the case. In its 2015 national road traffic forecasts, the DfT (for the first time taking a scenarios approach addressing the notion of plausible futures) set out five scenarios[34]. Earlier this year Infrastructure Victoria set out seven scenarios for automated and zero emission vehicles[35]. The National Infrastructure Commission (with a remit extending beyond transport alone) has considered even more. The Infrastructure Victoria example focuses upon

[34] https://www.gov.uk/government/publications/road-traffic-forecasts-2015
[35] https://yoursay.infrastructurevictoria.com.au/download_file/296/380

qualitative scenarios that test extremes. The DfT and NIC examples concern quantitative modelling wherein there is a reliance on the tools available.

Broad and shallow

Selective combinations of drivers of change resulting in a confined number of scenarios can offer the opportunity to look in greater analytical depth at those scenarios. However, in terms of seeking to handle uncertainty, the question remains as to whether or not such a selective approach risks overlooking other plausible combinations of drivers (leading to significantly different future states that could have implications for the robustness of decision making). An alternative approach - which could be qualitative but perhaps better lends itself to quantitative analysis – is to consider large numbers of combinations of factors (scenarios) that move more towards looking (in less depth with the employment of less sophisticated modelling) at the full uncertainty space of plausible futures[36] (a full-factorial approach). This holds the prospect of considering how policy options and measures would fare in this space, with the theoretical means at least to be able to have decision making that has minimised regret in X per cent of the many future states considered. One of the limitations is the confidence one can have in the underpinning assumptions of a much more simplified modelling approach that is capable of playing out hundreds or thousands of combinations of multiple drivers of change. False precision and misplaced notions of accuracy may lurk within.

Best of both

What emerges is a sense that there is an appeal (resources and timescales notwithstanding) to trying to get the best of both of the above. This concerns ensuring the uncertainty space of plausible futures is adequately covered and appreciated while being able to 'get closer' to a subset of such futures and explore with actors in the decision making process how such futures could affect the robustness of different decision options. There is also a need to recognise the place of both 'narrative' and 'numbers' in relation to how to ensure effective engagement with actors and to communicate the plausibility and credibility of the scenarios analysis.

[36] Monte Carlo analysis could play a part here in its sampling of probability distributions of individual variables to produce large numbers of possible outcome states from sets of variables and in turn calculate the probability of different outcomes occurring.

What are the most pressing issues (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?

The roundtable was quite deliberately comprised of a set of invited participants more directly engaged in thinking about, and acting upon, the matter of handling uncertainty than is the case for the community of transport planners and decision makers as a whole. On the basis that handling uncertainty should be seen as a critical consideration for policymaking and investment, a key challenge becomes how to improve the effectiveness of handling uncertainty and promote its wider uptake across transport planning and decision making. The two overarching pressing issues to emerge were: (i) resources and expertise (the capability to address the challenge); and (ii) embracing and evolving the handling of uncertainty (the means by which momentum can be created to foster improvements in practice).

Resources and expertise

At the very time when new thinking in transport planning and analysis is called for, public sector resources are more squeezed than ever. There is a diminishing pool of people in local authorities with the time, inclination or know-how to be able to engage in the matters being discussed by the roundtable gathering.

A perfect storm?

Public authority staff face considerable demands to undertake 'business as usual' tasks associated with shorter-term delivery plans and the chasing of central government funding, creating conflicts with input to strategic planning and any intentions to address new horizons and the handling of uncertainty. Meanwhile, the transport planning consultancy industry remains geared up for regime compliance and its underlying predict and provide mentality – 'give us the rules and we'll do it'. Unless public sector clients are able to develop greater capability to rethink some of the work they procure and to support, check and challenge that work undertaken by consultants then the consultants will commonly (and perhaps quite reasonably) 'just do what's said on the tin'. Public authorities represented at the roundtable discussion were large bodies, yet even they tend to have limited in-house capabilities when it comes to handling uncertainty.

It could be suggested that there is an endemic and serious problem for the UK (and other countries perhaps) to address in terms of having appropriate resources and expertise to support handling of uncertainty that can inform robust decision making.

New or reallocated resource and expertise

It may be that the quantum of resource available is reasonable and that it is a case of some redeployment of that resource that is called for within the transport analysis that supports the decision making process. This might be, for instance, moving some of the investment in sophisticated transport modelling tools at the level of scheme appraisal upstream to help develop more robust approaches to handling uncertainty at the strategic planning stage, in addressing

optioneering and in supporting adaptive planning. Major public sector bodies, including government departments, have significant buying power when it comes to procurement of consultancy work and they could provide a lead for other public sector bodies to follow. Changes to how work is specified and commissioned could help in resource redeployment. Resource redeployment should also involve consideration of what *types* of experts are required to tackle the handling of uncertainty and its communication to decision makers. For instance, the subjective nature of the topic and the fact that it can be particularly prone to bias lends itself to expertise from social and organisational psychology.

Handling uncertainty risks being more of a bolt-on to orthodox practice rather than becoming integral to it. Mainstream practice, procedures and incentives need to incorporate the handling of uncertainty, otherwise the bolt-on approach faces the prospect of being misaligned and even ignored. Similarly, mainstream practice needs to be open to regime-testing and consideration – through vision-led approaches – of supply shaping demand as well as, or instead of, demand shaping supply. Even if appropriate capability in terms of know-how and individuals with suitable expertise and experience are introduced, they may be unable to get traction with, and exert helpful influence on, the mainstream. This is reminiscent of school travel plans and school travel plan officers who were employed across local authorities but who were more or less 'sole traders' in their organisations and were swimming against the tide of car dependence.

Embracing and evolving the handling of uncertainty

During the course of the roundtable and the underpinning written comments, the need to encourage testing of new approaches that involve new people (broadening the expertise) and to share experiences came across strongly.

More widespread embracing of uncertainty could help in better handling it

From the perspective of bigger public authorities whose remit affects, and is affected by, smaller local authorities, it is important that the latter are also able to contribute to embracing uncertainty. Not least, this is because (as noted earlier) uncertainty for one organisation's remit may arise in part from the decisions being made by other organisations. Greater engagement in exploring futures and options and sharing of insights and decision making intentions could help in closing down overall uncertainty.

A persisting need to adequately explore the uncertainty space of plausible futures

Encouraging testing of new approaches and evolving approaches remains important for both opening out and closing down uncertainty. In relation to opening out uncertainty, concern remains that there can be a strong inclination to focus upon the factors that have been historically considered and where there is more analytical competence and confidence – factors such as population, economic output and fuel price in the case of road traffic for instance. Meanwhile, there may be a reluctance – especially in terms of opening out that is followed by closing down towards policy action - to embrace a wider set of drivers of change for which little or no empirical insight exists regarding how such drivers may affect outcome states – connected, autonomous vehicles being a case in point.

In adequately exploring the uncertainty space, it is particularly important to recognise the significance of examining behaviour change as a key determinant of future states and outcomes. This involves a need for greater efforts to monitor and understand established and emerging trends to inform exploration of the uncertainty space – for instance in relation to people's access to different types of mobility resource, the changing appeal of different modes and reasons behind this and the extent to which people are prepared to share mobility resources.

Sharing knowledge and experience

The need to share experience of handling uncertainty in practice and the insights from doing so is paramount. This should involve a broadening of participation and a willingness to challenge, if the risk of group think amongst the relatively small pool of players currently engaged is to be avoided and approaches are to be evolved. Included in this broadening and involvement of new players should be new (types of) experts and new decision making bodies.

UWE Bristol and Transport Scotland, prompted by the ongoing work to develop a scenario planning process and tool to handle uncertainty relating to Scotland's National Transport Strategy, have seized the initiative to encourage further sharing of experience. They have joined forces with the Chartered Institution of Highways & Transportation, PBL Netherlands Environmental Assessment Agency, the Dutch Ministry of Infrastructure and Water/Rijkswaterstaat and UK Department for Transport. They have organised a half-day seminar to take place on 11 October in Dublin as part of the 2018 European Transport Conference. The event is titled '*Decision making under uncertainty - the perils of ignorance and a means of effective response*'. Meanwhile CIHT, through its CIHT FUTURES initiative, has begun assembling short videos from those who are embracing uncertainty to help share their experiences and provide encouragement to others – see https://www.ciht.org.uk/knowledge-resource-centre/resources/futures/futures-inspirations/.

Development of guidance is an important form of synthesising the growing body of experience and helping to point towards best (or better) practice.

Finally, those involved in the roundtable recognised the value for them of being able to come together and address the topic. The roundtable format was something welcomed as a possible model to be repeated periodically in the future.

Appendix 1

Written submissions by invited participants in advance of or immediately following the roundtable discussion

Reactions in advance of the event from **Stephen Cragg** to the roundtable questions

Transport Scotland are updating Scotland's National Transport Strategy (NTS). Scenario Planning is informing this project. The update involves a number of Thematic Working Groups and two workshops were held with representatives of these groups to start mapping out the Scenarios we will work with. The answers below to the roundtable questions are written in this context. This is still very much a 'work in progress' though, so the plans for how it goes forward are, of course, uncertain and subject to change!

The views and opinions below are mine and may not represent those of Transport Scotland.

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

Approaches seen on this broadly fall into two camps:

- Incremental approach (e.g. DfT Road Traffic Forecasts and Transport Scotland Alternative Forecasts)
- 4 Quadrants approach (e.g. Network Rail, New Zealand).

The incremental approach adds in another dimension of uncertainty in a step by step manner. The main advantage of this approach, from an analysis perspective, is that you know exactly how your outputs relate to your inputs. The main disadvantage is that it's very time-intensive to undertake.

The quadrant approach takes what you consider to be the two most significant drivers of change and by combining them you get 4 variants. Quick to do, but limiting to just two drivers of change.

To open out we ran the concept of scenario planning at our annual Appraisal and Modelling User Group. We like to have an element of interaction with our attendees so we asked them what they thought might disrupt transport in the future:

1. What major transport disruptors will we need to test?
2. What major economic disruptors will we need to test?
3. Any other disruptors will we need to test?

220 suggestions were received! Many were duplicates, some were 'odd', but it gave us a rich seam of ideas. These were analysed and categorised into 33 'candidate' drivers and allocated into one of 5 'STEEP' categories [Social, Technological, Environmental, Economic and Political].

A workshop with stakeholders was held and the 33 candidates were whittled down to 8 key drivers:

- Population,
- Popularity of Walking and Cycling
- Demand for Personal Travel
- Capabilities and Affordability of Digital Technologies
- Change in share of Manually Controlled Motor Vehicles (i.e. rise of Autonomous Vehicles)
- GDP / (Disposable) Income

- Share of Knowledge work within the Economy
- Energy Supply Capacity relative to Demand

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

Taking the 8 key drivers of change: Even with just two options for each driver, this would give 256 variants. However, a number of the drivers are linked (i.e. if one goes up then another must also go up (or down)), but this has still given us over 30 'Do Nothing' scenarios.

We feel that over 30 variants of the future is still too many to practically work with. The current plan is to focus on what the NTS is seeking to achieve. This has identified four themes: Promotes Equality, Helps our Economy Prosper, Improves our Health and Wellbeing, and Takes Climate Action. Using these we will look to create 8 variants of the future based around whether we are doing well or doing badly in achieving these outcomes (in the absence of a new transport strategy).

Once we do this, we may find that there are fewer than 8 scenarios as some themes may always have a positive or negative correlation to other themes.

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

There is a lot to still be thought through here in terms of at what 'level' is scenario planning / uncertainty applied. I would suggest we categorise uncertainty into four levels – global, national, regional and local.

In terms of delivering an intervention on the ground, so to speak, that intervention does not exist in isolation. We will have a:

- NTS; delivering that strategy will require a
- Programme of interventions; each intervention will then need to be
- Designed, before it can be
- Delivered.

At the NTS end of the spectrum, global and national uncertainties are important.

At the NTS level we know where we are, we know where we want to get to but we don't know what life will throw at us in between. These are the uncertainties and we need to explore them because the Programme of interventions will differ depending on what path life ultimately takes us down.

Once we have decided what Programme of interventions we're taking, do we still need to consider all the uncertainties when we design a specific intervention? If we know that in a particular scenario that this intervention would not have been selected to be in the programme, then surely there is no point testing it because we already know it should not get implemented anyway?

There is also uncertainty at a local level which will be linked to national uncertainties (e.g. those allocations of housing and employment are going to be affected by population and economy). Other uncertainties (particularly the technology ones) may affect the intervention more directly (e.g. road design being affected by the proportion of CAVs) rather than the 'exogenous' drivers of demand. Together this makes me feel that a simplistic approach of say using a +/- 10% demand isn't enough. Thus, uncertainty, the relationships between drivers of uncertainty and the intervention, and the risk this brings becomes a very substantive (and arguably new to our industry) part of the process of transport planning and design.

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

It is difficult to see how this will not add complexity to the industry of transport planning. Hence, we need to give both decision makers and practitioners the confidence that addressing uncertainty will improve transport outcomes. That, however, isn't a modelling problem, but one which goes to the heart of how we do transport planning and appraisal.

The most pressing issue is to have 'case studies' particularly where we can learn about what we got wrong (which is usually more informative than what we got right). This should highlight the gaps in methodology and evidence, how we communicate with decision makers, etc.

Reactions in advance of the event from **Phil Goodwin** to the roundtable questions

Overview. Generally I support the line of argument (eg Glenn's scenarios, the Demand Commission, the 'peak car' discussion, Young People's Travel project) that many established 'certainties[37]' are no longer definite, especially (a) the presumption of indefinitely continued traffic growth; (b) the reliability of the established tools for explaining and forecasting it; (c) major technical, economic and social change, which is structural; (d) behavioural responses to all these, which are already changing trends. We need to put more emphasis on credible, substantially different scenarios, discuss which we prefer, and then work out viable trajectories to get there (if agreed) or to keep options open (if not agreed), instead of identifying a 'most probable' trajectory, then used for appraisal of projects and strategies.

The Problem of Traffic Forecasts. Future traffic levels are not repeated trials, to which we can assign quantified probabilities. There are broadly two qualitatively different credible future possibilities, that traffic volume can increase or reduce, each with an evidence base and conditions. They are mutually exclusive. Even if we assigned equal legitimacy to both, it would still not be valid to say that the most likely future is of stable traffic levels. The outcome will be determined by choices (within our control or not), events (expected or not), pressures (chosen or not), trends (understood or not) and policies (deliberate or not).

Currently[38] the forecasts increase, rather than reduce, uncertainty, because (note the syntax):

1. Most users and critics of traffic forecasts have a very high degree of certainty *that*
2. the DfT has a rather high degree of certainty *that*
   - traffic will continue to grow in the future broadly within the fan as published in the Road Traffic forecasts;
   - (and probably close to the middle of the fan);
   - and a falling traffic trajectory is not sufficiently likely to require formal inclusion in appraisal of projects or policies.
3. Some users think DfT verbal explanations mean traffic forecasts do not have such confidence, so DfT would approve of systematic appraisal based on reasoned other traffic trajectories, but cannot find unambiguous published advice confirming this.

Correcting these uncertainties would increase clarity and help to determine the future.

Advice. Politicians may want to be certain, but encouraging *over*-confidence is as dangerous as explaining complexity. If political parties have different policies or views of behaviour, I can foresee them needing different traffic forecasts (with the policies necessary to give effect to the desired traffic). This might require changes in the roles of Government Departments and/or politically independent advisers, and open access to tools and models.

Adaptability. If we don't know (or don't agree) what future we want, or what levers will give effect to it, then we need flexible adaptable low risk policies. Now there are unresolved professional issues about the evidence, trends and levers, incomplete public consensus on objectives, the perception of excessive DfT confidence in the forecasts, and almost complete political certainty about policies and strategies. That doesn't feel like a good combination.

[37] I am uncomfortable with the terminology 'the future is uncertain'. Uncertainty is a state of mind applying to people. I think it would be better to say that the future is undetermined, and we are uncertain.

[38] Written before publication of Road Traffic Forecasts 2018, which might change the argument.

Reactions in advance of the event from **Patrick Harris** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

- **Brexit fixation affecting focus and long term ability -** At this particular point in time, the greatest uncertainty remains as Brexit. The dominance of this topic is perfectly understandable given its significance now and for many years to come. The sheer scale of its uncertainty likely keeps other topics in abeyance, howver. Secondly, Brexit politics remains a 'near term' item (May 19). This focus will likely negatively influence the ability to think long term in other areas.
- **Scaling back of activities in GoScience Foresight and the Horizon Scanning Centre** - yields three concerns: a focal group, expertise and influence across departments.
    - Focal group - These organisations in past led large scale activities of circa 18 months, which interrogated specific topics and which brought together experts from multiple disciplines. These units seem to suffer these days from less attention (and I suspect less budget).
    - Expertise – There is very likely a near complete loss of futures-knowledgeable staff in these core teams, due to less frequent in-house management of large-scale, foresight activities and given natural staff turnover.
    - Cross department influence – with no one (or two) organisations leading the government futures ability, it becomes more difficult for departments to coordinate their long term thinking and to exchange ideas as well successes and suggested process improvements .

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

- There seems to remain a fixation on scenarios as a popular tool. However, I'm less sure/aware of how well departments are using scenarios in practice. It might be useful to consider other techniques that are more directly transferrable to strategic / policy response (e.g. trend analysis).

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

- Focus on quantitative versus qualitative is heavily influenced by timescale. Nearer term items should always favour quantitative. But true foresight often requires individuals to imagine routes that are harder to embrace – considering a world perhaps without them in it and progress that is non-linear to today.

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

- **Collaborative expert workshops** remains a great way to engage a broader community and **expert interviews** (aka Seven Questions) remains as a great method for capture of a large percentage of issues for a given topic.

- **Issues Trees**, perhaps resulting from research, workshops and expert interviews, can be a powerful way to structure broad topics, achieve appropriateness of focus and set context for the topic.

Reactions in advance of the event from **Tim Jones** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

- Recognising the opportunities for radical change in, for example, growing acceptance and support for access vs ownership supported by a plethora of new business models – e.g. Grab / Go-Jek in Jakarta
- Entry of new players into transport and increasing cross over within and between existing providers and topics such as Mobility as a Service becoming common focus for change
- Investment constraints in many economies (e.g. UK/US) driving need for rethinking of prior models
- Investment increase in others (e.g. China / India) enabling for bolder moves and accelerating of nascent ideas at scale – such as large-scale AV etc

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

- Alignment on best practice regulation and models regarding addressing key issues such as air quality, congestion, EV adoption, accessibility etc – especially in fast growing cities
- Greater price sensitivity and competition in several markets driving consolidation of services and sharing of infrastructure (e.g. EV changing)
- Recognised interplay (e.g. CASE) in several arenas driving technology / model sharing for new vehicle options
- Rise of global standards on the back of corporate reach for product adoption (e.g. VW, Tesla etc) and growing platform sharing for services (e.g. Uber, Didi, Grab etc)
- Lack of flexibility in some locations for future plans – e.g. investing in one transport solution to exclusion of others and / or lack of multi-modal approaches

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

- Lack of shared, coherent views on some pivotal elements driving change – such as EV charging, energy storage etc
- Localised decision making looking only at national options in some regions failing to see the opportunities from taking lessons from other regions (e.g. Medellin and Bogota)
- Few fast-growing cities actually having a master plan and so lacking coherence of transport strategy within overall economic and social development – for example contrast London / Shanghai / Singapore (clear 20-year plus views etc) with Dubai / Mumbai etc (more ad hoc)

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

- Better awareness of working with scenarios as means of stress testing rather than choosing options
- Improved global sharing of challenges, opportunities and emerging concerns and how best to address

- Investment constraints in some countries (e.g. US) forcing a shorter-term band-aid approach to infrastructure and so lacking ambition
- Not looking out far enough to the 50 to 100 year view of possibility as stimulus for policy development

Reactions in advance of the event from **Julian Laidler** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

In transport, the scope for opening out uncertainty is limited by the Public Inquiry system for new infrastructure interventions, in which emphasising uncertainty about the future is discouraged. The complex models of the transport network - "computer models" – typically used in Public Inquiries often have the effect – whether or not intentional - of disguising the very strong assumptions about the future that drive transport scheme appraisals.

The DfT's recent innovation of allowing a wider range of road traffic growth forecasts is an improvement, but all of these forecasts are showing increases over time. Especially in major urban areas, there are strong forces (including limited scope for reducing journey-times and a move towards high-density urban living) acting to reduce road traffic. The possibility that road traffic could decline in the future is seldom considered.

Local authorities are inhibited from embracing uncertainty when seeking funding for transport infrastructure due to the (perceived?) need to follow DfT guidance, which includes standard road traffic growth forecasts.

There is a general challenge in transport planning that strong business cases (at least for highway investment) often depend on predictions of severe future traffic congestion in the "do-minimum", and so it is difficult to acknowledge the possibility that road traffic might fall.

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

Since in the UK we typically don't open out uncertainty as part of our standard approach to analysis, the question of closing it down to inform targeted policymaking action is seldom a live issue.

An alternative approach to dealing with uncertainty is to define the broad characteristics of the kind of future that meets policy objectives and plan transport and other interventions – typically using real options analysis - in order to achieve that future, adjusting the plan over time to respond to the (inevitable) unexpected factors that will affect its results. That is the "vision and validate" approach.

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

Decision-makers in transport planning focus strongly on the "BCR", because there is a widespread perception that – despite the official guidance about the "five cases" – the BCR is the only element of a funding bid that matters (excluding the politics of the scheme in question, of course). The focus is always on a single value for the BCR, again because there's a perception that the DfT/Treasury is only focused on the BCR for the "central case".

There are often opportunities for a more holistic decision-making process in the early stages of scheme identification and development, but, once a scheme has progressed to a funding bid, it will already have been agreed at the local level, and the focus is always on a single value for the BCR.

A genuinely devolved decision-making process would reduce the focus of analytical work on generating a single BCR value, which is a direct consequence of the emphasis placed on it by the DfT. Otherwise, a change in approach by DfT would be needed to generate more focus on uncertainty in the analytical work that informs decisions on transport investment.

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

The culture of suppressing uncertainty is deeply embedded in the decision-making process on transport investment in England. For methodologies to change, institutional reform may be needed, perhaps including the legal system, the Treasury, the DfT, the land-use planning system, and the extent to which power and funding is devolved from central government.

To maximise the influence of the new approaches to uncertainty that are being discussed, they need to extend beyond the world of research and guidance and be piloted in live major studies. Otherwise opportunities to influence major decisions on transport will be missed, and thinking on uncertainty may well have moved on further before any new research and guidance is ready to be applied.

Reactions in advance of the event from **Mark Ledbury** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

A range of techniques are already used to test uncertainty within business cases e.g. sensitivity tests, scenarios, monte carlo analysis. My observations are that:

- The focus of testing tends to be on understanding the impact of historical sources of uncertainty (e.g. how has GDP or employment varied in the past).
- The testing of uncertainty tends to be specific to each business case.
- The focus of testing is on "go/no go" investment decisions and strategy work.

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

The conventional approach is to understand the inputs, assumptions and impacts in a reference case and then seek to understand the extent advice is resilient to changes to the sensitivities or scenarios that have been tested. As part of its standard reporting on business cases, departmental analysts are asked to set out what would be required in terms of changes to costs and/or benefits for the Value for Money category of a scheme to be affected and the likelihood of this scenario. This approach is more challenging when faced with non-binary decision and/or the range of uncertainty is relatively large.

There is an increasing focus on the use of common demand scenarios as a way of testing and presenting uncertainty on a consistent basis. It is unclear what the most effective way of presenting scenarios to decision makers or how to formulate optimal advice.

Finally, issues of uncertainty are usually considered on a scheme by scheme basis with comparatively little consideration given to uncertainty at the portfolio level. This introduces risks (e.g. correlated risks within the portfolio) and means that opportunities to "self-insure" by building a balanced portfolio are potentially being missed.

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

There are two things to note in terms of DfT's current approach:

- WebTAG and Analytical Assurance guidance sets out a number of requirements in relation to sensitivity testing, uncertainty logs and reporting on the sensitivity of investment advice to uncertainty in the analysis. The analyst is required to consider uncertainty in formulating their advice and explain how this uncertainty influences outcomes and the overall confidence in the analysis.
- Value for Money advice is expressed using a number of VfM categories (rather than point estimate BCRs). In many cases the VfM category allocated to a scheme will be invariant to

the range of assumptions tested. Where the VfM category is sensitive to these tests it is usually reported.

Extensive sensitivity testing is routinely undertaken which gives good insights into the impact of certain conditions arising. However, it can be harder to take a view on the significance of these tests in terms of their likelihood.

Finally, whilst closely linked I'd argue that the ultimate goals should be to deliver "resilient decisions" not just analytical robustness. This requires an understanding of the consequences of different outcomes not just their likelihood.

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

I'd highlight three areas:

- Effective communication of uncertainty to decision-makers.
- Effective decision rules particularly in relation to the design of portfolios or programmes which are resilient to a range of potential futures.
- Modelling/analytical tools which allow a broad range of scenarios to be tested e.g. meta-models which represent high level relationships within detailed models.

Reactions in advance of the event from **Glenn Lyons** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

- A sense of growing - but still not widespread - awareness and application of scenario planning and a scenarios approach to forecasting with consideration of *plausible* futures (beyond 'sensitivity testing' around a *most likely* future).
- Concern that scenario planning can often be disconnected from policymaking and at risk of being perceived (by some) as remote, fanciful and lacking in robustness – moreso still if entirely qualitative in nature.
- Consideration of *multiple* do minimum scenarios rather than a single scenario is an important step forward that sets a new context against which to appraise do-something policy and investment options.
- Continuing challenge of determining the appropriate focal question(s) and critical uncertainties for scenarios development and the composition of players engaged in developing scenarios.

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

- A troubling persistence of orthodox thinking and practice associated with a 'central projection' mentality that has the effect of concealing uncertainty with a reversion to 'one-shot' appraisal (avoiding the prospect of having a BCR fan rather than a single BCR).
- A lack of awareness, let alone application, of techniques associated with *adaptive* planning such as real options analysis that maintain an exposure of uncertainty, monitor over time and build in flexibility to policy and investment decisions.
- A promising new 'RAG matrix' approach that allows compatibility (Red/Amber/Green) of policy measures with multiple plausible futures to be considered and in turn a comparison of robustness across and between candidate policy measures to be made.

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

- Decision makers appear predominantly uncomfortable with, and unwilling to acknowledge, uncertainty or more particularly the limited confidence that can be had in any estimate of return on investment estimate(s).
- Deep uncertainty signals fundamental difficulty in having confidence in the input values (and potentially internalised cause-effect relationships) of modelling tools used as the basis for forecasting.
- There is disproportionate emphasis on complex modelling tools, deep analysis of a limited number of scenarios and a tendency towards false precision in reporting; as opposed to (also)

introducing simpler tools that can explore greater breadth of scenarios and forego precision as a (false) indicator of analytical robustness.

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

- A need to continuously monitor trends in drivers of change and to portray these in a co-ordinated way that helps 'paint a picture of society and mobility' over time (as was once done by the ONS publication series 'Social Trends').
- A need to gain greater insight into, and give greater prominence to, the shortcomings of orthodox approaches (notably to scheme appraisal) to handling uncertainty and thereby help overcome inertia to change in approach.
- A need to pioneer and promote the application of new approaches and to ensure such approaches involve a diversity of players and are designed, applied and reported upon in ways that foster confidence in analytical robustness.

Reactions in advance of the event from **Greg Marsden** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

My impression is that there now exists a range of studies which have tried to broaden out what is considered in transport demand futures. This includes NRTF 2015, RAND's study on mobility futures to 2035, NRTF 2018 and the Foresight Future of Mobility study. An observation is that the focus is very much on different mobility futures and what that will do to travel demand rather than on different social futures and what they will mean to travel demand. Where social futures are included they tend to be "global –local" "digital – physical" which seem to overlook the rather blended ways in which digital is influencing our lives and the activities that comprise them. So, overall there is lots of discussion on opening out but perhaps happening too much with a transport lens and so some types of uncertainty are given much greater prominence than others.

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

This I think depends on your anticipation of the real scale and nature of change. The current analytical approach is to (broadly) justify a starting scenario and then ask the question as to whether a scheme would make sense if demand were x% higher or lower. IF the principal source of demand variation is the quantum and that is only likely to vary with some well understood factors then I think that passes the robustness test. However, if the range and scale of scenarios set out in most of the meaningful opening out scenarios are believed/believable, then this would suggest some very different sets of interventions. For example, the investment package you would develop for a highly localised and digitally connected future would be really different from one where long distance physical access were the norm. You would not just want to test whether a scheme works in one scenario give or take some uncertainty – you would want to look at potentially quite different interventions. We are some way off from thinking like this right now. I think the most compelling example was the work done by TfL around the Mayor's transport strategy which stress tested some of the implications of continuing changes in trip lengths and car travel and what that would mean to travel in inner and outer London – it was useful to understand the range and to ask whether those ranges looked feasible.

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

Does everyone agree what is meant by this? I think I have heard DfT suggest this is "what would need to happen for this scheme to not make sense?" – even so, that seems worthy of further exploration. I think I am intuitively in favour of a downscaling of our pretence to predictive power from ever increasingly sophisticated models – or at least to bounding that to what they can best reveal (e.g. relative sensitivities to congestion or cost). We did not predict nor did we have a theoretical tool kit that explains some of the recent (20 years!) changes in travel behaviour and so

we should be mindful of these limitations looking ahead. In general therefore, I think there is a case for spending a bit more effort in either testing a wider range of interventions and/or in testing interventions to a wider range of assumptions to examine their worth. I think this might also be a useful discipline to play back to the "opening out" community. Are the kinds of scenarios which might get thrown at scheme developers actually credible? I would worry about broadening the analytical ask of decision-makers in the name of robustness if we don't pay better attention to the quality of the scenarios which they are asked to use. This I think requires a lot more thought – the answer to getting better scenarios is not "more investment in models" – but seeking and structuring better insights across different areas.

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

We are working on Adaptive Decision-Making as one approach to dealing with uncertainty. This looks at investments not just in terms of their performance in one future world but in several. It tries to eliminate bad investments when the pathway becomes clearer and where those investments no longer make sense (e.g. once Level 4 automation on motorways becomes possible then lane management and communications (VMS) investments need to radically change) and encourages investments which keep pathways open whilst relevant uncertainties prevail (e.g. investing extra in interchanges to allow for upscaling pick up and drop offs at low cost if MaaS operations take off). I think this could be a bit of a departure from existing approaches where there is "one pathway" with some vaguery at the edges.

Understanding how quickly large changes in mobility systems might unfold is quite critical to knowing what issues need to be addressed when. If there will be long fleet replacement times then a slow adaptive process might be OK. As our understanding changes and as we learn we can more easily build that in.

I am not sure we can ever assess whether we are being effective in assessing/handling uncertainty and I think there is a risk of "herein lies madness". This is one reason why I think the "decide and provide" approach might be helpful. It places emphasis on creating a vision for a place and in trying to shape demand to that vision. It is not deterministic but it moves demand uncertainty more to the front end of the process rather than to the back end sensitivity testing.

Reactions in advance of the event from **Charlene Rohr** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

- The traditional approach to transport policy analysis embodies a "*predict then act*" framework.[39] Typically, analysts characterise future uncertainty (with either point forecasts or probability distributions over a handful of future states of the world) and then use these predictions to rank the desirability of policy options. But such methods do not allow for real-world surprises; nor do they connect near term investments or policy actions with long-term visions or goals. They do not bring together stakeholders with differing values or views, but instead engender argument and debate about parameter values, probability assumptions, etc. Finally and importantly, policymakers may shy away from taking long-term decisions using these tools because of concerns over the reliability of the forecasts and disagreements of stakeholders.
- RAND has developed an alternative decision framework that seeks to identify near-term policies that can achieve long-term objectives across a wide range of plausible futures. We call this approach: Robust Decision Making (RDM).
- A key aim of RDM is to **help identify and design robust policy options**. Often these represent **adaptive decision strategies** designed to evolve in response to new information. Policy options are assessed over a wide range of future scenarios using an assessment criterion of robustness rather than optimality. Instead of trying to characterise uncertainty by probabilities, RDM characterises it by assessing its influence on how different assumptions affect how we prioritise among options. It explicitly describes the set of beliefs about the uncertain state of the world that are consistent with choosing one option over another, thus allowing stakeholders to understand the key assumptions underlying alternative options before committing themselves to believing those assumptions.
- Much of RAND's work using RDM methods has been in the water sector (planning for infrastructure in areas with flood or drought risks)[40], the energy sector[41] and security[42]. But RDM could be very valuable for future transport planning, where social, economic and technology uncertainties abound, although to date we have not seen very much use of such methods in transport contexts.

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

- Clearly, no one can predict the future. But by reasoning over an ensemble of scenarios we can discover decisions that are **robust** and that shape and influence how the future will unfold. The goal is to find short-term actions that will prove to be consistent with achieving strategic objectives across a wide range of futures. Providing policymakers with a means for understanding the influence of different assumptions can help them better understand trade-

[39] Lempert, R.J., S.W. Popper, E.Y. Min and J.A. Dewar. 2009. Evaluating and Implementing Long-Term Decisions, RAND Corporation.

[40] For example, see Groves, D.G., M. Davis, R. Wilkinson and R. Lempert. 2008. Planning for Climate Change in the Inland Empire: Southern California, Water Resources Impact, Vol. 10, No. 4, pp. 14–18.

[41] For example, see Isley, S.C., R.J. Lempert, S.W. Popper and R. Vardavas. 2015. The Effect of Near-Term Policy Choices on Long-Term Greenhouse Gas Transformation Pathways, Global Environment Change, V24, pp 147-158.

[42] For example, see Lempert, R.J., H.R. Trujillo, D. Aaron, J.A. Dewar, S.H. Berry and S.W. Popper, Comparing Alternative U.S. Counterterrorism Strategies, RAND Corporation.

offs between options available to them and a means for determining what factors should be used to evaluate choices.

- So it is not that we 'close down' uncertainty but instead provide analytical support to 1) better understand how a multiplicity of futures may affect investments and policy decisions and 2) plan for such impacts by taking hedging or shaping decisions as well as by identifying signposts to monitor how the future may be unfolding.

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

- The use of scenarios can help stakeholders, decisions-makers and the public imagine what future states of the world may look like. The key point of using scenarios, however, should be to support (near-term) decision making.[43]
- Further, an approach like RDM can help communicate risks to decision-makers and other stakeholders by providing data and information to help them understand in what future states alternative policy options are successful and in what futures they are not, rather than requiring assessment of probabilistic outputs. Additionally, RDM analysis identifies signposts to indicate how the future is unfolding. Often stakeholders may agree about which decisions are best in which future, but disagree about how the future may unfold. RDM can help understand where disagreement lies and whether adaptive policies can be used, while monitoring how the future may unfold.
- RDM uses a (quantitative) exploratory modelling approach with computer simulations not used for prediction but for assessing consequences for a proposed course of action. However, the principles of RDM could be applied in a qualitative way to explore issues and options at a strategic level.[44]

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

- Beyond relieving the need for analysts to make predictions, a pressing issue is how to operate in a "wicked problem" environment with many stakeholders holding different assumptions and interests while the complexities mean many public agencies are involved with diffusion of responsibility.
- Another pressing issue is the need to encourage testing and use of new analytical approaches used by others and in other sectors to explore how these may perform in transport policy- and decision-making.

[43] Gong, M. 2016. Testing the scenario hypothesis: an experimental comparison of scenarios and forecasts for decision support in a complex decision environment, Environmental Modelling and Software (91): 135-155.

[44] For example, see Ecola, L., S.W. Popper, R. Silberglitt and L. Fraade-Blanar. 2018. The Road to Zero: A Vision for Achieving Zero Roadway Deaths by 2050, RAND Corporation.

Reactions in advance of the event from **Tom van Vuren** to the roundtable questions

*Q1. In terms of **opening out** uncertainty (embracing the extent of uncertainty faced), how well is this being addressed and in what ways in terms of (change in) approach?*

- Before any scenarios are developed, it would be useful to identify the dimensions in which we are willing to consider uncertainty; a limited number and probably those with the most salient impacts on travel demand forecasts;
- I am concerned about the profession's ability to develop a set of complete, consistent, possible and plausible future scenarios; I am also concerned about the (unconscious) bias in developing and testing scenarios that suit a professional's world view. If we open up uncertainty through scenarios, these must be developed in a transparent way, and through an inclusive process. I would like to see a debate on whether scenarios should be developed and imposed from above (eg DfT or regional bodies);

*Q2. In terms of **closing down** uncertainty (making sense of the plurality of futures for the purposes of informing targeted policymaking action) how well is this being addressed and in what ways in terms of (change in) approach?*

- There is in my view little value in presenting stakeholders and decision-makers with a plurality of scenario results, without being able to place these somehow in a context that illustrates which of these scenarios are more likely than others. Inevitably, people will continue to look for 'the most likely' or mean outcome, even though uncertainty is recognised. We as a profession cannot ignore the responsibility we have to be able to advise on the likelihood of, or the circumstances under which a certain scenario may occur. In the end we are the experts!
- Rather than presenting a range of futures without context, I think that exploring how to achieve desirable futures, and the risks in doing so, is how much uncertainty can be closed down. This will inevitably mean that some scenarios will not be explored in much detail, and that perhaps new scenarios may emerge;
- Monitoring developments in behavior, technology, economy, and a willingness to update scenarios regularly should help in continuously closing down uncertainty, also allowing adjustment of the policies and interventions put in place to achieve a desirable scenario outcome.

*Q3. In terms of **analytical robustness** (e.g. breadth versus depth, qualitative versus quantitative analysis, avoidance of false precision), how is this or how should it be understood in accounting for uncertainty and in the subsequent communication to decision makers?*

- We should only develop new analytical approaches where it is clear that existing analysis and modelling tools cannot reflect future technology and other societal developments. For example, shared mobility is difficult to reflect in current origin-destination based models and individual ownership; but changing modal preferences and values of time can be incorporated in the current structure;
- I appreciate that scenarios rather than sensitivity testing may better reflect the kind of uncertainty that we face. However, sensitivity testing allows us to understand better the sensitivity of our representation of possible futures with respect to certain drivers of demand (say population, or take-up of CAVs). Sensitivity testing should be part of the analytical robustness.

*Q4. What are the **most pressing issues** (e.g. relating to methodological approaches, stakeholder views, evidence gaps) to be addressed to ensure and/or improve confidence in the effectiveness of handling uncertainty?*

- Our profession is not well equipped for decision-making under uncertainty. For decades we have tried to reduce uncertainty by single versions of the truth (even if accepting that these will be wrong);
- High level guidance on how analysts should present uncertainty, and how decision-makers can be supported in making decisions that now include inherent uncertainties, is required. Without such guidance, statutory processes will grind to a halt (every stakeholder focuses on the scenario that suits them best) and this will lead to no decisions, rather than better decisions.