The Future of Autonomous Vehicles
Global Insights gained from Multiple Expert Discussions
This document provides an overview of the key insights on the future of AV. Based on insight from multiple expert discussions, it shares different views and highlights the core areas of progress, and associated implications, that we can anticipate by 2030.
CONTEXT
A wicked problem is a social or cultural problem that is difficult or impossible to solve for as many as four reasons:

1. Incomplete or contradictory knowledge,
2. The number of people and opinions involved,
3. The large economic burden, and
4. The interconnected nature of this with other problems.

The future of autonomous vehicles is considered to be a complex ‘wicked’ problem. To address it, we need to understand and challenge many different expert perspectives.
Global Insights

This project has identified where and what the key opportunities are by collectively challenging and sharing the future of AVs plus the key drivers of change across a number of pivotal locations.
We held eight expert workshops plus six extra discussions which have identified major challenges, new opportunities and emerging issues for the next decade.
Our Hosts and Partners
Leading organisations involved in the hosting of events included a broad mix of transport agencies, universities, consultancies, trade bodies and logistics companies.

[Images of logos for various organisations]
WHERE WE HAVE COME FROM
The possibility of developing an autonomous vehicle has been explored for many years. Since 1939, projects have been building momentum towards today’s intensive activity.
THE WAY FORWARD
Realistic Expectations
After a reset in 2019, more realistic ambitions for autonomy are providing greater focus for OEMs and big tech as well as guiding investor expectations on timelines and impact.
1. **AVs will Initially be Expensive:**
   With all the up-front investment as well as the additional technology that will be embedded within the vehicles and the wider intelligent infrastructure, the price of AVs will be significantly higher than today’s cars and trucks. Over time, costs will reduce but there will continue to be a premium. Fleet operations will thus dominate the early years as the economics rely on Return on Investment.

2. **High Utilisation is Critical:**
   For the target cost-per-mile to be viable, AV fleet business models assume high daily use of vehicles – potentially up to 24/7. Each AV will drive between 100,000 and 300,000km a year and so will more follow a consumer product lifecycle than a traditional long-term transportation model. Updates and upgrades will be frequent.

3. **China and the US in the Front Seat:**
   Given the size of the domestic market, technology development already underway, the level of investment underway, government support and proactive regulation, alongside the US, China and Chinese companies will also play a major role in the field. In the US the regulatory environment enables private funding to drive early deployment. A China discussion highlighted that the central government had given Shanghai alone $50bn to invest to be a world leader EV and AV.

4. **Monitoring is Assumed:**
   While highly automated and able to eventually operate autonomously, all AVs will be monitored by both people and machines. Human supervision, either in the vehicle or remotely, will be required by regulators and expected by users in the early years and, over time, as trust builds some of this will be undertaken by machines.

5. **Autonomous Vehicles will Look Different:**
   Although much of the testing is taking place with adapted conventional cars and trucks, when they are deployed at scale by fleets AVs will be distinctive. Autonomous trucks will eventually be cab-less while autonomous cars will be designed for multiple person shared occupancy. Prototypes such as Volvo Truck’s Vera and Cruise’s Origin are good examples. For privately-owned passenger cars, coming in significant volumes after 2030, interiors are also likely to evolve substantially.

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**What We Know**

While there are multiple debates, we see five main issues on which many agree. These are close to ‘certainties’ upon which assumptions and scenarios can be based.
1. Where will be the key hot-spots for AV development and deployment?
2. Which sociopolitical forces may accelerate the adoption of full Level 4/5 automation?
3. Where is advanced regulation most likely to act as a catalyst for AV deployment?
4. What level of safety (crashes) is acceptable for the full launch of AV in the next decade?
5. Will AV increase or decrease total traffic flow and congestion?
6. Will automated mobility services replace, reduce or extend the reach of public transport?
7. Of all the technologies in the mix, which ones are in greatest need of further development before the benefits of AV can be realised?
8. What are the distinct benefits from AV that are not already coming from current and future-connected ADAS?
9. How important will international standards and commonly shared technologies be for AV adoption - or will it be more regional?
10. Which will be the pivotal organisations, cities and governments that control adoption rates?
11. Who will lead on integrating all the varied systems needed to enable AV to operate?
12. Who will customers trust more to deliver a safe, reliable and comfortable AV experience?

Initial Questions
An initial perspective mapped the autonomous vehicle landscape and identified twelve key questions to explore via the research project.
1. What lessons can be learned from other sectors – for example, mobile and healthcare?
2. How much will AVs be tied to EVs, and therefore intertwined with charging infrastructure roll-out etc.?
3. Will air-taxis have impact beyond a few niche locations?
4. How much will drones used for parcel delivery integrate with drones for other purposes?
5. How will planning evolve to become a public/private partnership?
6. Will private companies contribute to the cost of the infrastructure, and will public sector agencies allow for this?
7. Will the growth of AVs mean more open/liveable/walkable urban public spaces?
8. How will cities adapt today’s public transport systems in an era in which automated MaaS overlaps their mission?
9. How will designers overcome resistance to sharing rides with strangers?
10. For what types of routes and freight will Level 4 truck automation happen first?
11. How will supply chain approaches be transformed by Level 4 truck automation?
12. What effect will growth in AV urban/suburban parcel/grocery/food delivery have on other road users?
Six Macro Themes

From the discussions, a number of key issues were prioritised, debated and explored in depth. Within these, there are six pivotal high-level macro drivers of change that are the focus of greatest debate.
Priority Areas for Focus
Underlying and connected to these six, there are another additional fourteen priority topics of focus. Together these 20 areas can all be considered pivotal for the future of AVs.
Regulation and Liability
The regions that gain most will be those where regulation acts as a catalyst for AV deployment. Successfully addressing reporting requirements and liability will be critical for adoption.
Common Standards

International standards and commonly shared technologies may be essential for driving global rather than regional AV adoption. Without them, a more fragmented approach will be taken.
Improved Safety

Reducing accidents and road deaths is the political priority behind support for AV. While many benefits can be gained from ADAS, the promise of further major safety improvements is pivotal.
Environmental and Social Impact

Ensuring that autonomous vehicles are cleaner than alternative options may be a pre-requisite in many regions, while the benefit of AVs for wider society is a crucial issue for public endorsement.
More Congestion
Decreasing congestion on the roads is a core ambition for AV advocates, but many recognise that, with mixed fleets operating for several years, we may initially see an increase in urban traffic.
Less Parking
Effective deployment of AVs could mean not only fewer vehicles on the streets, but also that parking spaces are removed enabling narrower roadways and more pedestrian space.
Rethinking Planning

Poor coordination between transit systems, urban planning and solutions may delay AV benefits. For full impact it will be necessary to take a more flexible approach to planning.
Public Transport Systems

Autonomous buses, shuttles and new mobility solutions to fill transport gaps are introduced. Security, flexibility, reach, interconnectivity and funding are the primary issues for many cities.
Resistance to Sharing

Public support for ridesharing will require a re-evaluation of vehicle design for small groups. Concerns about privacy and safety mean strangers may be unwilling to travel together.
Robo-Taxi Fleets

Robo-taxis are the way forward for passenger transport in suburbs and cities. As part of ‘Mobility as a Service’ robo-taxis change travel patterns, car ownership, and have to integrate with public transport.
First and Last Mile

Improving the inefficient first and last mile has health, energy and efficiency benefits. In urban environments, scooters, bikes and small autonomous robots all have a role to play.
Air Taxis

Several major cities will support the introduction of air-taxis - initially to allow the elite to bypass increasing congestion on the streets, but later for wider citizen use.
Goods Transport
Drones for Goods

Investment in timely drone delivery services accelerates deployment in multiple locations. Concerns about safety and collisions are overcome with automated UAV air traffic control.
Urban Delivery

Small, slow-moving, autonomous robots offer attractive ROI and act as an accelerator of deployment. They enable safe, clean, convenient and low-cost delivery and help to raise public confidence in AV.
Automated Freight
Driverless expressway trucks will transform long-haul journeys and the wider logistics sector. As safety goals are met and costs are reduced, regulatory support evolves with deployment.
Truck Platoons

As the first level of deployed automation, truck platoons help build wider momentum while delivering tangible improvements in efficiency, cost of transportation, energy use and safety.
Controlled Environments

Automation within controlled environments continues to expand steadily. AVs within airports, port terminals and logistics facilities start to venture onto the open road.
Data and Security
Data Sharing

Better, deeper and more secure, data sharing is pivotal to enabling the full AV ambition. Mobility brands agree protocols for V2X interaction and support the use of shared data sets.
Cyber Security

With a rising threat of hacks, denial of service, vandalism and theft of data, organisations seek to protect AV through building common approaches for broader, closed but collaborative systems.
Remote Support Centres
Manned support centres initially provide oversight, support and emergency response for all AVs. In the absence of drivers, public transport vehicles require clear remote human supervision.
CONCLUSIONS
1. **Fleets are now driving progress:** In terms of the dominant business models, momentum is clearly behind both robo-taxis and truck fleets.

2. **Automated trucks are coming:** Freight has much to gain in terms of efficiency; this has regulatory momentum and wide industry support.

3. **Safety is a pre-requisite:** Expectations are high, but as many advances are already in process, improvements look likely.

4. **Congestion is a conundrum:** While the aim is for less congestion and the role of connectivity is pivotal, user behaviour and Transportation Network Company (TNC) strategies could initially mean more congestion.

5. **Multiple options for the last mile:** There are many alternatives in the mix, all bridging different needs and location gaps.

6. **First vs widespread deployment:** Where and why we see initial AV services may not necessarily align with where mass impact will occur.

7. **Deeper collaboration will be needed:** Moving from partnerships to long-term multi-party collaboration is seen as a critical enabler.

8. **Technical standards may not be pivotal:** Although comprehensive technical standards are advocated, they are not essential for AV; in some regions, safety standards will support regulation.

9. **Regulators are influencing deployment:** Proactive regulation is attracting companies, but the balance of light vs. heavy regulatory approaches may impact this.

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**Nine Thoughts**

We can see nine core issues as significant for the next decade. All are intricately inter-connected but collectively define the highly ‘wicked’ problem to address.
More Information

If you would like additional details on this project, how it was undertaken or any of the insights shared in this report, please contact either of the authors.

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