# Do passengers prefer autonomous vehicles driven like machines or like humans?

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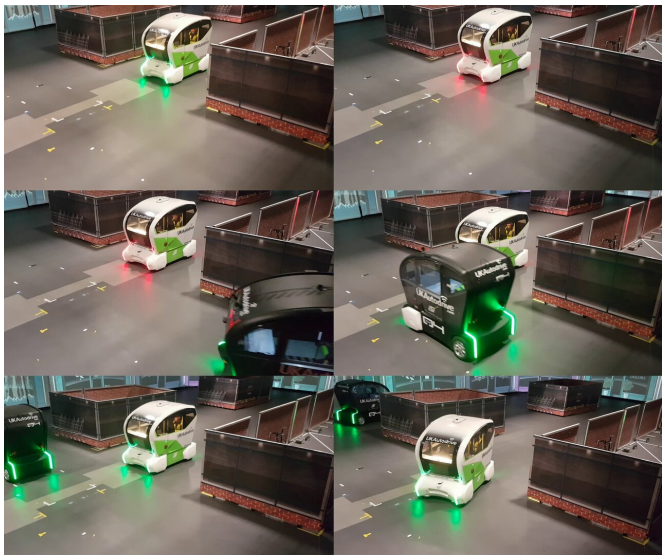


Credit: University of Warwick

Passenger and pedestrian confidence and acceptance will be key to the future and development of autonomous vehicles so researchers at WMG at the University of Warwick have just conducted and reported an experiment to see which autonomous vehicles driving style engendered the highest levels of confidence among autonomous vehicles passengers—driving with full machine efficiency, or driving in a way that emulates average human driving. The surprising result was that neither was optimal but that a blend of both might be best.

The researchers took 43 volunteers into a large warehouse designed to resemble a pedestrianised area in a town centre with a series of routes that included a range of junctions. Half were given 4 journeys around the route in an autonomous vehicle driving with full machine efficiency using all its capabilities to drive in as safe and efficient manner as possible while the others were given 4 journeys around the route in autonomous vehicles that tried to closely emulate average human driving patterns. They then scored the level of trust in the autonomous vehicles. The result has have just been published in the journal *Information*.

The overall result was that there was only a marginal difference in trust between the two driving methods. The efficient machine method was slightly favoured but even that small gap between the two driving styles narrowed over the four runs. What was noticeable for both the "machine" and "human" driving styles is that confidence in both grew with each new round suggesting that simple familiarity and growing accustomed to the experience will be one of the most effective ways of quickly building trust and acceptance of autonomous vehicles once their use becomes more widespread.

| Mean scores of trust | Human | Machine |
|---|---|---|
| First Run | 59.30 | 63.19 |
| Second Run | 59.55 | 66.33 |
| Third Run | 65.85 | 68.29 |
| Fourth Run | 67.20 | 69.38 |

Credit: University of Warwick

Dr. Luis Oliveira from WMG at the University of Warwick and the lead author on the paper said:

"The overall trust in both driving methods grew with every run. In the machine-like driving style this was steady upwards curve throughout the four journeys but in human-like behaviour there was a particularly steep change upwards in the scores between runs 2 and 3. The passengers in the experiment also acknowledged that future generations may be more comfortable with AVs and its features, as they learn to live with the new technology."

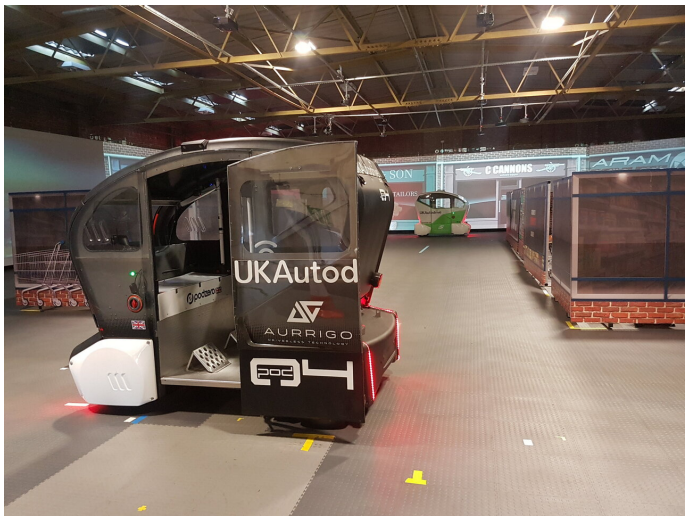
The researchers also asked the participants to give some narrative about their experience and this showed that there were advantages on both modes of driving that may therefore need to be blended together in any future final package. The researchers' literature review and warehouse experiment made clear that there re were two particularly clear lessons to be learned:

- Smooth speed change—Past studies had already shown that Human drivers' tendency is to brake most at the start of any manoeuvre that requires deceleration whilst the totally automated driving programmes applied speed changes more gradually and efficiently. Human passengers preferred the comfort of the smoother changes of acceleration and deceleration provided by the machine driving methods.
- Sharp turns—A common complaint was a feeling that the vehicles were performing uncomfortable and worrying sharp turns. This feeling was actually expressed by both those in the machine and Human style driving set ups but it was much more noticeable in the machine-like driving style condition. One typical negative comment was "what you'd expect from a driver is a bit of a gradual turn….there were moments where it was accelerating around corners, I think it catches you unaware."

WMG's Dr. Luis Oliveira said:

"This shows that the challenge is that the speed and trajectory of autonomous vehicles should be finely controlled, but at the same time the vehicle should be assertive to provide the benefits of automated driving."

However it was the AV's behaviours at junctions in the WMG University of Warwick warehouse test that produced the most diverse and surprising reactions.




Credit: University of Warwick

The machine driven AVs were left to make use of all of their sensors and ability to communicate with vehicles that may out of line of sight to decide whether to enter a junction. If their sensors said it was safe and their communications with other vehicles indicated no approaching threats they would simply enter the junction without stopping. If however they detected a vehicle that they believed should have right of way—even if it was not yet visible to the human passenger they would stop and let that vehicle pass. In contrast The AV's emulating human driving would always stop at a junction and would even edge into the junction as if the peek at what the oncoming traffic might be.

The reactions to those two different approaches were very varied and surprising.

Some liked the human approach with one saying that the AV was "…probably trying to inspire confidence in the passenger, I'm guessing, in terms of like the way it behaved, kind of quite similar to a human, it's only ever going to inspire confidence I think it's because that's what we're used to".

Some also liked the machine driving approach of stopping at junctions even though there was no visible issue but because it was in communication with another out of sight vehicle that it perceived had right of way. One passage said: "it stopped at a

junction, because I assume it knew that something was coming, as opposed to it reacting to seeing something coming".

Equally there was dislike for **both** the human and machine driving methods of handling a junction.

Some perceived problems with the machine approach of just entering the junction if it believed it to be clear to do so with one saying that they were concerned about vulnerable road users. "..such as pedestrians or cyclists that could have been there that don't communicate with the pod. That may be a safer way of doing it rather than flying around the corner".

However others were greatly surprised at the "human" driving method AV stopping at every junction as they saw it not just as waste of the machines capabilities to scan and communicate ahead to understand traffic. They were frustrated that the vehicle was not "more assertive" One passenger saying "sometimes I didn't expect it to stop, because I thought the other pod was a bit further away but then it did, so I guess it's cautious…if I was driving I'd probably have gone". Another passenger said "If I was in an autonomous pod with sensors giving a 360-degree view at all times, I'd expect the vehicle to instantaneously know whether it was safe or not, and not need to edge out".

A further passenger who tested the human-like version, commented that a machine driving like a human and trying to look around the corners seemed ironically unnatural saying: "I think it was a bit unexpected because my expectation with the pods is that that there would be some un-naturalism to it rather than a human driver".

Despite this seeming mass of contradictions in views about how AVs should handle junctions the research team do think there are valuable lessons to be learned even here. In particular:

- There is clearly a need to give the general public the details of the driving systems, for example, the recent technological features such as vehicle to vehicle communication
- For passengers in a vehicle consideration should be given to having a display and/or audio information that shares some of the information the vehicle is using so users can understand that the system is aware of hazards beyond the field of view.
- There may be some merit in presenting the full benefits of the most efficient methods of machine based driving progressively when mass use is first introduced, so that passengers can build confidence over time

**More information:** Luis Oliveira et al. Driving Style: How Should an Automated Vehicle Behave?, *Information* (2019). DOI: 10.3390/info10060219

Provided by University of Warwick