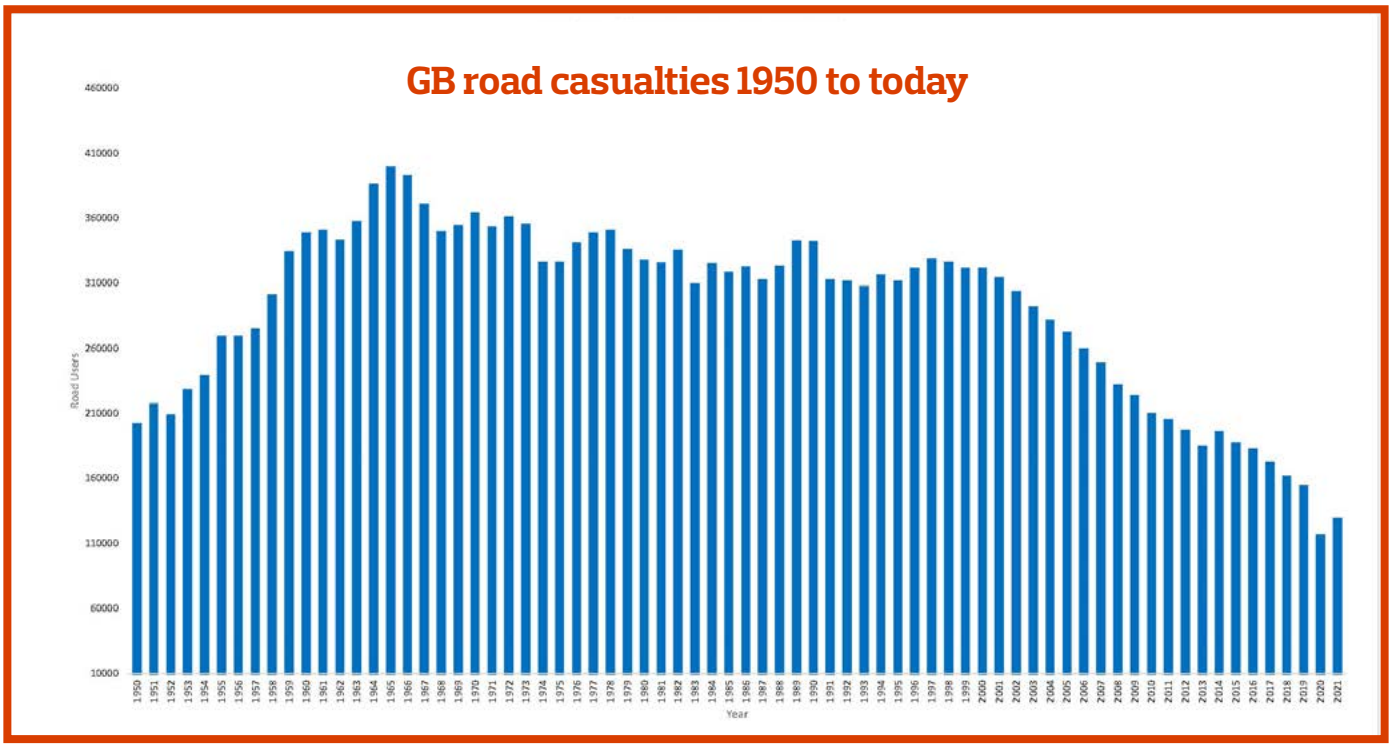
Establishing a safety goal and standard for autonomous vehicles

By Richard Cuerden



The challenge

The commercial success of Connected and Automated Vehicles (CAVs) is predicated on their safety and environmental performance being much better than today's road vehicles. Without clear evidence of the benefits of CAVs there will be an understandable reluctance to adopt them. They must demonstrate that they will aid in reducing the volume of collisions and bring road casualties down closer to zero.

Aligning to a North Star

The UK government recently consulted on a proposed safety ambition for self-driving vehicles, that they 'would be expected to achieve an *equivalent level of safety to that of a competent and careful human driver*'. The words '*careful*' and '*competent*' are adjectives and simply describe human attributes, or behaviours, which are not directly measurable. TRL's safety ambition is that automated vehicles must significantly exceed the safety performance of human driven vehicles. We believe this to be the public's assumption too. To achieve this, the approval requirements must be:

- relevant
- technology agnostic
- avoid ambiguity
- and crucially, set achievable standards that work in the real world.

There is a balance to be struck between setting safety requirements that are too onerous and which disproportionately harm our industry, and not having sufficient standards to establish and then maintain public confidence, which is necessary to build a competitive and sustainable industry. The need is to define the Goldilocks set of safety requirements, that are 'just right', which through an integrated framework design can, based on the best evidence, evolve to ensure ever increasing automated vehicle safety performance over time.

The first step is to establish an outcome metric for the required safety performance, or a North Star for government and industry alike, which aligns our efforts around a common goal, or set of goals, with clear reference to specific target points in time. The ultimate aim is to eradicate all road collisions and associated injuries – Vision Zero. However, while our roads are used by the first generation of automated vehicles, human driven and ridden vehicles, and walkers, all sharing the same space, an iterative improvement approach to safety is the only realistic and achievable option. To aim for perfection is to wait forever and to accept the current unacceptable levels of harm we experience on our roads today.

The number of injury collisions, by injury severity, per billion kilometres travelled provides the measure of road transport safety performance. It is important when making comparisons to differentiate between the type and nature of the modes of transport used and the types and nature of the roads and journeys taken. For example, motorcycles have a higher injury collision rate per mile travelled than buses, and injury collision rates on motorways are lower per mile travelled than witnessed on urban streets. In 2021, the casualty rates per billion passenger kilometres for car users was 199 compared to 3,889 for motorcyclists.

This is important to note, because by knowing specific injury collision rates by vehicle and journey types, there is a benchmark upon which automated road vehicles can be assessed and designed to exceed.

TRL has developed a methodology to define an outcome metric for the safety performance for self-driving vehicles, measured in injury collisions per billion miles they travel. The methodology uses in-depth collision analysis from the UK's Road Accident In-Depth Studies (RAIDS) weighted to be representative of the national reported road casualties, and combines this with vehicle fleet composition and journey data. Improvements to the methodology and validation of the proof of concept are required. However, it is a key step in establishing the approval requirements associated with how much safer automated vehicles must be compared to equivalent human driven vehicles doing like by like journeys.

Our initial work is focussed on the early adoption of automated vehicles, when they will be a small proportion of the fleet and sharing roads with other vehicles and people walking and cycling. Therefore, in the model it is only reasonable to set safety performance requirements for events which are in the control of the automated driving system. As automated vehicles become more common the safety performance metric will improve because the exposure to risk associated with human drivers will decrease. As an example, early TRL results show that the first generation of automated cars should be expected to have less than half the number of injury collisions per billion passenger kilometres compared to today's state-of-the-art vehicles.

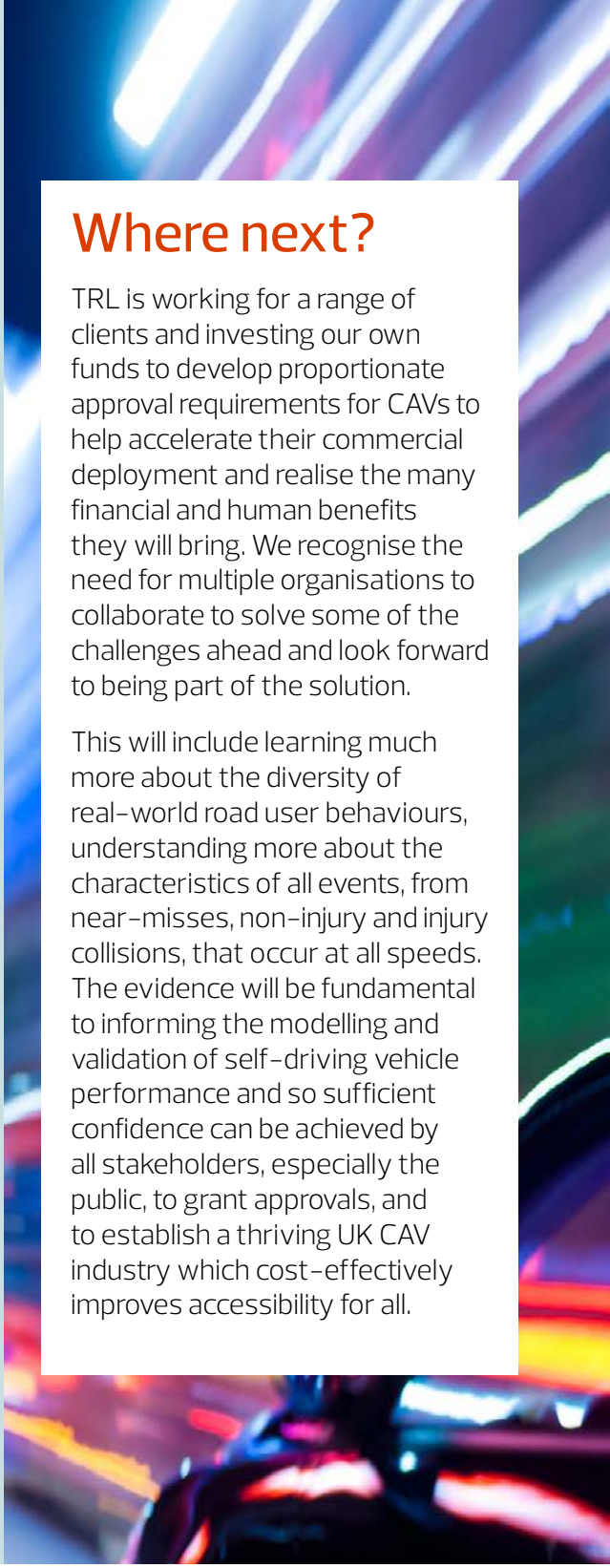
Demonstrating safety

The urgent challenge to overcome for the automated vehicle industry and regulators is to agree how to evidence that self-driving vehicles will be safer than today's fleet. The approach will be based both on assessing individual systems, and how the many systems combine (system of systems) to deliver a safety performance outcome.

The complexity of the problem necessitates a self-certification method, where the automated driving system provider, the vehicle manufacturer and depending on the use case, the service operator, must all work in alignment, and submit suitable evidence to an approval authority for the vehicles to be used. The evidence will in part be reliant on predictive modelling which is validated through test track and real-world assessments.

The lessons learnt through the development of the latest vehicle Type Approval requirements for the EU, where TRL created a safe-vehicle-system regulatory approach, and TRL's eCall regulation methodology, provide useful foundations. This is because the interaction of different systems and self-assessment techniques have been applied in relevant and robust regulations that are helping to save lives today, and crucially, have sought to mitigate unintended consequences.

When automated vehicles, including personally owned vehicles, and private and public services transporting people and goods, are in-use on our roads they must be continually monitored as part of their permission to operate. This will include gathering and rapidly interrogating data from collisions, near misses, and also identifying circumstances that could arise in the future, where a combination of factors could present previously unknown or unforeseen risks. The data will be part of an open feedback loop and integrated into the approval process, enabling automated vehicle safety performance to continually improve, aiming for zero people harmed by our road transport. This will require an open safety culture where lessons must be shared and not retained for commercial or other interests.



Where next?

TRL is working for a range of clients and investing our own funds to develop proportionate approval requirements for CAVs to help accelerate their commercial deployment and realise the many financial and human benefits they will bring. We recognise the need for multiple organisations to collaborate to solve some of the challenges ahead and look forward to being part of the solution.

This will include learning much more about the diversity of real-world road user behaviours, understanding more about the characteristics of all events, from near-misses, non-injury and injury collisions, that occur at all speeds. The evidence will be fundamental to informing the modelling and validation of self-driving vehicle performance and so sufficient confidence can be achieved by all stakeholders, especially the public, to grant approvals, and to establish a thriving UK CAV industry which cost-effectively improves accessibility for all.

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Richard is responsible for TRL's science and engineering strategy and the associated thought leadership investments and activities, ensuring technical quality of research outputs, supporting the academic development of staff and managing engagement with stakeholders on programmes of collaborative research. TRL's mission is to enable world-class transport and mobility solutions that underpin the needs of tomorrow's economy and society.