Driverless cars – a great opportunity for society?

Final report of the Driverless Cars Emulsion initiative

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Executive summary

Driverless cars (DCs) have in recent years been the subject of substantial investment and anticipation, as well as hype and exasperation. Governments have been drawn into a race for the gold at the end of the DC rainbow. But not everyone shares this view – there are many people opposed to DCs too.

This report shares insights from the "Driverless Cars Emulsion". This initiative was prompted by frustration at the lack of shared thinking and real debate about what DCs could and, more importantly, should mean for the future. The 'lovers' and the 'haters' of DCs exist in separate echo chambers. Like oil and water, they don't naturally mix. So we set about changing this, through an "emulsion" of the oil and water, via open minds holding different views working in a way designed to create dialogue and understanding.

We held six workshops around the UK between July and November 2019, involving over 100 DC evangelists, opponents and agnostics, carefully mixed together. Our aim was *not* to debate whether or not DCs should be part of our future. Instead, we invited participants to consider two plausible alternatives in 2050 where DCs have come to have a significant presence: utopia and dystopia.

We then examined the prospect of transitioning from today to these scenarios. We wanted to identify key issues in the medium-term future that should now be informing nearer-term planning for DCs, to ensure their contribution to mobility and society is positive.

In the workshop environment, people changed their initial views in the course of dialogue with others – some haters became more positive, while some lovers reduced their confidence. The emulsion concept was clearly working in mixing the oil and water.

People acknowledged that they had underestimated how many complicated issues needed to be addressed to progress towards a DC future, and now better appreciated how DCs form part of a wider but more complex mobility picture. This acknowledgement helps explain why, by the end of the workshops, over twice as many of our participants had become more negative than had become more positive about the proposition 'DCs are a great opportunity for society'.

Some participants noted how little safety had been discussed, relative to other issues. This may suggest that this key benefit from DCs was taken "as a given", so focus of attention turned to the wider consequences that follow from using DCs.
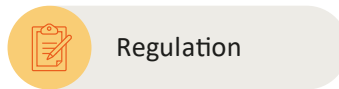
We found that DCs cannot be considered in a vacuum. Engaging in the workshops helped people to realise the need to move beyond the hype of DCs into a deeper grasp of the realities. The challenge is greater than might be assumed, as some of the issues to be resolved in pursuit of desirable outcomes pre-date DCs' development, reflecting the wider mobility system and its role in supporting society.

The following ten principles are a key output from our Emulsion and form a "call to action" for various stakeholders:
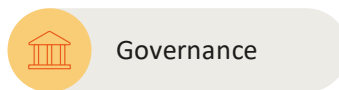
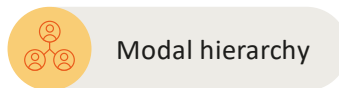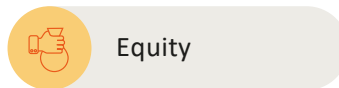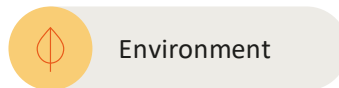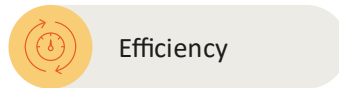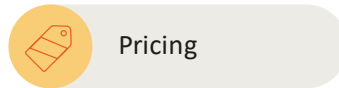|		
Governance	**Outcomes driven:**	A strong governance framework, set out in a national strategy, should reflect higher outcome goals whose delivery may be helped by DCs
Regulation	**Proportionate:**	Regulation spanning the other principles should be sufficient to ensure those principles are being put into practice
Safety	**Noticeably safer:**	As a cornerstone of DCs' use, the safety of every road user should demonstrably improve and this must be a shared goal of all those involved in DC design, development and operation
Modal hierarchy	**Contributing not dominating:**	DCs should positively contribute to a future where walking, cycling and public transport are priorities, especially in urban areas
Equity	**Mobility for all:**	DCs should be designed, priced and introduced to support rather than detract from greater social inclusion
Environment	**Environmentally friendly:**	DCs should, through design and operation, significantly contribute to improving air quality and reducing carbon emissions
Efficiency	**Space conscious:**	DCs should operate within the mobility system in a way that maximises use of in-vehicle space and minimises road and street space taken by vehicles
Pricing	**Pricing matters:**	The provision and usage of DCs should fit within a system of variable pricing for mobility, enabling public sector influence over the market
Data	**Sharing data and knowledge:**	data concerning DC operations should be shared by all in the public interest
Partnership	**Hand in hand:**	key public and private sector actors must foster a culture of collaboration

The initiative and its participants highlighted four other important points:

- While DCs were the focus of the workshops, the wider mobility system and how this supports society were actually the key areas of discussion. **Thinking about how DCs might impact us gives a new opportunity to explore existing strengths and weakness of mobility and consider how these can be positively addressed**.
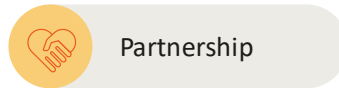
- DCs could improve mobility, but the work to be done to meet the ten principles is challenging, to say the least, especially in a resource-constrained environment. **To address them all effectively will require a new strength of public sector governance that surpasses much to date**. The private sector alone cannot deliver a fair system of services, but the public sector must support change too.

- **To maximise the benefits from DCs means they need to be seen as part of a "wicked problem"**. This is because DCs cover a range of perspectives across different stakeholders, have currently a lack of evidence to inform decisions, and have complex inter-relations with other changing aspects of society. **This requires collaboration where hype and evangelising, as well as doom mongering, are constructively challenged**. There is a need, like elsewhere in society, to move from polarised views and actions to better informed and more nuanced ones.

- "Echo chambers" of the same people talking to one another in conferences are not enough to deliver the ten principles. **We need structured, in-depth dialogue – as pioneered by the Driverless Cars Emulsion**. This is just the start.

It should be noted that the initiative was deliberately focused upon DCs. Indeed it centred on fully-autonomous (Level 5) cars or fully-autonomous journeys where no driver is required. This was to retain focus upon the most contentious and potentially disruptive area of automation for mobility.

Introduction

Is the siren sound of technology seducing us when it comes to mobility? Are driverless cars (DCs) the answer to our prayers or the stuff of nightmares?

While the climate crisis has seized attention and may pose an existential threat (beyond the COVID-19 pandemic gripping the world at the time of completing this report), technological innovation marches forwards with the prospect of fundamentally influencing the future of mobility. A global race is underway to develop autonomous vehicles that no longer require a driver in control during a journey. Given the huge current dependence on the car as a mode of transport, DCs in particular could be transformative.

In some professional circles this has caused excitement and prompted concerted efforts to make DCs a mainstream reality as part of a utopian outlook. In other circles the prospect is regarded with disdain and with great concern that DCs point towards a more dystopian future.

What is remarkable is the apparent limited interest or effort on the part of either constituency to engage with the other. The echo chambers prevail, within which confirmation bias thrives and minds risk becoming closed rather than alive to better appreciating different perspectives in the interests of a mutually enriched understanding.

The Driverless Cars Emulsion was conceived in order to address the apparent lack of constructive dialogue concerning DCs. The emulsion metaphor applies as follows:

Problem – oil and water don't mix by themselves – the 'lovers' and the 'haters' of DCs don't tend to have meaningful interaction with one another but instead exist as separate constituencies.

Solution – an emulsifier when added to oil and water can bring the two together to form a mixture (an emulsion) – in a suitably facilitated environment, DC lovers and haters can come together and combine their insight and perspectives.

The idea for the Driverless Cars Emulsion was first articulated in a LinkedIn article in February 2019:
https://www.linkedin.com/pulse/driverless-cars-emulsion-you-ready-come-together-glenn-lyons/

The article suggested there were, amongst others, four constituencies:

DC-evangelists – those who are persuaded that DCs will be a (great) benefit to (parts of) society and want to play a part in making them happen;

DC-opponents – those who are appalled by the prospect of DCs and either doubt they will ever happen or anticipate (great) disbenefit to (parts of) society;

DC-pragmatists – those who devote their expertise to research and development to help make DCs happen because the work is interesting and it 'pays the bills'; and

DC-agnostics – those who are ambivalent about the virtues of a possible DCs future.

It stressed the importance of distinguishing between invention and innovation with the latter calling for a need to understand the problem, the solution and its implementation.

The article went on to say: "If we are going to have DCs, let's properly understand why we should have them (to save lives?, to improve people's lives? to save the car industry?, to save the economy? to…) and reach a determination on whether and why DCs might be the right solution for the problem at hand. If the different constituencies come together, their combined expertise and understanding holds the prospect of a much stronger foundation upon which to proceed onwards with how to develop and implement DCs."

Funded through my Mott MacDonald Professor of Future Mobility role at UWE Bristol I joined forces with Landor Links to turn the concept of the Driverless Cars Emulsion into a reality.

A number of other key organisations joined as sponsors: the Chartered Institution of Highways & Transportation; Transport for Greater Manchester; Transport for West Midlands; Transport Scotland; Leeds City Council; and the Urban Transport Group.

A one-day (10am to 4pm) workshop format was designed that could be used for a series of six events around the UK that took place between July and November 2019. The events were free to attend and in total over 100 people participated (109 participants and 17 members of the facilitation team across the workshops).

Edinburgh

Leeds

Manchester

Birmingham

Bristol

London
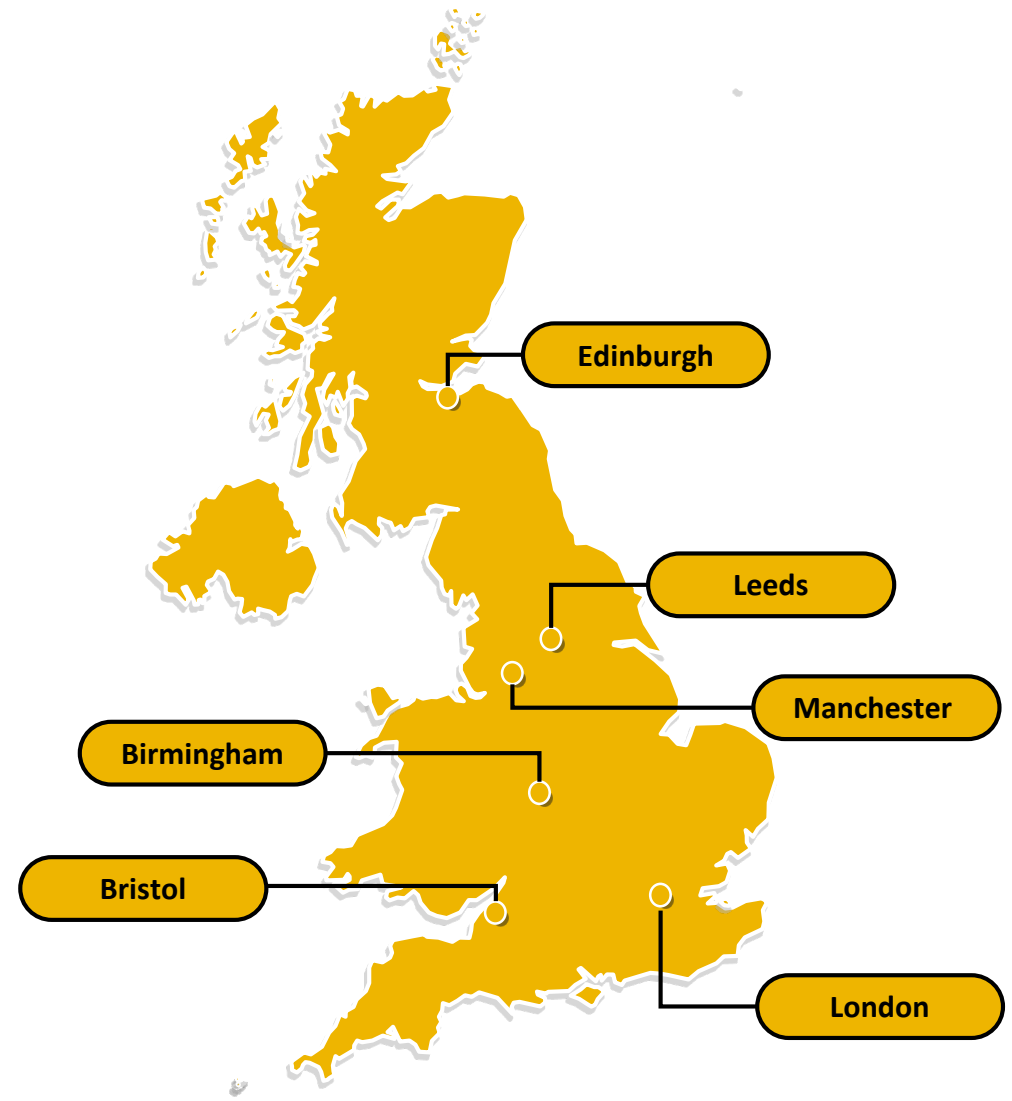
Workshop approach

Key features of the workshop approach were as follows:

- **A neutral environment** – The same approach and structure to the day was applied consistently across all the workshops. The workshops' design and facilitation sought to be non-judgemental on the merits of DCs, while drawing attention to unconscious biases and enabling participants to share, test and evolve their own views.

- **Not about winning or losing** – the structure of the workshop aimed to support the principle that all views are valid and avoid a sense of competition between different views while instead encouraging open-mindedness and self-awareness.

- **A DC future in 2050** – The premise of the workshops was that DCs *will* form a significant part of the mobility system in 2050. The priority of the initiative was to examine what form that future might take and identify key insights regarding how influence can be brought to bear on ensuring such a future is one that more utopian than dystopian.

- **Oil and water** – When requesting places to attend, individuals were asked to indicate whether they considered themselves evangelists, opponents or agnostics regarding DCs. Each workshop operated with four groups and participants were assigned to groups to achieve as much of a mix as possible, accounting also for age and gender.

Fully driverless cars – While autonomous vehicles encompass a range of vehicle types across modes and with varying levels of automation, the focus of the Driverless Cars Emulsion is on fully-autonomous (Level 5) cars or fully-autonomous journeys where no driver is required. This was to retain focus upon the most contentious and potentially disruptive area of automation for mobility.

No pretty pictures – Imagery of DCs was absent within the initiative to avoid distortion or distraction in the course of workshop dialogue, while recognising that people will have been exposed to such imagery outside the workshop setting.

Introductions

Each participant was given the opportunity to introduce themselves, to indicate why they came and asked to provide **one positive point and one negative point regarding a DCs future**

Starting positions

Using a wall-chart, participants were asked to stake out their starting position in relation to the proposition **"DCs are a great opportunity for society"** along with the reason for their position.

Plausible utopia/dystopia in 2050

The main morning exercise, in four breakout groups, was for participants to generate a characterisation of **what 2050 could plausibly look like in terms of a mobility system with a significant presence of DCs.** Two groups were assigned the task of creating 'plausible utopia' and the other two groups 'plausible dystopia'. The exercise was structured to distinguish where possible between first and second order positive/negative effects.

Three horizons

In newly mixed groups, those who had spent the morning in dystopia spent the afternoon in utopia and vice-versa. The main afternoon exercise involved applying a futures method called Three Horizons. This allows an examination of what is involved in moving from the present to the future state of utopia or dystopia in 2050. In particular **obstacles, risks and opportunities in the transition from the present to the future are highlighted**.

Ten principles

Drawing upon all the work so far, participants were then asked **"what principles do you believe need to be in place and upheld if DCs are to realise a great opportunity for society?"** Each participant offered up two principles for pursuing utopia and avoiding dystopia and these were clustered to try and home in on up to ten principles.

Ending positions

Returning to the wall-chart, participants were asked to stake out their ending position in relation to the proposition **"DCs are a great opportunity for society"** along with the reason for their position.

Final reflections

Each participant was given a closing opportunity to offer their **takeaway insight about DCs and a comment on whether or not an emulsion formed** in the workshop and whether it made a difference.

Incoming participants

The workshop participants were self-selecting but were each asked to provide some details when they applied for a workshop place. Overall, **a quarter of participants considered themselves evangelists** compared to **less than a fifth considering themselves opponents**. **Half of workshop participants started out as agnostics**. There was notable variation across workshops.

There was a stronger representation of men than women in all six workshops but **with more than 1 in 4 participants overall being female**.

A range of ages was present in each workshop.

Workshop participants held a wide variety of roles at different levels of seniority from chief executive to student. They were from both the public and private sectors including universities, start-ups and SMEs, major consultancies, transport authorities and professional bodies. **Most, but not all, participants indicated that they were involved in addressing the prospects of a DCs future in their paid work**, reflective of transport professionals. In many cases this included specific work addressing DCs or autonomous vehicles more widely. Others included transport planning professionals who wished to understand the implications for DCs for their areas and agendas. Some were in attendance out of personal curiosity or concern. Many expressed a wish to learn from others and enrich their understanding. As such those participating might be considered to be more open-minded than might currently more widely be the case (in professional circles) regarding this topic.

"I'm here because I've been increasingly frustrated with the lack of, in my opinion, a proper debate, on this topic. It's been a lot more like the gospel is being preached than actually having a debate, and I don't think that is unrelated to the streams of public sector funding."

Starting positions

Following a round of introductions, at the start of each workshop participants were asked to consider the proposition **'DCs are a great opportunity for society'** and indicate the extent of their agreement with the proposition. Each participant placed a post-it note with their name and reason for their positioning on the scale from 'strongly disagree' to 'strongly agree'. (One participant used two post-it notes, placing them at either end of the spectrum, depicting an internal conflict with diametrically opposing views.)

In each of the six workshops, **a range of views was apparent** (shown on the right, and with reasons summarised on the following page). The range reflects the 'oil and water' for the emulsion that was hoped to be formed during subsequent workshop discussions.
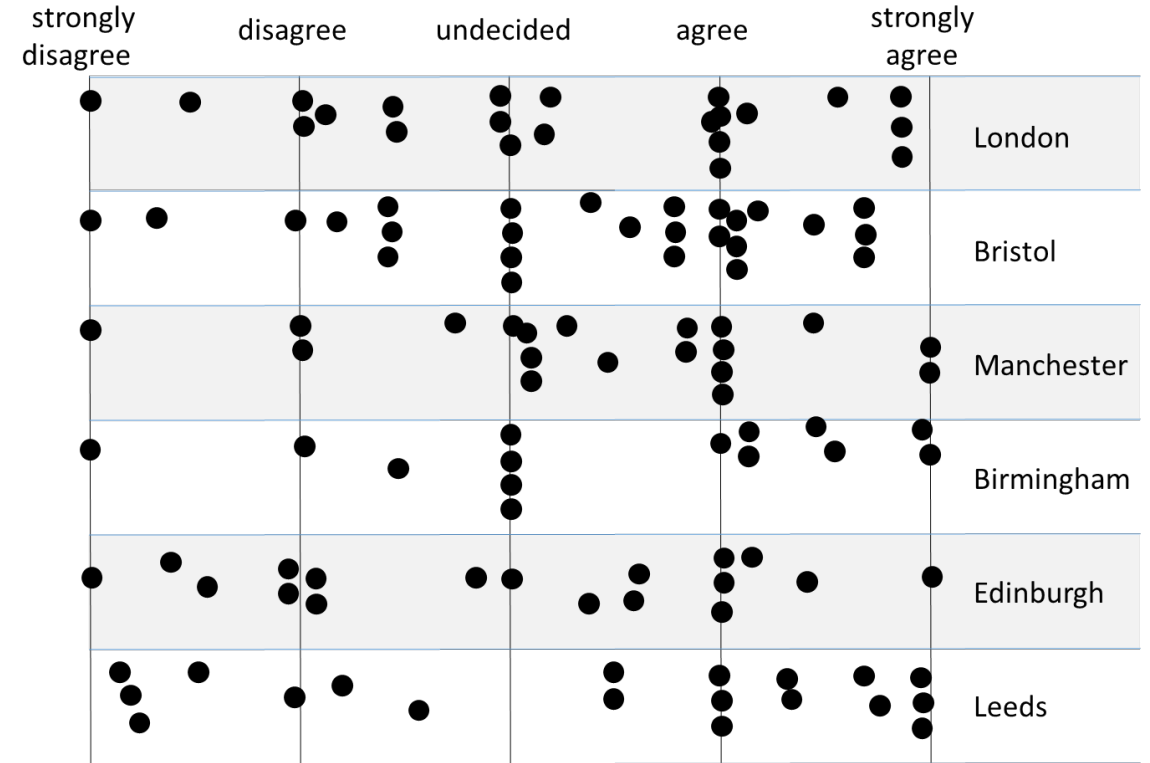
The proposition: 'DCs are a great opportunity for society'

disagreement

"They have the potential to be an opportunity for a positive change to society - however, I think the opportunity is outweighed by the more likely negative outcomes."

"Conflict with cultural richness and active travel in cities."

"Continuation of status quo – car dominated environment."

"Widespread naivety over technology and economic viability."

"DCs will be a disaster for society. There will be huge costs and they will increase inequality."

"DCs as a currently imagined development are a nightmare of resource consumption, expense, no guarantee of reducing consumption or increasing safety and accessibility"

"There appear to be better micro-mobility alternatives that meet public health and climate change objectives. Do I trust DCs to be implemented in a way that has no unintended consequences? No."

undecided

"It could go either way – it depends how joined up strategy on the purpose and use of DCs ends up being."

"Huge potential but needs to be regulated appropriately."

"The proof is in the pudding."

"Not enough evidence yet to decide."

"They offer potential benefits – safety, equality, congestion – massive disclaimer: only if the governance is for people as well/opposed to profit."

"The interests that will drive adoption may not have the overall interests of society as a priority."

"Technology is neutral. It's how it's used that's important. So there is an opportunity but our track record on innovation is not that good."

"Concerned that DCs are a distraction – we already have many of the tools we need to solve transport challenges – we need to get the basics right – more public transport, walking and cycling."

agreement

"Amazing economic potential for the country, companies and individuals. Amazing opportunity for improving inclusivity."

"Implemented properly, they offer a tremendous opportunity to unlock urban space, reduce infrastructure costs and free up personal time."

"Technology advancement is an amplifier/enabler. This can lead to utopia or dystopia, but it is an opportunity."

"A revolutionising enabler that will expand people's catchments".

"There are many benefits of DCs that may outweigh the negatives; the negatives are likely to be resolved but we cannot see this now."

"While there will be issues on engagement and inclusivity, the opportunities to significantly shift to positive transport behaviours is huge."

"Taking the 'human' away has the potential to massively improve safety, provide a far more efficient system and transform inclusivity. If we implement effectively."

Plausible utopia and dystopia in 2050

In each workshop, participants were placed in four groups. Each group was tasked with looking to 2050 with a principal assumption that DCs have become a significant feature of the mobility system. Two groups were asked to develop a plausible utopia and two groups were asked to develop a plausible dystopia. **Plausibility (while a subjective notion) was emphasised as an important consideration**. Participants were encouraged, where helpful, to distinguish between first and second order effects or characteristics of their scenarios. Acknowledging the significance of plausibility, consideration of positive and negative features in all scenarios was invited.

An 'oil and water' mix of participants in each group was arranged to ensure a coming together of alternative perspectives on DCs. The role play nature of the exercise was designed to help overcome unconscious bias, and encourage open minds and emulsification as participants worked together to co-create plausible and internally consistent scenarios for DC futures.

When scenarios were played back to the overall workshop gathering, participants were asked to offer any challenges to plausibility. While some individuals initially struggled with the role play exercise given their predisposition, **overwhelmingly across the workshops, participants were broadly comfortable with the plausibility of the scenarios generated**.
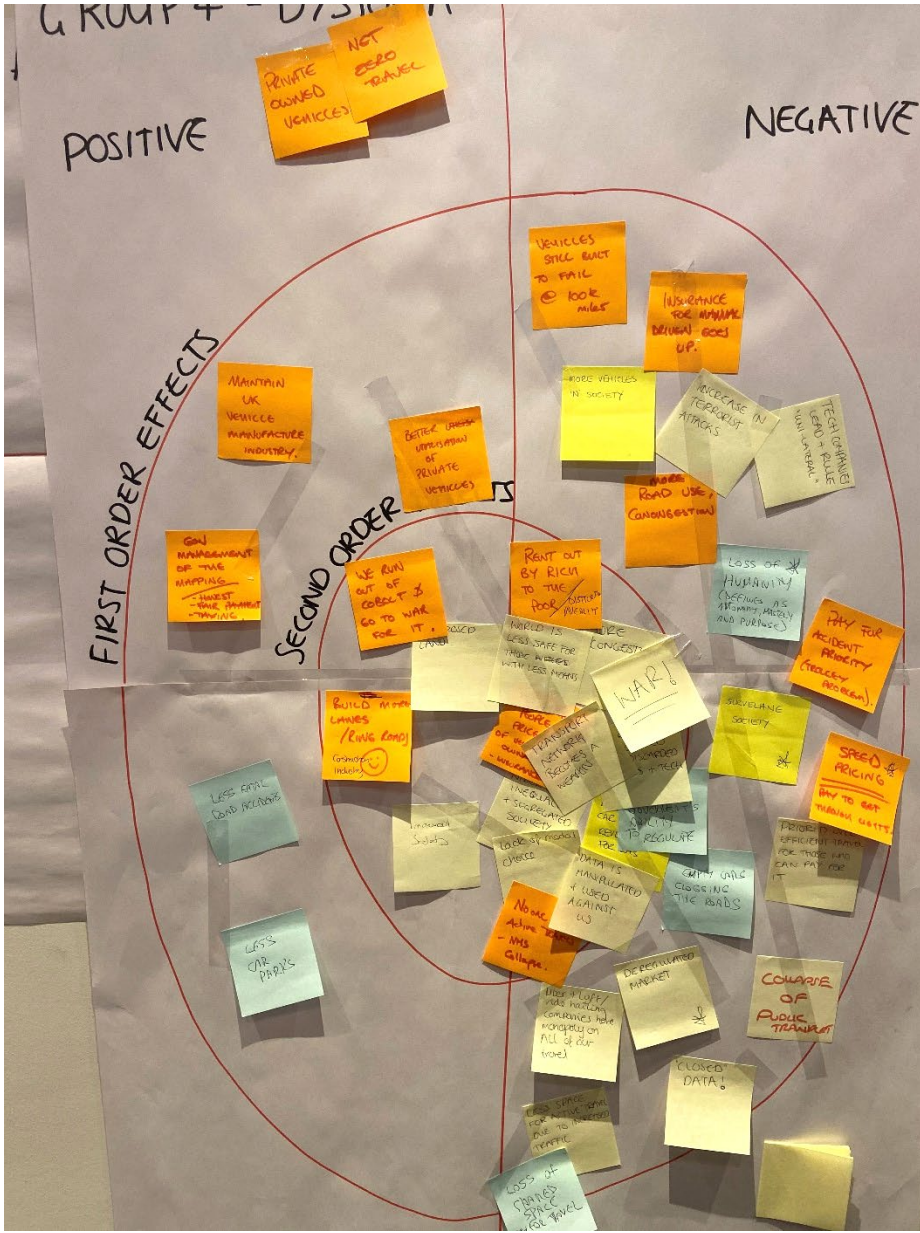
In reflecting upon descriptions of the scenarios produced, some key overarching messages emerged:

Dystopic thinking comes easily – The present is far from perfect. Knowledge of existing problems with, and consequences of, the mobility system readily fuelled contemplation of the plausibility of dystopian futures significantly defined by DCs in which **unsatisfactory aspects of today's mobility system persist or are exacerbated**.

Plausibility of strong governance – It was recognised that **many of the utopian scenarios were predicated upon an implied if not stated assumption of strong public sector governance**. For some this assumption was tending away from probable towards plausible and perhaps even less than plausible based upon current experience of the dynamics in the mobility system.

Seeing the bigger picture – The brief for participants encouraged a focus upon DCs but participants readily placed DCs in a wider context of mobility and society. There was also acknowledgement of other elements of systemic change that would be at play such as electrification of vehicles and **recognition of the long shadow that could be cast over all scenarios by the climate crisis**.

Scenarios are founded upon assumptions – The essence of scenarios was appreciated, namely that certain key assumptions can fundamentally define a given scenario's makeup. **Different assumptions produce different plausible scenarios**.

"Its not a million miles away from what's already happening"
[view on plausibility of a dystopian scenario for 2050]

"The plausibility for me is challenged by four things: funding, regulation, policy and behaviour"
[view on plausibility of a utopian scenario for 2050]

"It partly feels like you can take out the driverless cars from this and its just about making great liveable cities – this is all about making sustainable places that people want to live in"

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Across the workshops, 24 plausible scenarios for 2050 were generated and discussed. Each has been distilled into a concise summary of features and given a name in this report ('Escape from London' was given as the name by participants themselves for one plausible dystopia). All these summaries are included in the report. They reflect the diversity of assumptions and combinations of features, shaped in some cases by the specific workshop location. Participants were asked to consider the region for the city in which the workshop was taking place – for Edinburgh a decision was taken to consider Scotland as a whole.

The summaries also bring to light a number of recurring features of plausible utopias and of plausible dystopias. These are set out in the following two pages. Some features are two sides of the same coin (e.g. 'improved urban realm' versus 'streetspace reclaimed for cars'). Others reflect features that support plausibility in one set and which, by implication (rather than being stated), are absent in order to support plausibility in the other set (e.g. 'pricing for demand management'). **The mapping of key characteristics across each set of 12 scenarios offers a strong foundation for beginning to turn attention to what needs to be prioritised in the present in terms of planning for the future of mobility and the place of DCs.**

scenarios

characterising

12

plausible **utopias**

characteristics

Characteristic	London		Bristol		Manchester		Birmingham		Edinburgh / Scotland		Leeds	
	Well-priced performance	Reclaimed streets	Positively productive	People and place	Refreshingly integrated	Well-governed MaaS	Responsibly innovative	Fleet for purpose	Good governance	Efficient and effective	Shared success	Designed to work
Reduced urban parking provision	X	X	X	X	X				X	X	X	
Improved urban realm	X	X	X	X					X			X
Fit-for-purpose vehicle designs					X	X	X	X		X	X	
Integrated into modal hierarchy	X			X	X							X
Inclusive mobility	X			X	X				X	X		
Improved conditions for active travel		X	X	X			X		X			X
Improved road safety	X	X		X	X		X			X		
Improved efficiency of mobility	X	X						X	X			
Electric mobility and cleaner air			X	X	X	X				X		
Reduced private vehicle ownership	X						X		X		X	
Pricing for demand management	X						X		X		X	X
Greater flexibility of time use			X				X		X		X	
Improved wellbeing						X	X		X		X	
Strong public sector governance				X	X	X	X		X			
Improved vehicle occupancies		X							X			X

scenarios

characterising

12

plausible dystopias

characteristics

Scenario groupings:

- **London**
  - Resurrected car dependence
  - Escape from London
- **Bristol**
  - Profitable central control
  - Inefficient and unhealthy
- **Manchester**
  - Congestion and chaos
  - Dependent and divided
- **Birmingham**
  - Technological determinism
  - Selfish solitude
- **Edinburgh / Scotland**
  - Clunky state control
  - Shares before sustainability
- **Leeds**
  - Corporate control
  - Individualised mobility

Characteristics:

- Vulnerability to failure or disruption
- Increased social inequity
- Adverse public health effects
- Erosion of public transport services
- Less active travel friendly
- Increased social isolation
- Streetspace reclaimed for cars
- Sprawl encouraged
- Large corporations in control
- Uneven geographic coverage
- Transport sector unemployment
- Increased energy demands
- Private vehicle ownership prevails
- Growth in car traffic
- Inefficient vehicle utilisation

Dystopia 2050 – 'resurrected car dependence'

Increased mobility system vulnerability to disruption or failure ■ Incomplete geographic coverage of DC availability and usage ■ space previously taken away from cars in London is being reclaimed for DCs ■ South East of England subject to sprawl effects of longer distance commuting due to DCs ■ poorer public health with reduced engagement in active travel ■ transport sector unemployment as redundant human drivers have not been sufficiently reskilled ■ higher energy demands to support the DC system ■ increased social exclusion and societal polarisation as people interact selectively ■ London less-worse than other urban areas in the UK given its stronger sustainable mobility heritage

Dystopia 2050 – 'escape from London'

Central London more protected while inner and outer London have seen a huge increase in cars (DCs) ■ shared ownership of DCs limited ■ DCs seen as 'cool' for the young with the chance to stay connected on the move ■ DC dependence for replacing child escort trips and enabling mobility for those unable to drive ■ mobility system is safer but street network including previous space for parking optimised for DCs including controlled pedestrian movement ■ some highway capacity expansion ■ decline in public transport with investment shifted to DCs ■ DCs privately owned and operated with 'haves' and 'have nots' ■ increased social isolation and adverse public health ■ London a magnet for skilled employment fuelling suburbanisation

Utopia 2050 – 'well-priced performance'

DCs are fully incorporated into an integrated mobility system ■ the system is efficient and inclusive with greatly improved safety ■ mobility services incorporating DCs are personalised and allow choice over who to share journeys with which can promote sociability ■ DCs help offer a rather more pleasant experience than peak-period travelling on the Tube ■ private car ownership is significantly diminished ■ pricing of mobility is a key part of the system which is used to shape demand to meet efficiency and equity goals - although peak demand remains challenging ■ parking space has been repurposed in ways that promote social interaction ■ new jobs have been created as others were lost in the face of the mobility system now in place

Utopia 2050 – 'reclaimed streets'

DCs change London's streetscapes by reducing parking and narrowing roadwidths ■ urban areas have been redesigned to be more pleasant and human-focused ■ more predictable movements of DCs has made motorised traffic less intimidating and encouraged walking and cycling and the use of streets ■ through regulation, DCs are serving to complement public transport ■ social equity has been improved as the means to access leisure and healthcare facilities has improved for those previously less able to travel independently ■ efficient use of available highway capacity by DCs reducing pressure for as much capacity allocation ■ unintended adverse consequences also possible and may be brought about by societal change beyond DCs

Bristol

Dystopia 2050 – 'profitable central control'

DCs are operated as a centrally controlled government system run by a small number of large corporations ■ individuals' movements are governed and monitored by the system ■ the corporations benefit through DC sales' and operations' revenues while the public sector meet the costs of externalities such as adverse public health effects ■ the DC fleet is not well maintained in terms of user experience ■ use of public transport and active travel modes has been discouraged by the apparent convenience of DCs ■ low skilled jobs have declined in society thanks to automation ■ a car-dependent society persists but now also with technology-dependence and risk of system failure ■ inequality is exacerbated by DC demand and pricing for access

Utopia 2050 – 'positively productive'

Society's productivity is greatly improved as people are moved more efficiently through the transport network and spend less time in the office as they can work on the move ■ private ownership of vehicles is substantially reduced and DCs are electric and operated as shared services ■ mobility has become much more accessible to all with improved social mobility for older people and quicker and easier access to healthcare ■ road safety for vehicle users is improved ■individuals exercise more control over their personal data ■ reduced need for parking has unlocked significant areas of space for 'greening' ■ new patterns of health impacts from mobility are beginning to emerge that require attention

Dystopia 2050 – 'inefficient and unhealthy'

DCs are seldom shared in use ■ inefficient utilisation exacerbates congestion and energy demands ■ many utilise the connectivity offered by DCs but digital system failures and security threats can disrupt service and some cannot afford such connectivity and rely instead on depleted public transport services levels ■ public health problems have mounted with adverse mental health effects of DC isolation and inability to be productive on the move due to travel sickness compounding increasing obesity in the face of declining active travel ■ government is struggling to reconcile the energy intensive DC system with measures to address climate change ■ local authorities are under severe budgetary pressure to maintain highway networks for DC use

Utopia 2050 – 'people and place'

DCs have enabled cars to move from the foreground into the background in terms of Bristol city centre where quality of place is more dominant ■ parking problems of the past have largely disappeared with an urban landscape that is much more friendly towards active travel ■ DCs are electric and their complementary role alongside other modes together mean air quality in the city centre is much improved ■ road safety has been significantly enhanced and the compliance of machine intelligence with regulations means much less law enforcement is required ■ traffic speed for DCs and other driverless vehicles is controlled to make vulnerable road users feel and be less vulnerable while achieving efficiency of movement elsewhere

Dystopia 2050 – 'congestion and chaos'

Traffic conditions have deteriorated further since 2020 with an increase in single-occupancy DCs and less discriminate use of road hierarchy with adverse impacts on local residents and communities ■ kerbside congestion and chaos characterise hotspot locations and times including children arriving at, and departing from, schools ■ a monopolistic DC market sees costs to consumers increase, exacerbated by lack of investment in, and erosion of, public transport ■ some communities have become (further) marginalised and the system as a whole is vulnerable to single points of failure ■ data privacy and security concerns exist yet private sector providers have lobbied for less regulation

Dystopia 2050 – 'dependent and divided'

DCs offer a range of service levels based upon willingness and means to pay ■ system vulnerability is significant in the face of threats from technical faults as well as vandalism and terrorism ■ the system is predominantly controlled and operated by large profit-led corporations ■ spatial patterns of land use and activity are in a state of flux as DCs reduce disutility of travel ■ mobility is an increasingly lonely and isolated experience with adverse mental health effects as people have become dependent upon the system available ■ the economic viability of public transport has been undermined and services are increasingly difficult to maintain

Utopia 2050 – 'refreshingly integrated'

Access for all characterises the DC-rich mobility system ■ DCs typically take the form of micro pods that are complementary to, and integrated with, mass transit ■ air quality is good as the DC fleet is electric and deliveries, through automation, are increasingly at night ■ efficient kerbside management for drop-off and pick-up has replaced inefficient space use for parking ■ Manchester's urban space is better apportioned with improved provision for active travel addressing the concern that DCs' convenience could discourage walking ■ in-vehicle surveillance ensures safe and clean DC environments that are creatively designed to suit a range of activities on the move ■ reduced cognitive and affective effort of travel has improved people's wellbeing

Utopia 2050 – 'well-governed MaaS'

Manchester is safer for all road users ■ DCs have allowed more efficient vehicle design with lightweight materials and are electric ■ DCs operate in convoys, efficiently using dedicated road space ■ they form part of a wider Mobility as a Service system that is strongly governed by Transport for Greater Manchester ■ DC providers are required to operate within a regulatory framework and in partnership with local authorities who have powers to set market boundaries ■ mobility credits are part of efforts to ensure more equitable access to the MaaS system ■ people's time is freed up from escort journeys and those previously less independent in their mobility now spend less time and have less stress catering for their mobility needs

Dystopia 2050 – 'technological determinism'

The DC-based mobility system is technically functional with good roadspace utilisation for vehicle throughput ■ a 'wild west' of service providers exists with uneven levels of service and geographic coverage ■ there is public disquiet over inequities of system operation based on algorithms designed by white middle-class males who have been the dominant architects ■ DCs generate a significant level of empty running, and a wider population now able to be mobile with a growing dependence on DCs has fuelled traffic growth and energy demands ■ lifestyles have become more sedentary and more isolationist with urban sprawl increasing ■ people suffer stress in a controlled mobility system in which they no longer have control over journey speeds

Dystopia 2050 – 'selfish solitude'

DCs have exacerbated human tendencies towards selfish behaviours at a cost to society ■ private ownership of DCs is widespread and the car as a status symbol endures with those who can afford to, having creative and high-spec vehicle designs to enhance their travel time use ■ dwell time in public spaces and places has diminished as people increasingly 'live' in their DCs, adding to congestion ■ DCs are typically designed for occupants to see out but with others unable to see in ■ there have been transport sector job losses because of automation and public transport has been in decline, both contributing to social inequality ■ system geographic coverage is incomplete and infrequent but serious incidents arise from system failure

Utopia 2050 – 'responsibly innovative'

Strong governance and regulation provide a framework for ongoing responsible innovation ■ DCs are exhibiting ever more versatility in their design including modular features to customise functionality and experience for particular use cases ■ DCs are generally not owned by individuals but operated as fleets for shared use and seen as part of a diversified 'public transport' system ■ human error has all but disappeared from cars in terms of DC operation ■ separation between DCs and pedestrians is less necessary with guard railing having been widely removed ■ DC operations are expected to respect other users rather than dictate constraints placed upon such users ■ distance-based charging helps lock in the benefits of DCs

Utopia 2050 – 'fleet for purpose'

A strongly governed mobility system is delivering a highly utilised and efficient fleet-based approach to mobility ■ there are fewer cars on the road network per capita than in 2020 and freed up space is able to be used by other road users ■ DCs are available in a range of types to suit user budgets, needs and journey purposes ■ longer-haul DC journeys overnight are competing with a reducing domestic flights ■ high vehicle utilisation means that parking requirements in urban areas are low

Dystopia 2050 – 'clunky state control'

Significant government control over a system of DCs that does not work very well ■ DCs only work in certain favourable conditions and locations creating forms of disruption and segregation (urban versus rural, cross-border incompatibility) ■ loss of personal freedom as government controls use of DCs to improve efficiency and (perceived) overall public benefit (shared occupancy, unavailable for walkable journeys) ■ data intensive with energy-hungry data centres needed to support operation ■ DCs susceptible to minor damage rendering them inoperable or unsafe until repaired ■ significant job market dynamics brought about by DCs ■ people's lives are curated by the system ■ reduced agency in movement diminishes appeal of tourism

Dystopia 2050 – 'shares before sustainability'

All DCs are privately owned (but zero emissions) and OEMs determine the vehicle control systems in operation ■ differential speed and level of safety according to means and willingness to pay ■ citizens conscious of being 'watched' by the system with reduced agency in their own movements ■ DCs fuel the divide between haves and have nots ■ DCs susceptible to cyber attack and not fail-safe ■ loss of parking revenues has put local authority budgets under strain ■ public health crisis associated with significant reduction in active travel ■ episodes of social unrest and a simmering prospect of this escalating ■ government has been ineffective in averting the problematic aspects of the mobility system and societal consequences

Utopia 2050 – 'good governance'

Strong public sector governance with public service ethos ■ active encouragement of multi-occupant journeys - promoting efficiency and sociability ■ privileged private use at a premium ■ travel time part of (un-extended) working day ■ enforced safe-speed safe-distance around vulnerable road users which helps encourage active travel ■ transfer of land for parking to land for place ■ DC depots for cleaning, maintenance and recharge have replaced dealership showrooms ■ impediments to independent mobility are reduced (e.g. pre-programmed journeys for dementia sufferers) ■ less street furniture ■ OEMs have shifted to a new business model combining vehicle manufacture and mobility service

Utopia 2050 – 'efficient and effective'

Level 5 (fully-autonomous capability anywhere) proven, accepted and widely used ■ efficient network operation through management as a unified system ■ access to mobility for non-'drivers' (children, elderly, mobility impaired) ■ reduced car ownership levels with greater car *user*ship ■ chance to sleep ('teleport') on longer journeys and reduced travel stress ■ reduced need and justification for subsidising rail ■ on demand public transport also widely available ■ reduced need for parking ■ driving experience still possible but cars override manual driving when needed to ensure safety ■ productive use of travel time ■ greater flexibility in where to live (affecting housing market) ■ risks of reduced active travel and extended working day

Dystopia 2050 – 'corporate control'

Large corporations dominate the transport landscape and own and operate DCs ■ great economic disparity is apparent between 'haves' and 'have nots' with the shaping of a DC-centric mobility system according to the well-off earlier adopters ■ increased segregation between different classes of road users giving priority to DCs ■ loss of driver jobs experienced within the traditional transport sector ■ significant threat to the mobility system in terms of cyber attacks on DCs ■market forces have created a cycle of growing dependence on DCs ■ professionals are harking back to the Buchanan Report 'Traffic in Towns' and its warnings from the 1960s

Dystopia 2050 – 'individualised mobility'

Private ownership of DCs dominates for reasons as in 2020 such as baggage and personal space ■ those able to pay more can enjoy a premium level of service on the network ■ increased congestion has arisen from increased catchment areas for destination activities such as education resulting from reduced disutility of travel ■ public transport that still exists is patchy and loss of services leave those unable to afford DCs more isolated ■ ghetto areas have grown creating no-go places for DCs ■ Leeds is disconnected as movement corridors dominate over placemaking with increased social isolation for many ■ walking and cycling has been further discouraged through pressure from the driverless lobby ■ climate change casts a dark shadow

Utopia 2050 – 'shared success'

A far better quality of life arising from a reworking of transport choices ■ private car ownership has been and continues to be in steep decline ■ without the capital cost of DC ownership, marginal cost of use is higher and priced to encourage environmentally conscious decisions ■ efficient smooth operation of DCs has improved air quality and road maintenance; virtual road trains of connected DC pods improve throughput ■ urban and residential areas have been decluttered in terms of parking and street furniture with improved use of space for urban realm improvement ■ DC types are varied to cater for use needs and sharing of DCs is common, promoting wellbeing ■ DCs are stored when demand is low in remote (underground) locations

Utopia 2050 – 'designed to work'

A system of shared mobility whose efficient use is encouraged through a combination of regulation, pricing and social norms ■ residential areas substantially DC-free with walking in residential areas to and from main corridors of vehicular movement ■ residential streets places of interaction with constrained use cases for car access ■ DCs are integral to a comprehensive public transport system ■ fiscal and security measures in place to encourage vehicle sharing and interchanging between vehicle types ■ creatively developed array of vehicle designs to suit different levels of service and internal function ■ integration of road and rail infrastructure and elements of shared usage
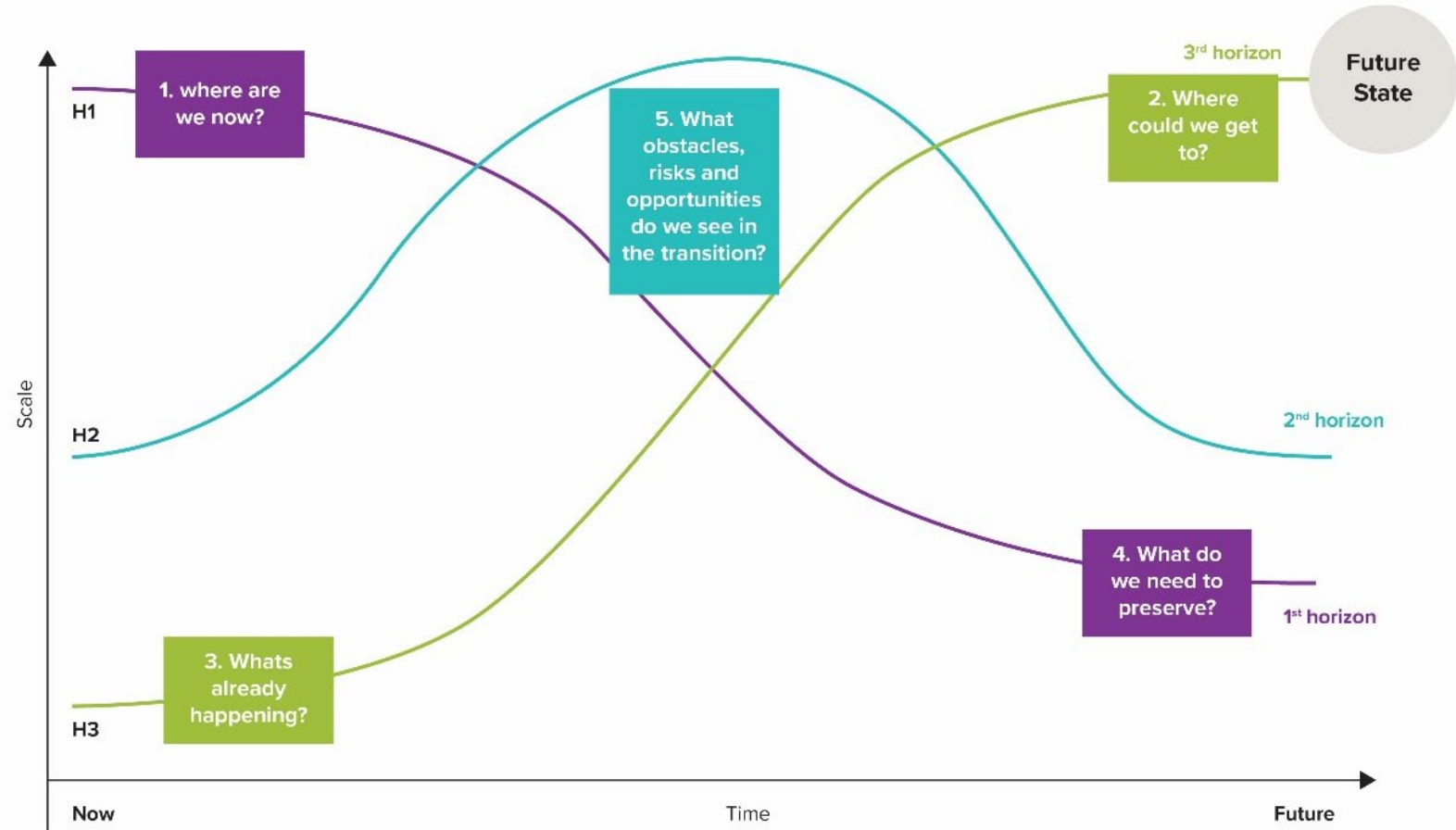
Three Horizons

The [Three Horizons method](#) was developed by Tony Hodgson and Bill Sharpe. It was first applied by them working with Andrew Curry in the UK Government Foresight project 'Intelligent Infrastructure Futures' in 2005 in a 50-year forward look at the future of transport.

The method is a means of **structuring engagement to explore a transition from the present to a future state**. In particular it helps elicit insights concerning the obstacles, risks and opportunities at play during the transition.

Horizon 1 represents the present system and its characteristics, whose dominance diminishes over time (with some of these characteristics potentially being preserved).

Horizon 3 represents the emergence, from niche developments in the present, of the dominant future state and its characteristics.

Horizon 2 reflects the disruptive process of transitioning from horizon 1 to horizon 3 dominance.

Participants were placed in newly mixed groups such that those who had focused upon dystopia in the previous scenarios exercise would focus upon utopia in the Three Horizons exercise, and vice versa.

Each group focused upon one plausible scenario produced from the earlier exercise. This scenario was taken to constitute the future state in 2050 for the Three Horizons exercise. In each group, a five step discussion took place:

- **Where are we now?** (key characteristics of today's mobility system)

- **Where could we get to?** (the plausible 2050 scenario)

- **What's already happening?** (early signs of the plausible scenario in the present)

- **What do we need to preserve?** (characteristics from the present that should endure in 2050)

- **What obstacles, risks and opportunities do we see in the transition?** (issues that planning for the future should be taking account of in order to help realise the future state)

It felt counter-intuitive initially for those groups focused upon dystopian future 2050 states to run through an exercise that was consciously seeking to work towards such a negative outcome.

However, groups attuned to the task and began to realise that the obstacles, risks and opportunities associated with transitioning to dystopia were in many respects a mirror image of those associated with transitioning to utopia. Threats become opportunities and vice versa. Indeed thinking through a pathway to dystopia can more readily highlight what needs to be addressed.

In effect, **by tasking groups with starting from different perspectives (utopia or dystopia) they were able to arrive at common ground from two different directions**.

Groups showed no shortage of feedback from the exercise in terms of highlighting characteristics of the present and what would be at play in the transition from the present to a 2050 DC future.

"Our biggest struggle was with that final column because we're used to always trying to solve problems but we had to keep trying to think how to perpetuate this horrible state of affairs." [transitioning to dystopia]

"Political apathy, lack of public sector investment, fragmented infrastructure and an overreliance on the private ownership model. Those are our key ingredients for chaos." [transitioning to dystopia]

"Questions around whether the public sector has the knowledge and capacity to shape this debate and if there is enough funding. Are there too many policy distractions or is there even enough leadership?" [transitioning to utopia]

Where are we now?

The range of characteristics of today's mobility environment is illustrated here by relative frequency of mention across the workshops (larger text – more frequently mentioned). This range is reinforced and extended on the following page when considering signs of the future in the present and what needs to be preserved in the present for the future. **The orientation on this page towards elements of the present perceived as negative is striking. It highlights the extent of what needs to be improved, but which could be exacerbated, by DCs.** It may also point towards the well-rehearsed frustrations of participants.

private car / car ownership dominates

inadequate active travel priority

insufficient public transport

congestion

insufficient regulation

climate concern

social inequality

individualised society

deteriorating air quality

safe streets

underfunding

private sector agenda-setting

urban/rural divide

modal options increasing

fragmented institutions

obesity crisis

technological innovation

poor integration

new plans / strategies

What's already happening and what needs to be preserved?

Depending upon the future state (utopia or dystopia), a number of developments are already in play that are signals of such a future emerging or are features of the present that need to be retained. Set out below is a wide array of existing developments and features relevant for future utopias and for future dystopias. Regardless of whether raised in one or in multiple workshops, **developments remain glimpses of change in parts of the UK that *could* strengthen over time out to 2050**.

Towards utopia

■ greater focus on, and priority for, active travel and for a sustainable travel hierarchy ■ rise of micromobility ■ more compact and mixed use development and continued role of land-use planning ■ improvements in shared space and car-free areas ■ air quality higher on the political agenda ■ accessibility higher on the political agenda ■ maintaining public transport and increasing concessions ■ falling proportion of car ownership for young people ■ heightened concern over climate change and political responses ■ plans and strategies such as Manchester's Right-mix 2050 Vision and Scotland's National Transport Strategy ■ connected-vehicle technology emerging ■ 5G developments ■ emerging examples of public-private partnership ■ emerging regulation for DCs ■ pace of technological development and emerging technology trials such as CAV Fourth and Future Mobility Zones ■ expanding electric vehicle infrastructure ■ growing distrust of technology companies ■ developments in artificial intelligence ■ signs of strong(er) leadership in devolved transport environment

Towards dystopia

■ continuation of business as usual and government support of incumbent companies ■ rising populism ■ rise of the gig economy ■ declining trust in experts ■ increasing (perceived) lack of transparency and invasion of personal data ■ continued and increasing corporate power (and tax avoidance) controlling technology developments ■ continued insufficient regulation of technology companies and continuation of the free market ■ emerging rival and incompatible technology platforms ■ persisting focus on technology means rather than societal ends ■ a weakened nation state ■ continued lack of (national) policy direction ■ continued poor degree of integration between transport and land-use planning ■ overall mode split resistant to change ■ the rise of Transport Network Companies (e.g. Uber) ■ declining investment in public transport and declining bus use ■ continued insufficient investment in active travel modes ■ continued priority for motor vehicles on streets ■ increasing investment in road building ■ increasing sprawl

What are the obstacles, risks and opportunities in the transition to the future state?

This page and the next highlight how the Three Horizons method can help reveal two sides of the same coin (in particular those pairs of points joined by orange lines in the lists below) in terms of the issues of significance to be addressed in the transition to a future state. It should be noted that a well-organised backlash from professional drivers was seen as a risk to both utopian and dystopian end states (though this provides a reminder that the Driverless Cars Emulsion initiative has focused on what a DC future could or should look like rather than *whether* any DC future will materialise).

Obstacles/risks to **utopia**

Opportunities for **dystopia**

Obstacles/risks to utopia	Opportunities for dystopia
inability to change social norms	business as usual
market driven with vested interests of the private sector dominating	growth of GAFA (Google Amazon Facebook Apple) and influence of big tech
inability of central and devolved governments to influence	lack of political will and government regulation
persistence of private vehicle ownership	everyone wants to have their own DC
lack of demand management	encouragement of urban sprawl
the influence of car manufacturers, shareholders and neoliberal economics	fast technology development
lack of sufficient skills base to shape utopia	continued lack of integrated land-use/transport planning
lack of funding to make DCs inclusive and utopia unaffordable	lack of support for active travel
mixed fleet of DCs in manual and autonomous modes	increased public health problems and DC dependence
insufficient funding of necessary infrastructure	vulnerable road users held liable for incidents with DCs
jurisdictional boundary effects of DCs	continued ambiguity between public/private sector roles
open data not open	

Obstacles/risks to **dystopia**

Opportunities for **utopia**

greater environmental awareness and public protest —————————————— the 'Greta effect' and people standing up
rising anger at inequality ——————————————————————— young people's attitudes
a strengthening and joined up public sector ——————————————— greater agility of devolved authorities
public sector vision and credible efforts to deliver it ———————————— public/private partnership
strong regulatory framework ————————————————————— local regulation and governance
attractive/affordable/integrated public transport and transit-oriented development —— improved connectivity and integration
increased demand management and traffic management ——————————— road travel/pricing model
decarbonisation strategies
growing support and use of active travel modes with recognition of health benefits
strong evidence challenging developments
a better educated and informed public
inability to sell the private sector vision to the public
people still want to be able to drive
growing concerns over privacy and public demand for open data
sharing of data and insights and effective cyber security
successful Future Mobility Zones initiative
widespread roll out of 5G
the professions that support stewardship of a better future are effective in their efforts

From across the workshops a number of further points arose from the Three Horizons exercise:

Framing of the discussions – it should be noted that the workshops took place over a period of time preceding the December 2019 UK General Election, when Brexit still hung in the balance. The workshop series began after the significant occupation of parts of London by Extinction Rebellion in April 2019 allied to the Greta Thunberg phenomenon which gained momentum during the Driverless Cars Emulsion initiative. Such contextual matters are likely to have, to some extent, shaped participants' thinking and discussion. There may have been a somewhat different flavour to parts of the discussions had the initiative been a year earlier. Had it been a year later the initiative would likely not have gone ahead in the face of the COVID-19 pandemic.

DCs as a lens to examine mobility more widely – as discussions within workshops proceeded it became even more apparent that, while DCs were the focus, many of the issues being considered reflected the mobility system and its role in supporting society more widely. It begged the question of why, as well-rehearsed points were brought into the exercise, hadn't such points been resolved over time already? In other words, some of the issues at play are perennial within the transport sector. It seems hard to conceive of any new development – DCs or otherwise – that will easily make them go away.

Plausibility is subjective – plausibility is a subjective notion and views will vary between individuals as was experienced in the preceding scenario development exercise. The value of bringing people together with differing views into structured engagement is that a shared sense of plausibility can be developed. It is noticeable how negative characteristics of today's mobility system lend themselves to being perpetuated into a future dystopian state. Indeed 'business as usual' was seen as an opportunity for moving towards a future dystopia where DCs have been added into the mobility mix. Across the Three Horizons exercise a poignant contemplation arises**: is it more plausible to transition to dystopia than to utopia?** Readers can judge for themselves across the material on the previous four pages.

Cruel to be kind – It was recognised that as part of the transition towards utopia, an unplanned negative shock may prove to be an enabler - something that helps sharpen political and public minds and concern. This may take the form of a serious incident involving DCs (or may now already have happened more dramatically in the form of COVID-19).

What principles do you believe need to be in place and upheld if DCs are to realise a great opportunity for society?

Participants through the workshop journey were attuned to the many issues at play for a DC future including recognising what factors could conspire to lead us towards plausible utopia or dystopia. From this informed position, they set out what they considered to be the important principles that should govern what we do to shape the future.

Input from across participants was clustered and a number of clear themes emerged. Each workshop yielded its own 'mapping' of points. However, there was a strong degree of consistency across the six workshops in terms of emerging themes for guiding principles. In particular these included modal hierarchy (the relative importance of different modes for different types of journeys) and equity in relation to the mobility system and the society it supports.

Thematic analysis across all six points' mappings was undertaken to produce a set of ten principles to guide the contribution DCs make to the future of mobility and society.

The ten principles are summarised on the following page and then explained in more detail.

The Driverless Cars Emulsion participants recognised that the principles they were shaping are not uniquely applicable to DCs. They are applicable to the future of mobility.

However, and importantly, the prospect of DCs playing a part in the future of mobility helps to shine a light on these principles and also upon **the criticality of being able to put the principles into practice** if we are to seize the opportunity of securing change for the better.

"We're thinking about what the outcomes will be, or we want them to be, in 2050. Driverless cars might be part of that, they might not be; those principles still apply."

"This one sounds like the [DfT's] 'Future of Mobility: Urban Strategy' – a lot of the principles align very well with that."

"I think it has a good correlation to the strategy [Scotland's revised National Transport Strategy] and the four priority areas we've got set out in the strategy."

"To deliver real change we need a fundamental shift in power towards those words."

Ten principles for ensuring DCs are part of shaping a better future

Governance	**Outcomes driven:** A strong governance framework, set out in a national strategy, should reflect higher outcome goals whose delivery may be helped by DCs
Regulation	**Proportionate:** Regulation spanning the other principles should be sufficient to ensure those principles are being put into practice
Safety	**Noticeably safer:** As a cornerstone of DCs' use, safety of every road user should demonstrably improve and this must be a shared goal of all those involved in DC design, development and operation
Modal hierarchy	**Contributing not dominating:** DCs should positively contribute to a future where walking, cycling and public transport are priorities, especially in urban areas
Equity	**Mobility for all:** DCs should be designed, priced and introduced to support rather than detract from greater social inclusion
Environment	**Environmentally friendly:** DCs should, through design and operation, significantly contribute to improving air quality and reducing carbon emissions
Efficiency	**Space conscious:** DCs should operate within the mobility system in a way that maximises use of in-vehicle space and minimises road and street space taken by vehicles
Pricing	**Pricing matters:** The provision and usage of DCs should fit within a system of variable pricing for mobility, enabling public sector influence over the market
Data	**Sharing data and knowledge:** data concerning DC operations should be shared by all in the public interest
Partnership	**Hand in hand:** key public and private sector actors must foster a culture of collaboration

Governance

Outcomes driven: A strong governance framework, set out in a national strategy, should reflect higher outcome goals whose delivery may be helped by DCs

DCs present the prospect of significantly and perhaps fundamentally contributing to reshaping mobility and society. They should be strongly governed to guide their introduction so that they are geared towards fulfilment of societal outcomes that are set out within a national strategy – addressing not only the mobility system but the wider economy so as to guard against unintended consequences. Policymaking should ensure a consistent framework at national, regional and local levels.

Regulation

Proportionate: Regulation spanning the other principles should be sufficient to ensure those principles are being put into practice

As part of a strong governance framework, regulation should help strike the right balance between requirements and outcomes of different stakeholders. It should guard against a market-driven approach that falls short (as has been the case in the past) of fulfilling other principles and the desired societal outcomes. Regulatory *reform* may also be needed with digital technology providing a new (perhaps golden) opportunity to implement and enforce regulation across the mobility system in an integrated way. Regulation will need to be adaptive but, if upholding other principles is at its core, the overall framework of regulation should be resilient.

Safety

Noticeably safer: As a cornerstone of DCs' use, safety of every road user should demonstrably improve and this must be a shared goal of all those involved in DC design, development and operation

There should be a step change improvement in road safety for motorised and non-motorised road users alike, which suggests a need for baseline measurement and ongoing monitoring; and regulatory power and indeed duty to apply redress where significant improvement is not apparent. Safety should be recognised to extend beyond only road traffic accidents and to include security relating to protection of personal details (i.e. privacy) and civil liberties.

Modal hierarchy

Contributing not dominating: DCs should positively contribute to a future where walking, cycling and public transport are priorities, especially in urban areas

DCs should be a complement, not substitute, to other modes that can better contribute to the vitality and sustainability of built environments and to public health. They should be seen as an opportunity to diminish how the private car and its use has detracted from a modal hierarchy in which walking and cycling should be prioritised for short journeys and in which shared journeys centred on public transport should serve longer distances.

Equity

Mobility for all: DCs should be designed, priced and introduced to support rather than detract from greater social inclusion

DCs as a mobility service should be designed inclusively to account for age, physical and mental ability, gender, means to pay, location (urban or rural) and other characteristics such that all individuals have the opportunity to benefit from them in terms of improved mobility. The balance of use of DCs should reflect their positive contribution to social inclusion with the means to enact change in service provision if this is not the case.

Environment

Environmentally friendly: DCs should, through design and operation, significantly contribute to improving air quality and reducing carbon emissions

The timing of the entry of DCs into the mobility system and the prospect that they could fundamentally influence that system means that they must not merely avoid exacerbating negative environmental externalities of mobility but should instead make a significant contribution to improving air quality and reducing carbon emissions. Such a contribution should be at the aggregate for total mobility as opposed to only per unit of movement.

Efficiency

Space conscious: DCs should operate within the mobility system in a way that maximises use of in-vehicle space and minimises road and street space taken by vehicles

DCs offer the opportunity to improve the efficiency of movement of people such that the car's dominance over the built environment is diminished. This opportunity should be taken with strong incentives for DCs to encourage a shift from vehicle ownership to shared vehicle usership with passenger carrying capacity well-utilised. In turn, highway and parking capacity allowances for DCs should be minimised in order to maximise benefits from alternative forms of land use.

Pricing

Pricing matters: The provision and usage of DCs should fit within a system of variable pricing for mobility, enabling public sector influence over the market

Pricing can send strong signals to encourage where, when, how and how much DCs are relied upon for people's mobility. In order to help ensure the market is aligned with other principles and that a system-optimal approach is pursued over time, a mobility pricing system should be in place that can be used to influence behaviour of DC suppliers, operators and users and which can be adjusted over time to respond to insights on how DCs are affecting the wider mobility system.

Data

Sharing data and knowledge: data concerning DC operations should be shared by all in the public interest

DC operations are founded upon high levels of monitoring and control. Underpinning data that enables the public and private sector to monitor compliance with regulation and standards and to generate insights to support ongoing improvements in system performance should be shared. A publicly accountable body should be responsible for access to data and its subsequent use in helping to uphold the other principles.

Partnership

Hand in hand: key public and private sector actors must foster a culture of collaboration

The changing mobility landscape within which DCs appear is complex and multifaceted and no single actor or organisation has the ability to shape the future of mobility alone. The public sector seeks to assure economic, environmental and social outcomes while the private sector seeks commercial success. Both can benefit from the other if a culture of collaboration is encouraged that helps improve clarity of direction and enhanced agency to progress.

starting positions
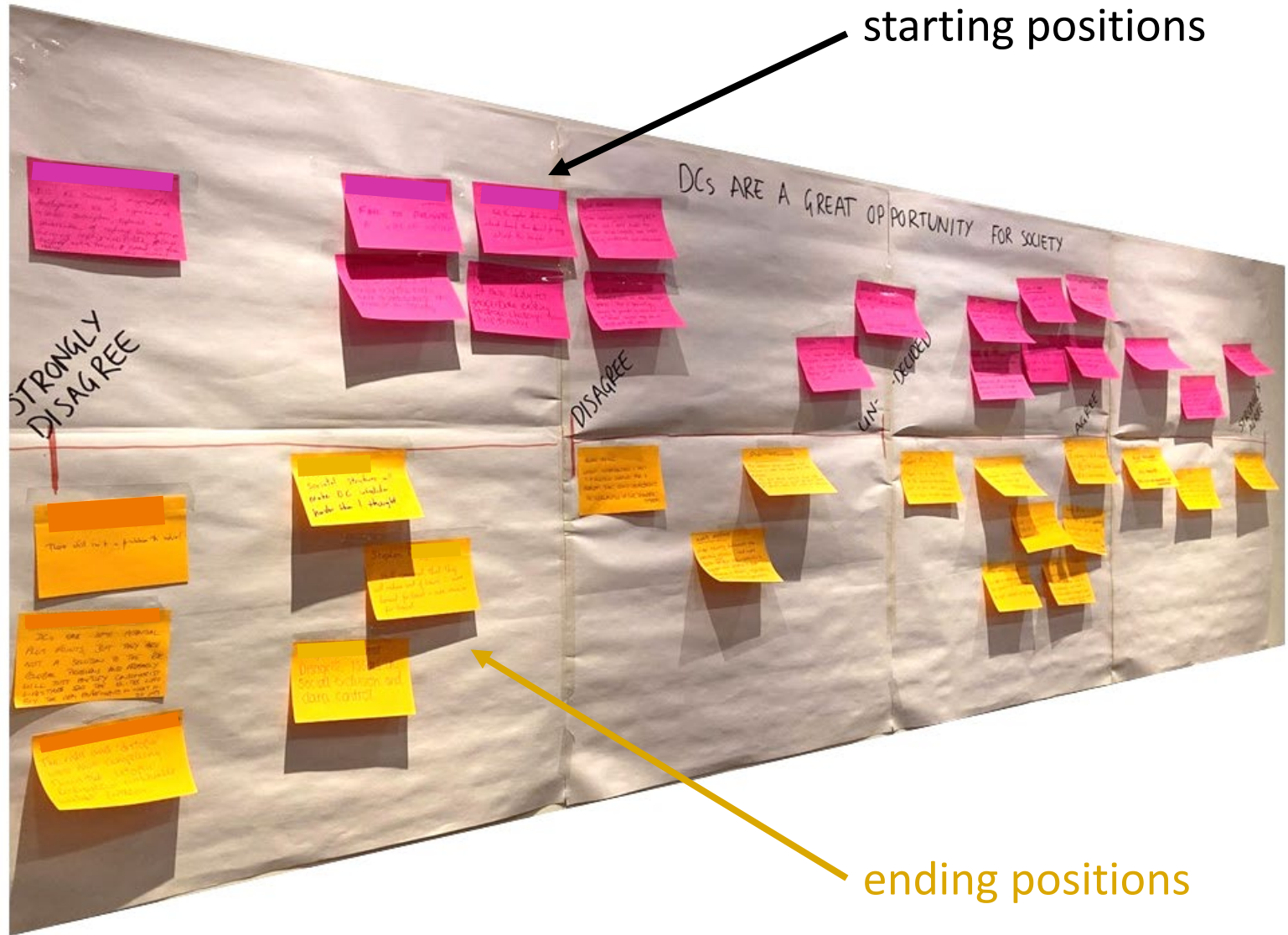
ending positions

Ending positions

Following the workshop discussions, participants were invited to revisit the core proposition of the initiative, namely that "DCs are a great opportunity for society". Having indicated where they stood at the start of the day (ranging from 'strongly disagree' to 'strongly agree' with the proposition), they set out their (revised) position and reason in light of the discussions during the day.

Participants were asked to indicate **how their ending position compared to their starting position**. Of those who responded, **about half had *not* changed their position** (even if, in some cases, their understanding and reasoning had changed). Considerably more of these 'no change' participants were tending towards being positive about the opportunity represented by DCs compared to being more negative.

Of those participants who *had* changed their position, **over twice as many had become more negative than had become more positive about the proposition** 'DCs are a great opportunity for society'.

A more detailed portrayal about how positions were at the end compared to the beginning in each workshop is shown on the next page.

When asked whether or not 'by 2050 DCs will have *realised* their great opportunity for society', nearly three quarters of participants across the workshops thought not, compared to just over a quarter who thought so.

Workshop	Unchanged	Move towards strongly disagree	Move towards strongly agree
London	11	3	5
Bristol	8	10	4
Manchester	11	3	2
Birmingham	4	7	0
Edinburgh	11	6	1
Leeds	7	7	2
TOTAL	52	36	14

DCs are a great opportunity for society   ● position at start of workshop   ● position at end of workshop
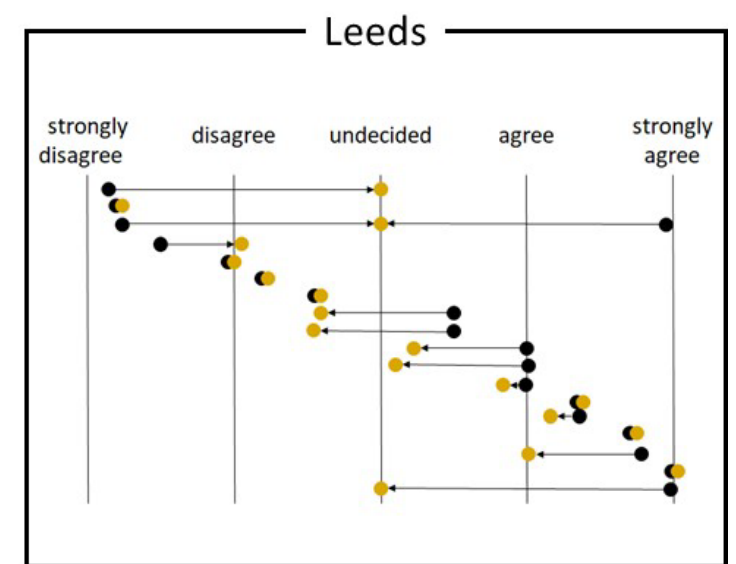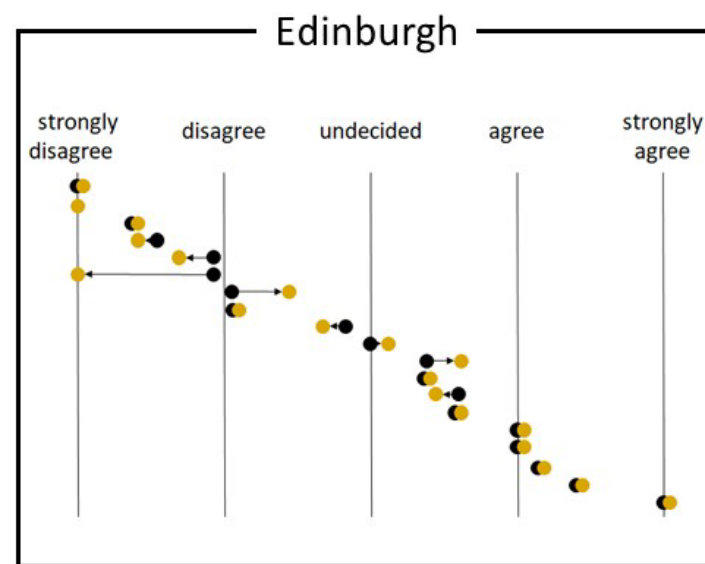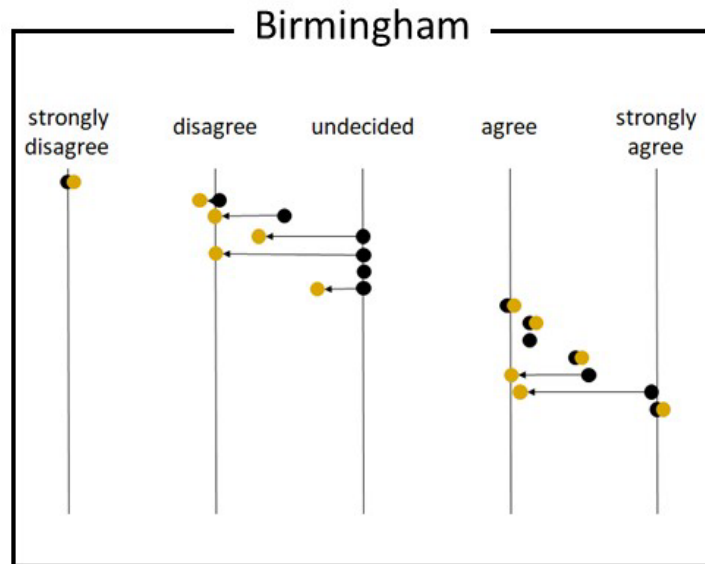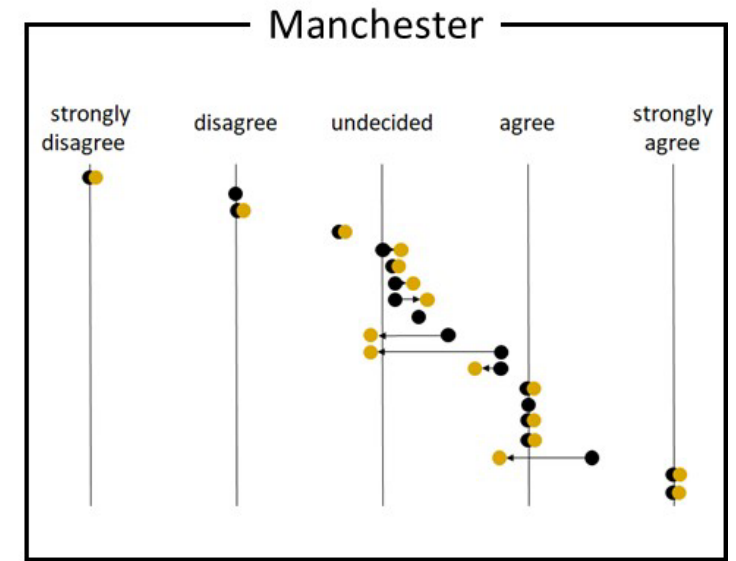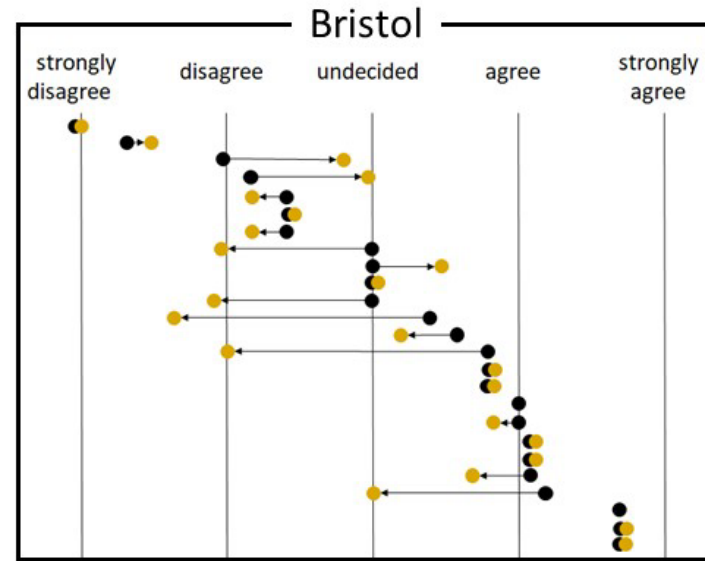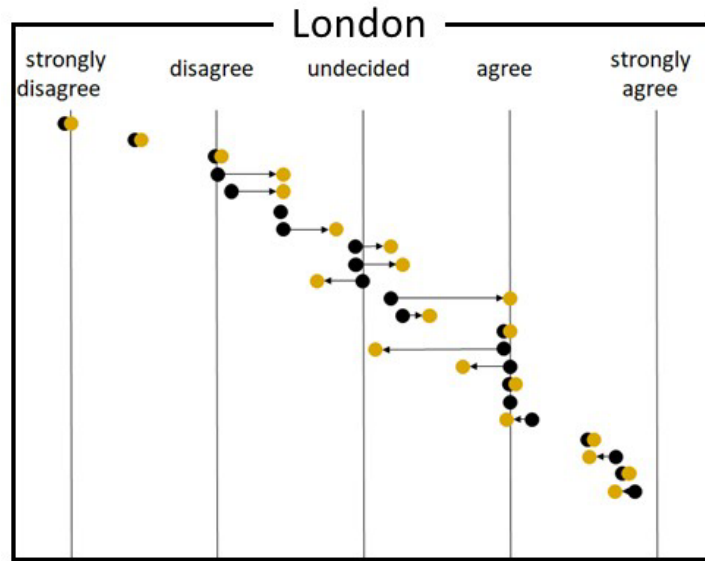
Those who became more negative about the opportunity

"DCs will potentially increase accessibility, more equitably, but this won't happen without regulation to ensure key principles are met."

"Business as usual is more likely to push us towards dystopia than utopia."

"The barriers are too high and dystopia is extremely plausible / likely."

"The opportunity is smaller and the issues of delivery are tougher!"

"I still think that DCs are an opportunity for society, but I am sceptical about whether our society is capable of taking opportunities."

"Opportunities to provide safety, equality and use of travel time. But there are many obstacles to be overcome, potentially overcoming vested interests."

"Lots of good discussion but its clear the risks are high so unfortunately I am less optimistic now."

"Less optimistic. I cannot see how the opportunities can be achieved due to mis-alignment of stakeholder strategies – profit being the main issue."

"The risks and 'dystopia' were more compelling than 'utopia'. Realisation - unsolvable 'wicked' problem."

"I still believe DCs could be either a big opportunity or a big threat. But I'm more apprehensive that the 'big threat' is more likely than the 'big opportunity'."

"Been opened to the many challenges we face to ensure DCs are equitable and good for the environment."

"DCs are neither a threat or an opportunity. They are merely a feature of threats and opportunities that already exist. Often they magnify these threats and opportunities. They do not create choices but they make them starker."

Those who became more positive about the opportunity

"DCs may be inevitable, so we will have to find ways to deal with it and I am a bit more aware of ways their negative impacts could be minimised."

"Other than increased road safety, not convinced DCs are a major solution to traffic and mobility issues but could be an opportunity to re-evaluate what we want."

"More positive because it seems that the 'driverless emulsion' is establishing wider principles for mobility in which DCs can play a significant positive role."

"But there are other more basic important opportunities in transport we should be focusing on before we can get there."

"Having discussed the potential pitfalls I have more faith that the risks/obstacles to dystopia will prevent it from becoming a reality – especially due to changing generations."

"Think it will be very negative unless we get the regulation and principles right – bit more optimistic that we can do this."

The workshop format was designed to create – as far as possible – a level playing field for participants holding different views to share, enrich and potentially change those views.

Views at both the start and end of workshops were mixed. However, across the initiative as a whole, **participants became collectively more sceptical about the prospect of DCs contributing positively to the future of mobility and society**. While the technological possibility to re-engineer mobility exists, DCs were seen as much as a threat as an opportunity in terms of how this possibility might be put to use.

The workshops served to draw out many factors that could conspire against positive outcomes, raising the prospect that **a DC future tending towards dystopia was more plausible than one tending towards utopia**. This related especially to the significance of **strong governance and regulation being required if positive outcomes were to be secured**.

As noted earlier, consideration of the future prospects of DCs prompted a realisation that this led, in effect, to examining the future of mobility as a whole and the threats and opportunities presented. **Addressing DCs as a nascent technology brings key issues that already prevail today for the mobility system into even sharper relief**.

Closing remarks

To end each workshop, participants each had a chance to say what their main takeaway from the day had been and what they felt about the design of the workshop and the core concept of the 'emulsion'.

A rich collection of comments were provided – the fruits of many hundred hours of engagement across over 100 people.

Main takeaways from participating

Across the comments made, the following themes of takeaways from the workshops emerged:

Safety underplayed – some participants noted how little safety had been discussed, relative to some of the other issues. This may suggest that this primary benefit from DCs was taken as a given to some extent while focus of attention turned instead to the wider set of consequences that follow from seeking to use DCs to deliver this benefit.

Understanding DCs is complicated – people acknowledged that they had underestimated how many issues needed to be addressed in order to progress towards a DC future and now better appreciated how DCs form part of a wider and more complex mobility picture. DCs cannot be considered in a vacuum.

From hype to realism – engaging in the workshops helped people to realise an important need to move beyond the hype of DCs into a deeper grasp of the realities being faced in seeking to progress DCs over time towards being instrumental in a more positive future. The challenge is greater than might first be assumed – especially since some of the issues to be resolved pre-date any prospect of DCs.

DCs are one solution – across the workshops, the process allowed people to constructively explore the issues that must be addressed if DCs are to realise a great opportunity for society. However, the focus on DCs also shone a light on the more fundamental question of what do we want from our mobility system and how can this be realised, whether or not DCs represent the solution on offer. Not all participants learnt much more about specific DC issues but they did benefit from more strongly considering the ends rather than (only) the means – a vision is needed within which to situate DCs as a possible means to help realise it.

Public sector governance – some doubt was expressed about whether, given the improved understanding from participating in the Driverless Cars Emulsion initiative, public sector governance was capable of being strong enough to marshal the many key issues involved in a way that would truly contribute to stewardship over a better future.

"My main takeaway really is, that having come into this being quite optimistic about driverless cars, I have a better appreciation of some of the negative effects that we need to work really hard to avoid. And I think that appreciation is a direct result of the emulsion process."

"I think my takeaway insight is really about how amazing humans are at inventing things, how we're less good at recognising how once we've invented something it takes on a life of its own and we can't fully control that as we are quite bad at making decisions about the future."

"I'm not sure from the various different aspects we've been discussing I've learned a lot from it but I think it's cemented a couple of things, I think in transport we don't have a problem with means, we have a problem with knowing what the end is and I think this is a useful thought experiment, driverless cars."

"Driverless cars themselves are neither the cause nor the solution to most of the problems we've discussed today."

"it just made me think, if people really dislike driverless cars, they should hate all types of cars as well and we should be out protesting that there should be no cars at all!"

"I was well aware of the technical challenges. The takeaway from here today is that they probably pale into insignificance against the societal and legislative challenges that countries face."

"It's been an extremely useful exercise to have different people from different backgrounds, different organisations, to not only discuss driverless cars but actually the wider state of transport governance in the country really and I think that's been illuminating from my perspective."

"The biggest insight I have taken away today is about data and technology in general. Technology is never fail safe although we have developed so much over the last 10-20 years its never fool proof so how can it be fool proof in the future?"

"My main takeaway is that DCs don't really make sense unless they're integrated into a wider transport system."

"it's an opportunity to throw a lens on an existing system."

"My takeaway insight about DCs is that I think we're really rubbish implementing sustainable transport policy right now."

"I'm more positive coming out of today than I was in the morning cause I can see the potential benefits of DCs."

"Still really positive about the opportunity- however realisation that my hopes are dwindling."

"Articulating it as a wicked problem has put a label on it for me which is good."

"I came in with lots of the benefits. I think what I went away with was that lots of the things we're trying to solve, we could actually solve without DCs."

Views about the 'emulsion' methodology

Across all the workshops, the participants expressed positive views about the approach taken in the Driverless Cars Emulsion initiative. Recurring points included the following:

In depth and different – people valued the experience of moving out of an echo chamber environment to engage with a variety of viewpoints from people with a range of backgrounds. They also welcomed the chance to take a deep dive, in contrast to the experience at many other events.

A civilized emulsion – all of the workshops were remarkably civilized with little if any confrontation (to some people's disappointment) which suggested that the most vociferous protagonists may have stayed away and that perhaps the mix of different people, backgrounds and perspectives could have been even richer (reaching further beyond professionals and also including (even) younger and older voices). However, in each workshop (at its start and end) a wide range of views about whether or not DCs represented a great opportunity was apparent, suggesting significant diversity. Participants acknowledged that the emulsion format fostered non-confrontational, constructive exchanges.

The elephant not in the room - As a self-selecting group of participants it was recognised that there are many others involved with examining the prospects of DCs who would have benefitted, and brought benefit, from participating – particularly the 'new tech people' who are entering the transport sector with their ideas for solutions, and indeed the incumbent car manufacturers. It was not for want of trying that tech industry representation was conspicuous by its absence (seemingly not an uncommon problem). The workshop methodology was recognised as something that helped address this absence.

Thinking differently – the core concept of the workshop methodology was to ensure that each participant was obliged to think differently by engaging with both utopian and dystopian thinking. This was very well received and deemed to have been an effective mechanism. The Three Horizons method as part of this was also welcomed and considered thought-provoking.

An emulsion of sorts formed – it was very broadly acknowledged that in each workshop participants had come together from different perspectives in a constructive, open-minded manner where differences had been able to mix together. This is not the same as everyone agreeing, which was not the intention. Each workshop varied in terms of its composition, and the absence of vocal extremes suggested for some that the emulsion was not made up of as much 'oily' oil and 'watery' water as they would have liked.

Listening not just hearing – it was suggested that the workshop format encouraged people to really listen to each other rather than only wait their turn to speak and in this respect was a success. This was helped by the workshop approach requiring people to role play in dystopia and utopia.

"The dystopia/utopia thing was a really interesting exercise for me, it's got me thinking a lot and I'm going to be reflecting a lot more after this session about, dystopia for who, utopia for who, because it sounded like our idea of dystopia were quite specific to what we brought into the room with us."

"I actually preferred being on the dystopian table because it was so much easier to come up with loads of negative things which is really strange because I'm quite positive and everything I do at work is starting to push towards a more positive future but that was great fun."

"I'm very proud of myself for coming up with two positives which surprised me a bit! So, I pushed myself out of my own comfort envelope to do that."

"I go to a lot of conferences where there are a lot of new tech people who are advocates of new business models and different ways of doing automotive and mostly they're the other sort of echo chamber where lots of people are going "hey we've got this new cool thing, it's going to change everything but we need to talk to cities about how to make their city brilliant" and they really are literally the people we should have in this room because they don't talk to people."

"I think the format was very good. Initially I was hesitant that this might be a consultancy type process but it came together really well."

"I really enjoyed working from opposite ends."

"I have been really impressed with the amount of people who've said I didn't know or I hadn't thought."

"We didn't have anybody here who said driverless cars are an invention of Satan, we didn't have anybody here who said I'm only interested in how I can make money out of them, we didn't have anybody here whose prime calculus was what voters would think and how many votes there were in it, we didn't have anybody here who thought that planning was an invention of an oppressive system."

"I think the dystopia/utopia has been a very powerful mechanism for making us think outside our boxes."

"The elephant that's definitely not in the room is the tech industry."

"I really enjoyed the process of the three horizons technique, and using the five questions to get into the detail, looking at the utopia or dystopia."

"In terms of the emulsion format, I think it's been really good, in that it has allowed people who potentially have quite differing viewpoints have a very constructive conversation, without arguing about anything."

"I would have like a few more extreme mavericks."

Conclusions and recommendations

The Driverless Cars Emulsion set out to use a novel methodology of engagement in the interests of producing insights of value regarding the prospect of DCs becoming a significant feature of future mobility.

The methodology has proved thought provoking and largely effective. It drew together a diversity of people with a shared wish to learn from each other in order to better understand DCs.

The initiative has revealed that DCs (as would be case for any other potentially disruptive technological innovation) must be situated within the wider mobility system. Through the efforts of all those involved, a set of ten key principles have been produced for governing efforts to realise positive outcomes from DCs. These espouse DC-specific requirements while also reflecting expectations of the mobility system as a whole.

The following two recommendations are made:

1. The public sector at all levels should reflect upon the principles offered by this initiative and consider the implications for the public sector's stewardship over the future of mobility and emergent innovations such as DCs. Principles must be turned into practice.

2. All stakeholders in a future of mobility potentially shaped by DCs should recognise the fundamental importance of engaging a diversity of views in a manner that fosters constructively challenging dialogue. Echo chambers alone are inadequate and potentially counterproductive.
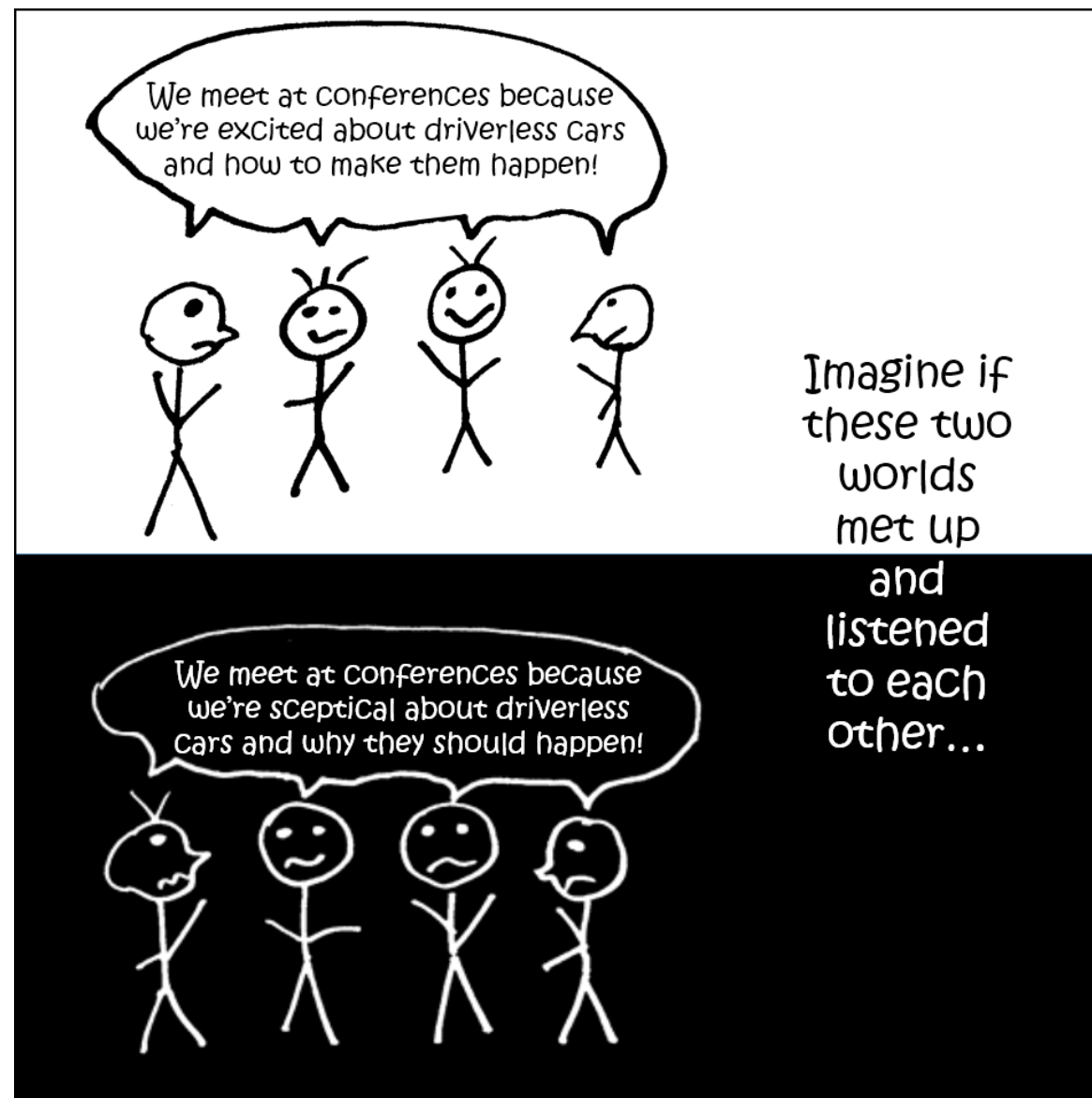
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The Driverless Cars Emulsion was only made possible by the enthusiasm and willingness to constructively engage of its contributors – both participants and facilitators. All are owed a debt of thanks, as are the initiative's sponsors and Landor LINKS. **Participants** across the six workshops were as follows:

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