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KING'S College LONDON

UKRI TAS Hub

Policy Lab, 29th June

Social inclusion and autonomous vehicles

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1. Introduction

About Trustworthy Autonomous Systems Hub (TAS-hub)

The UKRI TAS Hub assembles a team from the Universities of Southampton, Nottingham and King's College London. The Hub sits at the centre of the £33M Trustworthy Autonomous Systems Programme, funded by the UKRI Strategic Priorities Fund.

The role of the TAS Hub is to coordinate and work with six research nodes (Functionality, Governance and Regulation, Resilience, Security and Trust and Verifiability) to establish a collaborative platform for the UK to enable the development of **socially beneficial** autonomous systems that are both ***trustworthy in principle and trusted in practice*** by individuals, society and government.

The TAS hub defines autonomous systems as systems involving software applications, machines, and people, that is able to take actions with little or no human supervision.

What is a ‘Policy Lab’?

- The Policy Institute at King’s College London aims to bridge the gap between research, policy and practice using a variety of activities.

- A ‘Policy Lab’ is a focused, collaborative workshop bringing together a wide range of different stakeholders around a particular challenge to…
    - Assess the evidence
    - Understand barriers and constraints to change
    - Develop new ideas and practical approaches to improve outcomes

Overarching topic for this Policy Lab

How do we ensure that autonomous vehicles are designed, developed and deployed in order to benefit everyone?

2. Key definitions and concepts

Autonomous vehicles: definitions and variations

- **Autonomous vehicles (AVs, or self-driving, driverless cars)** are road based vehicles capable of sensing their environment and operating without human involvement. There are different levels of automation, ranging from Level 0 (no automation where a driver performs all tasks) to Level 5 (fully autonomous, no driver intervention needed).

- **Connected and autonomous vehicles (CAVs)** combine connected and automated technologies. They can talk to each other (vehicle to vehicle) as well as to the infrastructure around them (vehicle to infrastructure).

- **Shared and connected autonomous vehicles (SCAVs)** combine connected and automated technologies with the assumption that vehicles will be shared (and also electric).

Source: SAE International (2022) *Taxonomy and Definitions for Terms Related to On-road Motor Vehicle Automated Driving Systems*. Available from: https://www.sae.org/standards/content/j3016_202104.
Centre for Advanced Automotive Technology (2018) Connected and Automated Vehicles. Available from: http://autocaat.org/Technologies/Automated_and_Connected_Vehicles/

Autonomous vehicles: our approach to definition

The Automated and Electric Vehicles Act 2018 (AEV Act 2018) has introduced a definition of “self-driving” into law.

Under section 1, the Secretary of State must prepare a list of all motor vehicles that are (in the Secretary of State’s opinion) “**designed or adapted to be capable, at least in some circumstances or situations, of safely driving themselves**” and may be lawfully used on roads or other public places in Great Britain.

“Driving itself” is defined as “**operating in a mode in which it is not being controlled, and does not need to be monitored, by an individual”**.

In our workshop, we follow Automation Levels distinguished by the Society of Automotive Engineers (SAE) ranging from SAE level 0 for no automation to SAE level 5 for full autonomy.

A vehicle that is ‘designed or adapted to be capable**, at least in some circumstances or situations,** of safely driving themselves’ would be considered level 3—conditional automation or level 4— high automation in the SEA classification.

Sources: AEV Act 2018. Available from: https://www.legislation.gov.uk/ukpga/2018/18/contents/enacted.
SAE International (2022) *Taxonomy and Definitions for Terms Related to On-road Motor Vehicle Automated Driving Systems*. Available from: https://www.sae.org/standards/content/j3016_202104

Autonomous vehicles: our approach to definition

SAE International **Taxonomy**

Level 0	**No automation:** All driving tasks are performed by a human driver.
Level 1	**Driver assistance:** features like steering, brake or acceleration provide support to the driver, but the human driver performs all remaining aspects of driving.
Level 2	**Partial automation:** one or more driver assistance systems are engaged, but the human driver performs all remaining aspects of driving.
Level 3	**Conditional automation:** features can drive the vehicle**,** but the human driver needs to take over the driving task when required.
Level 4	**High automation:** features can drive the vehicle under limited conditions, even when a human driver does not respond to overtake the driving task.
Level 5	**Full automation:** features can drive the vehicle under all conditions, even when a human driver does not respond to overtake the driving task.

Currently, on British roads, we can see vehicles with Level 2 (or 3) automation (eg Tesla Autopilot). However, some companies are working on high or full automation levels. The first fully-size driverless bus trials started in Scotland this year.

Level 0: *referred as a human-driven vehicle,* ***Level 1-4:*** *semi-autonomous vehicles,* ***Level 5:*** *fully autonomous vehicles*

Source: SAE International (2022) *Taxonomy and Definitions for Terms Related to On-road Motor Vehicle Automated Driving Systems*. Available from: https://www.sae.org/standards/content/j3016_202104

Autonomous vehicles: key technologies

- Computer vision (how a car **sees**)
- Environment perception (how a car **understands** its environment e.g. laser sensor, radar sensor)
- Location system (how a car **knows** its location)
- Car navigation system (how a car **thinks** about the **most optimal** route)
- Vehicle control (how a car **steers** the wheel)
- In-cabin monitoring (how **a car engages** with a person in-charge and other passengers)

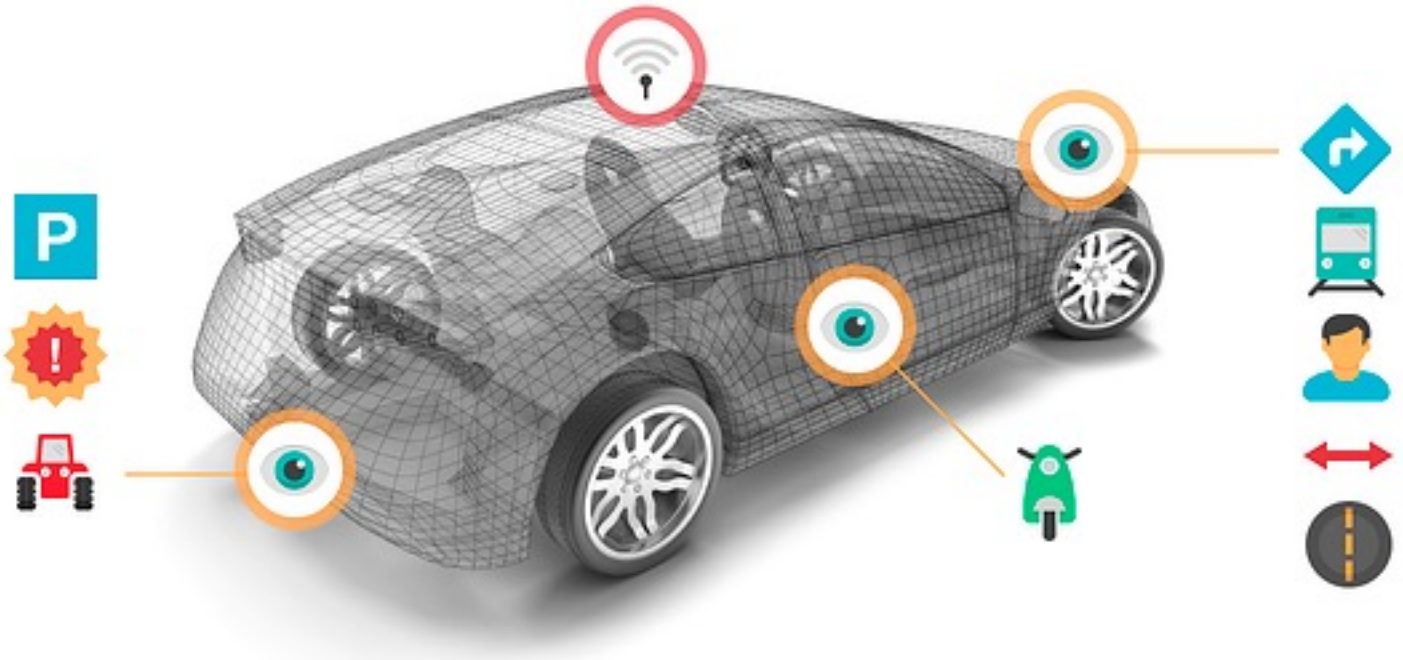

Image source: https://content.intland.com/blog/the-key-enabler-technologies-of-autonomous-driving

Sources: Zhao, J. et al (2018) The key technology toward the self-driving car. *International Journal of Intelligent Unmanned Systems* ISSN: 2049-6427. Law, W. (2019) *An Introduction to Autonomous Vehicles*. Available from: https://towardsdatascience.com/an-introduction-to-autonomous-vehicles-91d61ff81a40

The role of AVs in social inclusion

Although AVs can potentially bring some benefits to vulnerable social groups, they **are not in themselves necessarily beneficial**. There are various transport models for the development of AVs (e.g. private vs shared AVs) that will have a potentially different impact on different segments of society**. In addition to this, some decisions made at the stage of designing, developing and deploying technology** (autonomous systems) can pose a risk to some groups and exclude them from full participation in society.

To ensure that AVs promote equity rather than increase existing inequalities and social exclusion, it is important to consider issues of **social inclusion and exclusion from the design to implementation** stages of some technological solutions.

In our workshop, we will think about social inclusion and exclusion issues by working on case studies through **the project lifecycle development**.

Social inclusion and exclusion: working definitions

We will use the following definitions for the purposes of this workshop:

- ‘**social exclusion** describes a state in which individuals are unable to participate fully in economic, social, political and cultural life, as well as the process leading to and sustaining such a state…Age, sex, disability, race, ethnicity, religion, migration status, socioeconomic status, place of residence, and sexual orientation and gender identity have been grounds for social exclusion over time."

- **social inclusion** is ‘the process of improving the terms of participation in society for people who are disadvantaged on the basis of age, sex, disability, race, ethnicity, origin, religion, or economic or other status, through enhanced opportunities, access to resources, voice and respect for rights.’

Source: The United Nations Department of Economic and Social Affairs *World Social Report* 2016: https://www.un.org/development/desa/dspd/world-social-report/rwss2016.html

3. Background information

Key UK policy papers and developments in AVs

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Established the Centre for Connected and Automated Vehicles (CCAV)

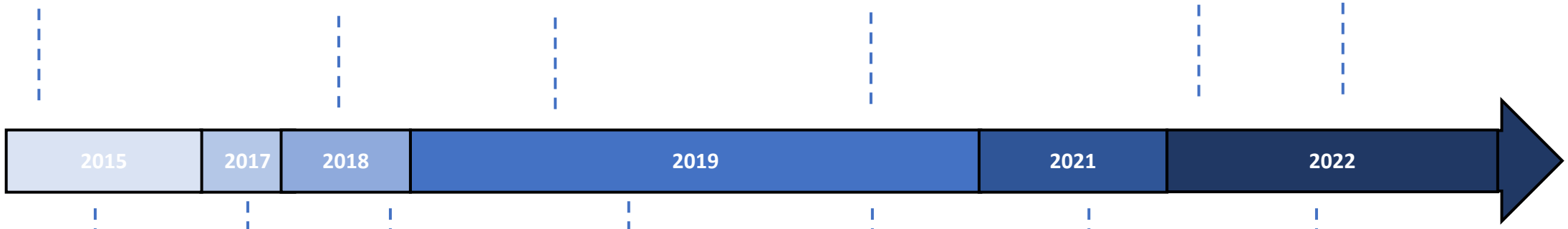
The Automated and Electric Vehicles Act creates compulsory automated vehicle insurance

Introduction of legislative projects with the Law Commission in the UK. Two paper published

Launch of Future of Transport: rural strategy – call for evidence

Updated The Grand Challenges

Law Commission published a joint report on Automated Vehicles



Code of Practice is published for testing AVs

Social Behavioural Research Report produced

Inclusive Transport Strategy

Future of Mobility: Urban strategy released

CAV public acceptability dialogue published

Launch of the Future of Transport Urban Strategy Regulatory Review to ask questions about how transport is regulated

Build Back Better: our plan for growth

DfT's Future of Mobility: urban strategy (2019)

Nine principles for future of transport

Principle 1	Principle 2	Principle 3	Principle 4	Principle 5	Principle 6	Principle 7	Principle 8	Principle 9
New mobility services must be safe and secure by design	**The benefits must be available to all parts of the UK and all segments of society.**	Walking, cycling and active travel must remain the best options for short urban journeys.	Mass transit must remain fundamental to an efficient transport system.	New mobility services must lead the transition to zero emissions.	Less congestion, for example through sharing rides, or consolidating freight.	The marketplace for mobility must be open to stimulate innovation and give the best deal to consumers.	New mobility services must be designed to operate as part of an integrated transport system.	Data from new mobility services must be shared where appropriate.

DfT's driverless model for urban transport

Social inclusion challenges and opportunities

Opportunities

Driverless model: SCAVs

- **Shared transport:** possibility to plan trips by using shared transport by disabled and older people
- **Availability and affordability:** more competitive market with greater availability and affordability

Challenges

Driverless model: SCAVs

- **Digital literacy:** skills needed to book shared trips/accessibility for people with different needs
- **Monopolisation** – will this service be affordable to everyone?
- **Digital divide** – who would be able to use this service?

Source: DfT (2019) *Future of Mobility: Urban Strategy*. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/846593/future-of-mobility-strategy.pdf

UK TRANSPORT VISION 2050: investing in the future of mobility

"We expect to see private vehicles capable of Society of Automotive Engineers level 4 autonomy – operating in driverless mode in limited areas – by 2030 and common by 2035.

They will allow less-able-bodied people to gain or maintain independence.

***Automated buses** and **minibuses** will undergo trials by 2025 and become commonplace (40% of those in service) by 2035.*

Low-speed public service vehicles will likely be deployed first." Innovate UK's UK Transport Vision 2050

Source: UKRI (2021*) UK Transport Vision 2050*. Available from: https://www.ukri.org/publications/uk-transport-vision-2050/

The future of mobility: government approach

*”Self-driving technology in cars, buses and delivery vehicles could spark **the beginning of the end of urban congestion**, **with traffic lights and vehicles speaking to each other** to keep traffic flowing, reducing emissions and improving air quality in our towns and cities.*

*The technology could also **improve access** to transport **for people with mobility issues and** lead to more reliable public transport services, **helping to level-up** access to transport in historically disconnected and rural areas.”*

”We will become a world leader in shaping the future of mobility”. UK Grand Challenges

Source: BEIS (2021) *The Grand Challenges*. Available from: https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges

Inclusive Transport Strategy

The government wants to deliver a **fully inclusive transport system**.

The aim is **"to move from infrastructure design and service provision which focuses on achieving *'accessible transport'* (eg by changing existing infrastructure to meet the needs of disabled people) to delivering *'inclusive travel'*** (with services designed through dialogue with disabled people and other groups so that the needs of transport users are identified upfront)". *Inclusive Transport Strategy*

Based on this aim, it is important to ensure that future technological advancements in transportation **are designed from the beginning** by taking into consideration different users' needs.

Source: Source: DfT (2021) *The inclusive transport strategy: achieving equal access for disabled people*.
Available from: https://www.gov.uk/government/publications/inclusive-transport-strategy/the-inclusive-transport-strategy-achieving-equal-access-for-disabled-people

Some current trends

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Ageing society

- The number of people **aged 65+** is set to grow by around 50% in both urban and rural areas between 2016 and 2039.
- **The number of 85+ year olds is set to double** to over 3 million in a similar timeframe.

(ONS, 2018)

Poverty

- In 2019/2020, more than one in five of the UK population (22%) were in poverty– 14.5 million.
- This finding is in relation to relative poverty (after housing costs).

(JRF, 2022)

Digital exclusion and digital literacy skills

- 11.9m people (22% of the population) do not have the digital skills needed for everyday life in the UK (UK Consumer Digital Index 2021).
- **6% of households** have **no internet access**.

(Ofcom, 2022)

Mobility and disability issues

- In 2020/21**, 22% of people in the UK reported having a disability**, equivalent to 14.6 million people.
- 46% of people who are disabled cited **mobility** as an issue, making it the most prevalent impairment.

(DWP, 2022)

4. Preparatory work to inform our group work

Group work: the project lifecycle development

In thinking about the relationship between the technologies underpinning AVs and their impact on social inclusion/exclusion, it is important to think about all stages of the design, development and deployment of these innovations.

We will therefore be using **a framework of project lifecycle development** to help us think through these issues (see more: Turing Commons).

The project lifecycle encourages critical reflection and deliberation across every stage of a research or innovation project's lifecycle. It helps explore different activities with each of the three phases and identify social exclusion risks.

Source: Turing Commons (2022) *Introducing the Project Lifecycle (A Sociotechnical Approach).* Available from: https://turing-commons.netlify.app/rri/chapter2/project_lifecycle/

The project lifecycle

The project lifecycle is a three key stages process: *project design*, *development*, and *deployment*. These stages are not mutually exclusive categories, but they summarise activities/tasks that are likely to be carried out by different individuals, teams or organisations.

Using this framework, we will think together about:
possible issues when designing systems in the context of social exclusion?

i) **what regulatory safeguards are currently in place or needed to avoid social exclusion problems? Is self-regulation enough**?

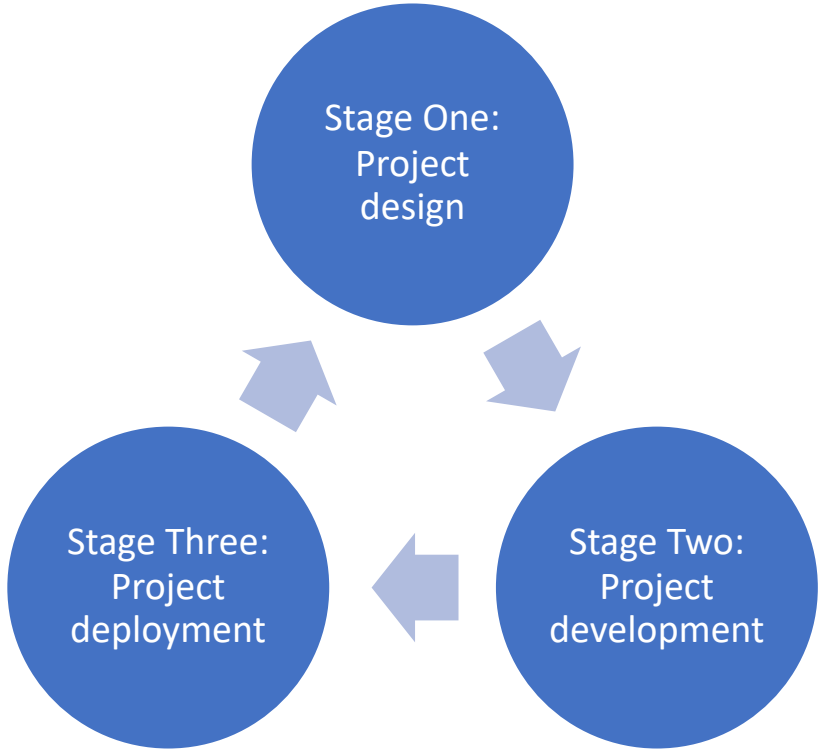

Fig 1 The project lifecycle

The project lifecycle

To facilitate our discussion about ***inclusive future transport***, we will be using the framework of **the project lifecycle development (design, development and deployment).**

Please think about some of the following questions

Stage one: design

- **User Needs:** Who is the technology aimed at and what needs is it being designed to meet? How were these needs identified, and who participated in the process of defining them? Does the technology need to be built in the first place? Are there existing solutions already available that would be better?
- **User Capabilities:** What skills or capabilities will be needed to use the technology, and how can it be designed so that all target users can benefit from it?
- **Ethical and Legal Consideration:** What existing legal and policy frameworks apply to the use case? Are there any regulatory gaps that arise because of the novelty of the technology? Are there ethics committees or internal review boards that can help evaluate the ethical credentials of the project?
- **Stakeholder Impact Assessments:** Which affected people and communities should be consulted to identify and evaluate possible harms and benefits associated with the project (eg socioeconomic inequalities that may be exacerbated or reduced as a result of carrying out the project)?

The project lifecycle

Please think about some of the following questions

Stage two: development

- **Data collection and data bias:** What data need to be collected? How can projects ensure that data (and data preparation and engineering) do not reflect existing bias, resulting in biased or discriminatory outcomes, with a negative impact on marginalised communities?
- **Explainable AI**: Developers/computer scientists would need to decide which model they want to use and how complex it should be in terms of interpretability. For example, certain learning algorithm models are less interpretable than others. Lower interpretability offers greater accuracy or prediction. However, there is a risk of using a ''black-box model" where the relationship between the input features and the output is often too difficult to interpret or explain.
- **User testing/usability:** how will you ensure that design/product/technology works for everyone? On which groups, will you be conducting tests?

The project lifecycle

Please think about some of the following questions

Stage three: deployment

- **Over-trusting and under-trusting technology:** We want you to consider the human factors that can affect technology's performance. You don't want users to over-rely or under-rely on technology. What are the risks associated with over-trusting and under-trusting technology? How can they relate to the problem of social exclusion? How to solve them?
- **Technology Updating:** How should the data for the technology be updated? Would it affect users more positively or negatively if it was updated either continuously or periodically?
- **Product/technology assessment:** How do we ensure that the product is useable, equitable, enjoyable and useful?

Automated Lane Keeping Systems (ALKS)

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ALKS are automated systems that can take control of a vehicle. They control position and speed of a car in a single lane. Vehicles with ALKS were announced by the government will be permitted on **motorways** in Britain, but **only** at speeds of up to **37mph (60km/h).**

The government announced that vehicles with ALKS technology can be legally defined as self-driving, "**as long as they receive GB type approval [approval to be used on British roads] and that there is no evidence to challenge the vehicle's ability to self-drive**."

Drivers **will not be required to monitor** the road or **keep their hands on the wheel** when the vehicle is driving itself. However, the driver **will need to stay alert** and be able **take over when requested by the system within 10 second**s. If a driver fails to respond to the transition demand, the vehicle will itself stop, alerting other vehicles.

Under proposed updates to the Highway Code, people using ALKS will be allowed to watch television on built-in screens, but they will not be allowed to use mobile phones.

Vehicles with engaged ALKS are considered by the government as self-driving cars, where a driver is not responsible for crashes. However, in terms of the SAE classification, these vehicles would be considered to be semi-autonomous (Level 3).

Source: DfT (2022) *Rules on safe use of automated vehicles on GB roads*. Available from: https://www.gov.uk/government/consultations/safe-use-rules-for-automated-vehicles-av/rules-on-safe-use-of-automated-vehicles-on-gb-roads#:~:text=Automated%20Lane%20Keeping%20Systems%20(%20ALKS,safe%20use%20on%20British%20roads.

Appendix

Algorithmic bias

Algorithmic decision-making systems can produce data that is biased or skewed in unfair ways:

Historical bias: The data that the model is built, tested and operated on could be based on historical inequalities. For example, if the sample from which the data are drawn is predominantly male then the algorithm may reinforce this.

Data selection bias: Data collection might be unrepresentative if, for example, there has been over or under recording of particular groups. This has been the main cause of some of the problems with the accuracy of some facial recognition algorithms across different ethnic groups.

Algorithmic design bias: Algorithms designed in certain ways can lead to the introduction of bias. For example, algorithms placing job advertisements online designed to optimise for engagement at a given cost can be more frequently targeted at men because women are more costly to advertise to.

Any of these biases can be exacerbated by human oversight and prejudice, and amplify feedback loops.

Source: Centre for Data Ethics and Innovation (2020) *Review into bias in algorithmic decision-making'*. Available from: https://www.gov.uk/government/publications/cdei-publishes-review-into-bias-in-algorithmic-decision-making/main-report-cdei-review-into-bias-in-algorithmic-decision-making

Emotional AI

”Emotional AI refers to technologies that use affective computing and artificial intelligence techniques to sense, learn about and interact with human emotional life. It is a weak form of AI in that these technologies aim to read and react to emotions through text, voice, computer vision, biometric sensing and, potentially, information about a person’s context” (Emotional AI Lab).

In the context of AVs and different levels of automation, companies are working on in-cabin sensors that can detect fatigue, drowsiness, intoxication and stress; and expressions of emotions (such as fear, anger, joy, sadness, contempt, disgust and surprise).

In-cabin sensing can potentially improve road safety; however, it raises issues such as data collection and how data might end up being used, the adequacy of training data, and psychological assumptions behind linking eg facial expression to emotion.

It is also unclear how emotional AI would be regulated through the new proposed EU AI Act.

Source: Emotional AI Lab (n.d.) *What is emotional AI*? Available from: https://emotionalai.org/so-what-is-emotional-ai . McStay & Lachlan Urquhart (2022) In cars (are we really safest of all?): interior sensing and emotional opacity, International Review of Law, Computers & Technology, DOI: 10.1080/13600869.2021.2009181

Some relevant legislation to consider

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The Equality Act 2010

It protects people from discrimination and sets out nine 'protected characteristics'. It is **unlawful to discriminate on the basis of**:

- age
- disability
- gender reassignment
- marriage and civil partnership
- pregnancy and maternity
- race
- religion or belief
- Sex
- Sexual orientation

It requires to make reasonable adjustments for people with disabilities, and it encourages for 'positive action' to enable the participation of disadvantaged groups.

Human Rights Act

Article 14 prohibits against discrimination:

"The enjoyment of the rights and freedoms set forth in this Convention shall be secured without discrimination on any ground such as sex, race, colour, language, religion, political or other opinion, national or social origin, association with a national minority, property, birth or other status."

General Data Protection Regulation (GDPR)

Article 5(1) data must be "processed lawfully, fairly and in a transparent manner"

Article 22(1) "The data subject shall have the right not to be subject to a decision based solely on automated processing, including profiling, which produces legal effects concerning him or her or similarly significantly affects him or her."

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