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Freight vehicles in the world of automated driving

After nearly 20 years working in the global R&D field of connected and automated vehicles (CAV), it's interesting to revisit the trucking industry as a specific case for vehicle automation. Please bear in mind that automated driving systems (ADSs) – machines that can drive vehicles, but not under all conditions – were not aimed at freight trucks. The huge global market for automated vehicles is largely driven by personal vehicles: these days, SUVs, light trucks, sedans, etc.

There are many explanations for the resulting R&D frenzy, but remember that there are trillions of personal trips each year in the US. Tech companies like Google realised that, if they gained a fraction of a cent for each mile traveled, they would have a bigger business than all of their current activities put together. This might come about if a vast number of personal trips could utilise a technology that has come to be known as robotaxis. Once Google started developing their autonomous technology (currently known as Waymo), all of the legacy automotive OEMs saw a potentially devastating disruption in a century-old industry.

This had a galvanising effect on the entire automotive industry, to the extent that today's vehicular offerings may not be automated, but they do contain the very highest level of engineering prowess. And they are gradually incorporating advanced driver assistance systems and elements of automation, all enabled by astonishing advances in vehicle data volume and velocity. The fact that we are now on the cusp of mainstream vehicle electrification also speaks to the sophisticated reimagination of vehicle systems.

The world of over-the-road freight vehicles could not be more different from the much larger, consumerist automotive industries. The cyclical freight industry cannot afford to invest in extreme technologies and is not subject to threats of disruption and extreme pressures to innovate. Nevertheless, as the development of automated vehicles has played out, unexpected barriers have appeared. For one thing, the range of operating conditions is infinitely wide; this has pushed back against the dream of universal robotaxis. If robotaxis couldn't provide the early-adopting commercial applications, where may they be found? Attention turned to the freight industry for a couple of reasons.

At least in the US context, long haul trucking represents a far simpler operating environment than personal vehicles which have always been much more impromptu in deployment and less purposeful in use. There is also a very direct and significant economic case in the freight sector, where driver compensation is a major target in reducing operating costs. And because many ADSs require some level of human supervision or intervention, there is advantage in the professional driver offering more potential for machine and man to work together.

Human drivers are extremely adaptable and resourceful, so the sudden appearance of new and challenging driving situations – whether related to weather, roadway conditions, other traffic, or non-recurring events — only rarely causes harm in the form of crashes. While ADS manufacturers are expected to nominate an operational design domain for their driving machines, this currently occurs only in general terms. It has turned out that so-called edge cases – perhaps novel situations such as animals on the road – are so numerous and diverse as to render ADSs susceptible to disablement. While this has greatly slowed the development and testing of general-use ADSs, freight operations on selected, repeated routes, with trained supervisors, offer more immediate potential for safe, commercial use. An excellent insight into the directions commercial ADSs are taking may be derived from the activities of the US technology company Aurora. This ADS commercialisation company was founded by Chris Urmson who had led the development of the Waymo driverless car. With its highly credible pattern of acquisitions and partnerships, Aurora has focused squarely on freight applications. These partnerships include major US Class 8 truck manufacturers and national fleets. In common with other innovators such as TuSimple, Aurora recruits freight shippers and carriers to carry out pilot operations that encompass loading and delivery phases, as well as actual trips. These activities will continue and expand, provided that road and traffic authorities continue to take a positive approach. Most government agencies accept that continued development of ADSs requires a strong element of testing and piloting on public roads. This is probably even more true for freight vehicles than for personal vehicles. So how do we know that ADSs are safe? And is safety likely to be a bigger barrier for freight vehicle automation than for personal vehicles?

Aurora Driver is a Level 4 advanced autonomous system.


Peterbilt New Model 579 with Aurora Driver.

Safety is of course a huge question for all types of automated vehicles, and this issue has already followed a somewhat convoluted path. In the first instance, government agencies have generally encouraged vehicle automation as a desirable form of future mobility innovation. The main reason for this positive approach is the long-term potential for transformational safety improvements. If more than 90 per cent of serious crashes are caused by driver error, then driving machines of eternally high reliability offer the prospect of trauma reduction on a scale never considered possible. Policy makers had already seen and appreciated the benefits of waves of crash mitigation and avoidance technologies offered by automakers. They could scarcely ignore automated safety technology, although safety is far from being the entire objective for vehicle automation.

Because most of the cutting-edge innovation around automation takes place in the US, motor vehicle safety norms that have evolved in the US environment have tended to be the first port of call for automated vehicles. This means a very punitive approach to placing the onus on the manufacturer, and minimalistic opportunity to shift responsibility to the government. We have already seen a few high-severity crashes that have generated such intensely negative publicity for the manufacturer that their R&D slowed, or even ceased. For example, Uber's automated vehicle effort was acquired by Aurora.

Expectations for the safe performance of ADSs remain very high, and it is widely believed that all ADSs need to be a lot safer than humans. It is not possible to test and certify ADSs at the design stage, and a great deal of nuance is involved in R&D that needs to be carried out on public roads. At this point, freight vehicles remain an important avenue for ADS development and commercialisation, particularly where operating conditions are well-defined. These applications are likely to be at the higher levels of automation. As for personal vehicles, OEMs are steadily rolling out lower levels of automation: more akin to driver assistance than robotaxis. The distinctions between ADSs for freight vehicles and personal vehicles are therefore increasing rather than decreasing.

Autonomous haul trucks are widely used in Australia's mining industry. Australia has about 600 driverless haul trucks, making it the world-leader in this segment. The machines are programmed for a particular mine site, which greatly reduces the technical challenges that exist on public roads. Their operation is also overseen by a human controller. This is a great example of understanding the limitations of the current technology: tightly-defined operating conditions and driving machine capabilities augmented by human oversight, remote from the vehicle.

This brings us to a final point about the extreme diversity evident in the design of ADSs. Just as operating conditions experienced by driving machines are almost infinitely variable, their capability levels have shown a huge variation in intent as well as execution. Now is the time for the freight industry to be at the table, along with infrastructure managers, to help figure out the operating conditions most relevant to early adopters of freight vehicle automation. And close collaboration is needed with ADS manufacturers to understand necessary and sufficient capabilities for automated haulage and delivery.

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