THE FUTURE OF MOBILITY

The previous issue of *HindSight* Magazine outlined some future and societal trends and implications for competency and the future of air traffic management. In this article, **Claire Williams, Liam Mullen** and **Wolfgang Schuster** look more broadly at the evolution of new goals for mobility, their 'messy' implications, and some of the technologies that support them.

Figure 1: WHO Sustainable Development Goals

KEY POINTS

- **There is a messy revolution happening in mobility.**
- **In an effort to unpack the 'mess', four attributes of the revolution are described – mobility should be human-centred and sustainable whilst building on the growing technological capabilities allowing it to be connected and autonomous.**
- **Enablers for the revolution are many, but include human-centred design tools, trials and pilots; cooperative intelligent transport systems (C-ITS) and ultra-low emission vehicles (ULEVs); 5G and ITS-G5; LiDAR, artificial intelligence and machine learning.**
- **New modelling approaches and trials are part of the work required in the domain to really deliver on the potential of Intelligent Mobility.**

The revolution is coming

In his book of the same title, Lukas Neckermann (2015) describes 'The Mobility Revolution' with the sub title 'Zero Emissions; Zero Accidents; Zero Ownership'. Whilst his focus is on cars (and we will continue this focus in our article) and his target of zero may be debatable, these goals are in areas that matter across the whole of the transportation sector (emissions, safety and models of use).

The revolution is 'messy'

As we have built a presence in the future mobility domain over the last few years, we have been forced to define and refine our purpose and focus. Work to date has coalesced around three main areas.

1. Our Intelligent Mobility Practice, as it is known, has been part of pioneering user-focused projects in the Connected Autonomous Vehicle (CAV) world (FLOURISH, VENTURER and Human Drive - see box). These vehicles can bring safety, environmental and social benefits.

2. We have also worked with City Authorities to trial new approaches to the provision of transportation services. Mobility as a Service (MaaS), as it is sometimes known, describes the aspiration of many authorities to supply tailored, end to end, seamless journeys for their communities. New business and operating models are fundamental to this work.

3. MaaS and CAVs are enabled by data, so we are involved in projects which deal with the collection, analytics and security of data.

VENTURER was a £5 million government co-funded research and development project, exploring the future of driverless cars, which concluded in June 2018. It deployed a combination of state-of-the-art technologies, industry expertise and world-class academic research to:

- Understand the blockers and drivers to the wide-scale adoption of CAV capability, including public trust and acceptance.
- Develop an understanding of the insurance and legal implications of increased vehicle autonomy.
- Develop a range of CAV technologies, including a fully immersive CAV simulator. To read about its findings, please see: https://www.venturer-cars.com/venturer-project/

FLOURISH is a £5.5 million multi-sector collaboration, co-funded by UK government, which is helping to advance the successful implementation of Connected and Autonomous Vehicles (CAVs), by developing services and capabilities that link user needs and system requirements. FLOURISH aims to build solutions which:

- improve mobility for older adults.
- ensure secure communications between autonomous vehicles and the surrounding transport infrastructure.
- use data to optimise regional transport networks.

Human Drive is a 30-month project that will see an autonomous vehicle perform a 200+ mile journey across the UK through live traffic and natural conditions. https://humandrive.co.uk/

For the latest research findings, go to: http://www.flourishmobility.com/

Thinking about the thread that joins these diverse CAV, MaaS and data projects is also a key issue in the industry. Intelligent mobility is emerging and is variously defined by its technological content (CAVs, data platforms, etc.), its goals (seamless journeys, congestion reduction, air quality improvement, etc.), and its philosophical underpinnings (human focus, inclusivity, etc.).

Working out what to do in this domain is hard because it is not a simple problem, but rather what Russell Ackoff termed a 'mess'. Messes are large in scope, complex, uncertain, unstable and less bounded than more traditional problems. This describes the intelligent mobility domain well. In this article, we are making sense of the intelligent mobility 'mess' by describing four of its attributes as we see them: it should be human-centred and sustainable and enabled by connectivity and autonomy.

What do these attributes mean?

- **Human-centred** – one of the dangers of a 'technology' revolution is that technological feasibility rather than human need drives developments. Expertise in Human Factors/Ergonomics is needed to optimise for human goals (alongside system goals), by starting with the people first.

- **Sustainable** – a human-centred approach leads to the desire for sustainability, and for us, sustainability covers all of the UN sustainability goals (see Figure 1) as well as the cyber security and threat protection that are fundamental to ensure system robustness.

- **Connected** – connectivity is a key component of the mobility revolution (and the technological revolution more broadly), including connectivity between vehicles, with surrounding transportation infrastructure and with everything else (the Internet of Things).

- **Autonomous** – autonomy has a range of definitions, but effectively means the immediate control of a vehicle is not in the hands of a person.

How will these new mobility attributes be realised?

Enabling the human-centred approach

To support the human-centred goal for future mobility, we have a Human-Centred Design Toolkit on which to draw for new projects. It points us to data, methods and approaches which ensure that, just as in projects like FLOURISH and VENTURER, we take an evidence-based approach to understanding the human in the system. Whilst much is knowable from existing data, much of what we need to know and understand emerges from real-world use. So pilots and trials are important to keep our work *human-centred*. This extends beyond real-world human use, to human and societal goals, as follows.

Enabling Sustainability

Ultimately, th e technologies and approaches to design must be human-centred at the macro scale, in that they provide outcomes that benefit humanity. This is where sustainability comes in.

Some of the UN goals (Figure 1) fit more obviously within a transportation domain, particularly those around climate action, health and wellbeing and clean energy. Cooperative Intelligent Transport Systems (C-ITS) enabled by new connectivity and autonomy technologies (see below) should support these sustainability goals by optimising traffic flow, positively impacting air quality and ultimately health outcomes. This can be further supported by the development and uptake of ultra-low emission vehicles (ULEVs) which form a key part of the UK government's strategy.

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Enabling connectivity

In its simplest form, connectivity is the ability to send data from one person to another. However, the mobility revolution is enabled by the ability to exchange data rapidly between more than just people; connecting people, vehicles, infrastructure and more – a vital aspect of the FLOURISH project.

Future enablers for this connectivity include 5G coverage available via mobile network masts or ITS-G5 available via roadside Wi-Fi routers. These new connectivity technologies have the potential for a wide range of cooperative opportunities such as:

vehicles relaying data to road operators on traffic status in real-time, enabling the equivalent of air-traffic control for cars, and

vehicles informing the local authority of infrastructure maintenance requirements before failures occur.

Understanding how this connectivity technology will work and how to realise the benefits it can bring is currently the focus for much of our work.

Enabling autonomy

If connectivity is the ability to share data – autonomy is the ability of the technology to 'make decisions' and act without human intervention, based on these data. Levels of automation can range from a basic cruise control system to a fully autonomous vehicle which takes *decisions* by itself without any driver input. The technologies that enable vehicle autonomy are those that will replace the human's role in driving. This is twofold in nature. Simplistically, first we must replace our 'senses with sensors', and then our 'brains with computers'.

Advances in sensors which can scan the road environment (such as LiDAR – which uses lasers to create a picture of the road ahead) will allow road vehicles to 'see' the surroundings. In addition to this, vehicle connectivity (as mentioned above), will enable information on speed, location and position of surrounding vehicles to be shared and processed seamlessly, in real-time.

The more difficult part of the puzzle is the question of how we 'replace' the brain, the part which makes decisions around where a car should drive and how it should drive. The answers lie at least in part in advances such as machine learning and artificial intelligence. With copious amounts of data to process – technology which replaces human learning can be used to optimise what the 'brain' of the car can process by iteratively testing and learning from different decisions. The outputs from the Human Drive project will be a significant step in this development.

Concluding remarks

The technologies needed to revolutionise mobility are developing and the potential for realising human-centred, sustainability outcomes is enormous. The situation is complex and 'messy', and in order to realise these desirable outcomes, the intelligent mobility industry is building new ways of modelling the future and undertaking real-world trials. These need to model and test whole mobility systems, which combine the technologies in ways that provide meaningful options for people.

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