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BOOK OF ABSTRACTS **Open Access**

Autonomous vehicles in the pro peloton: opportunities and threats

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Introduction

There is a need for motor vehicles to operate in close proximity to riders in professional races; there is a need for professional cyclists to move unpredictably in order to gain sporting advantage. Are collisions between cyclists and cars / motos therefore inevitable? There is an ongoing controversy over the number and action of motos and other support vehicles, including ‘classic’ incidents such as Hoogerland’s crash at the 2011 TdF where a media car collided with the riders; race affecting incidents such as the ‘Blockhaus’ incident affecting Thomas, Yates and Landa at 2017 Giro d’Italia where a stationary motorcycle caused an incident (Mansfield, 2017) and a similar incident involving Peter Sagan at the 2015 Vuelta a Espana. Other incidents have led to more serious outcomes. The automotive industry have made great improvements in vehicle safety and have invested increasing amounts of attention to protecting other road users. One leader has been Volvo who currently promote ‘Vision 2020’: "Our vision is that by 2020 no one should be killed or seriously injured in a new Volvo car" (Håkan Samuelsson, President and CEO, Volvo Cars, 2014). This paper seeks to outline opportunities and threats from automotive technologies and whether they might have scope to improve safety in the pro peloton.

Levels of autonomy and the state-of-the-art

Autonomous vehicle systems are set to revolutionise the transport environment across the world. There are enormous potential environmental benefits from autonomous vehicles including the ability to minimise emissions through smart engine management, minimising congestion through smart routing / parking, and reducing road collisions through elimination of distracted, intoxicated or tired drivers. Autonomous vehicles are classified using six levels of autonomy (SAE, 2014). These levels are:

Level 0 No automation:	No direct vehicle control, but warning systems may be present (e.g. parking sensors).
Level 1 Driver assistance:	Automated speed (cruise) control, lateral (lane keeping) control, and parking assistance.
Level 2 Partial automation:	System can take full control of vehicle (e.g. Tesla autopilot), but human supervisor is necessary to re-take control at any time.
Level 3 Conditional automation:	The driver can move their attention from the driving task in well-controlled environments (e.g. highways), but is needed to manually drive the car in complex scenarios. The car can take decisions on whether to overtake and can request a rapid return to human control.
Level 4 High automation:	The car can drive itself in almost all circumstances. Human control may be needed if systems fail (e.g. in poor weather) but the car can safely proceed if the driver is unable to take control. Human control may be possible at the human’s request.
Level 5 Full automation:	There is no possibility for the human operator to physically drive the car. The human occupant is effectively a passenger.

The most advanced autopilot systems currently operate at Level 2. These use radar and optical sensors to generate virtual situation awareness. Experimental systems (e.g. Google / Uber) use LIDAR laser scanning to support Levels 3-5. Currently automotive manufacturers are prioritising technology to safely control the vehicle and to detect (and avoid) obstacles. Autonomy has not only been developed in cars but has also been demonstrated by major motorcycle manufactures.

Some low-level autonomous systems are already standard equipment in many models of car and are well accepted due to clear improvements in safety (e.g. anti-lock braking, traction control). More sophisticated 'standard' autonomy such as lane-assist and adaptive cruise control will inevitably be present in some support vehicles but mostly de-activated. If Volvo's 'Vision 2020' and similar ambitious targets are to be achieved then high-level automatic safety systems will no longer be optional.

The challenge of mixing autonomous technologies with riders and fans

In cycle sport autonomous technologies will need to be reviewed in order to mandate / prohibit for support vehicles at road races. On the one hand, potential for improved performance exists in terms of collision avoidance with athletes, spectators, road furniture / debris and other support vehicles. It could minimise the risks associated with team directors / managers to multi-task through following the race on-screen, using race radio, and driving simultaneously. On the other hand there are many scenarios where autonomous systems may not perform as intended due to them being optimised for public roads with mixed transport systems rather than closed roads. Autonomous vehicles are currently 'hard wired' to be passive when it comes to pedestrian safety and therefore will stop if a human obstacle is detected. The reality of cycling fan behaviour means that this will not be acceptable on slow speed sections (i.e. mountain stages) where fans enjoy close engagement with athletes. In situations where spectators are close to riders, the autonomous vehicle will need to balance safety and assertiveness; this is a use-case that is low priority for automotive manufacturers.

There has been little consideration of the change in the behaviour of other road users in response to autonomous vehicles. If a cyclist recognises that a vehicle at a junction is autonomous they may choose to take an assertive approach and deliberately cross in front of it, expecting it to stop; alternatively if vulnerable road users feel unsafe with the perceived behaviour of autonomous vehicles they may be discouraged from using such forms of transport. One advantage for the professional rider is that the behaviour of the car will be predictable. A conservative approach from the vehicle artificial intelligence (AI) programmer could result in autonomous vehicles being an easy target for criminals and this will need to be considered. The problem of over-enthusiastic fans (e.g. Ventoux TdF 2016) could be exacerbated by those recognising that particular models and brands of car will incorporate collision-avoidance and therefore be tempted to step into the path of the vehicle.

Current autopilot systems work through using a high-level of data analytics and data sharing. This means that details of road conditions can be shared to other vehicles in the fleet and effectively dictate a maximum speed that can be comfortably used. During race descents, these limitations on speed are likely to be exceeded by the most proficient riders. If such safety systems cannot be de-activated unintended consequences and vehicle behaviour could occur. Similarly, the usual use of roads in their reverse directions (e.g. driving on the 'wrong' side, driving against the standard flow of traffic that would exist if the road was not closed) could cause the vehicle to prevent access to the race route.

Conclusion

In summary, there are many aspects of autonomy that should be welcomed by the cycle race community. However, teams and organisers should be cautious in selection and specification of vehicles that might include hard-wired automation and safety features. It is highly likely that safety systems designed to keep road users safe under 'normal' driving will be counter-productive when used in close proximity to cycle races on closed roads.

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