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Road Vehicle Automation: Safety Impact and Future Solutions

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Introduction

In order to ensure EU Road Safety 2020 target of 15,700 fatalities and long term vision of zero road fatalities could be realistically met, the EU and vehicle manufacturers have plans to introduce more automation technologies into road vehicles and eventually reaching an autonomous future. This research aim to justify the need for increasing automation in road vehicles by assessing the key accident causal factors and the safety impact of Advanced Driver Assistance System (ADAS) in addressing the accident factors. This is followed by identifying gaps and negative impact of ADAS which gives rise to the need for autonomous vehicles. Considering the test data of autonomous vehicles operating in a mixed-mode environment (autonomous and legacy vehicles), this research has also highlighted problems that are resulted from this environment and proposed solutions to suggest the direction for manufacturers moving forward.

Timeline of Automation Technologies in Road Vehicles

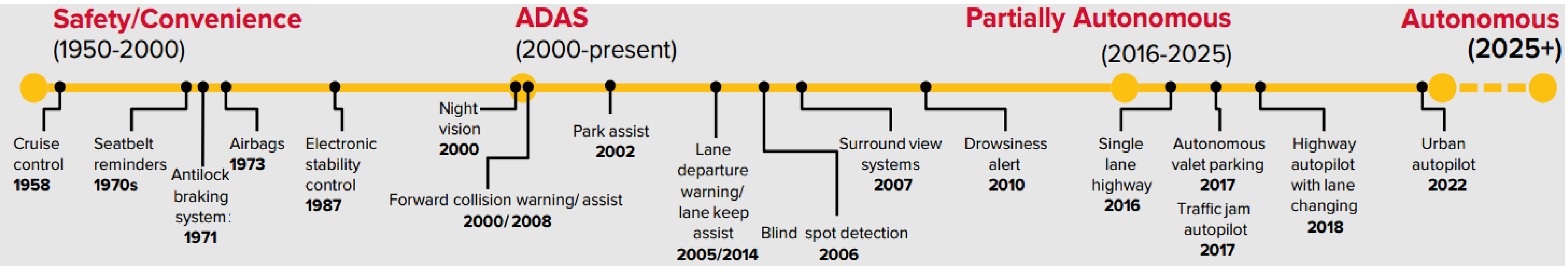

FIGURE 1: Timeline of Automation Technologies (Source: BCG, 2015)

Year 1950-2000: The era of automated safety systems begins and function-specific systems were introduced to assist drivers in handling vehicle controls.

Year 2000-2015: ADAS allows vehicles to sense surrounding environment and adapt function-specific automation systems towards drivers' real-time needs. Although the system has become smarter from the previous era, it does not fully address the problem where 90% of accidents came from human failure.

Year 2016-2025: Autopilot is allowed in some cases and driver need to take control during critical situations.

Year 2025+: Fully autonomous vehicles where drivers are not expected to take control of the vehicle.

Accident Causal Factors

Most of the accidents are the result of human failure, which constitutes 90% of all accident causes. The accident causal factors include:

(i) Fatigue and alcohol influence
(ii) Risky driving behaviour (speeding, not keeping distance, risky manoeuvres, offending traffic regulations)
(iii) Poor decision and timing during lane-changing or other manoeuvres
(iv) Not keeping in lane which causes lane departure and loss of control
(v) Visibility limitations due to blind spots/ narrow or bend roads/ lighting conditions
(vi) Driver's shift of attention to information boards/ secondary tasks
(vii) Adverse weather conditions (rain/ snow) causing a slip surface
(viii) Pedestrians illegal crossing or recognition error

Acknowledgement

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References

BCG (2015) A Roadmap To Safer Driving Through Advanced Driver Assistance System. Available at: http://www.mema.org/Document-Vault/PDFs/2015/MEMA-BCG-ADAS-Report.pdf (Accessed: 8 June 2016).

Safety Impact of ADAS

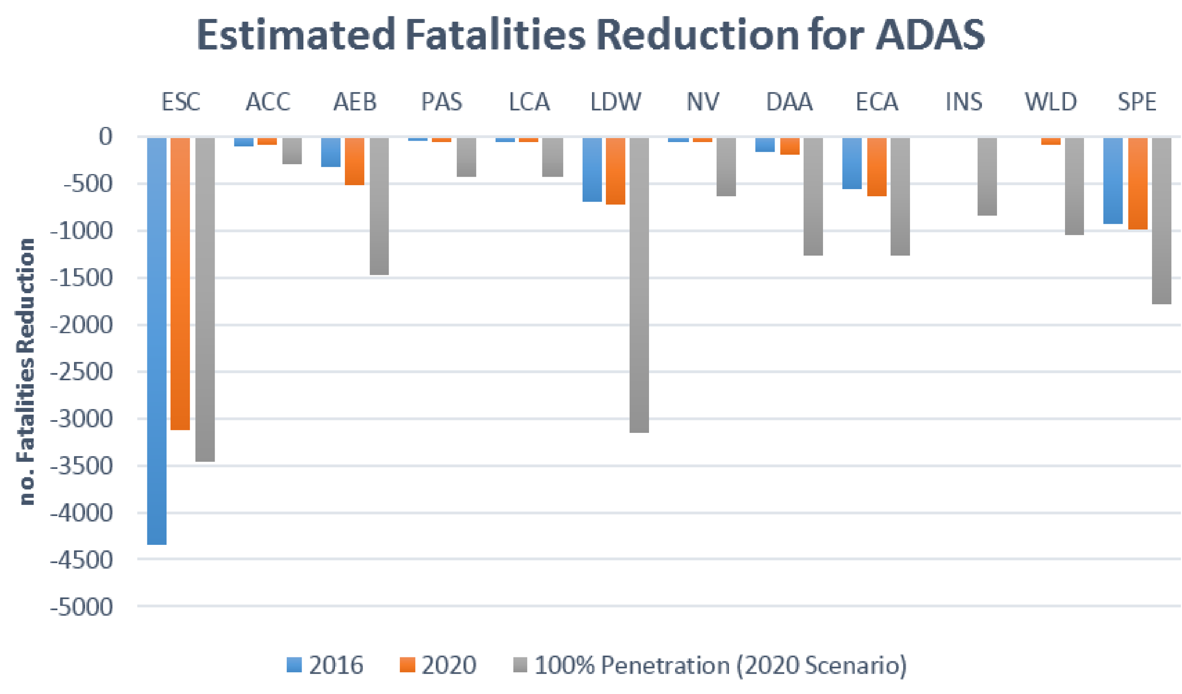

FIGURE 3: Fatalities Reduction for ADAS Technologies

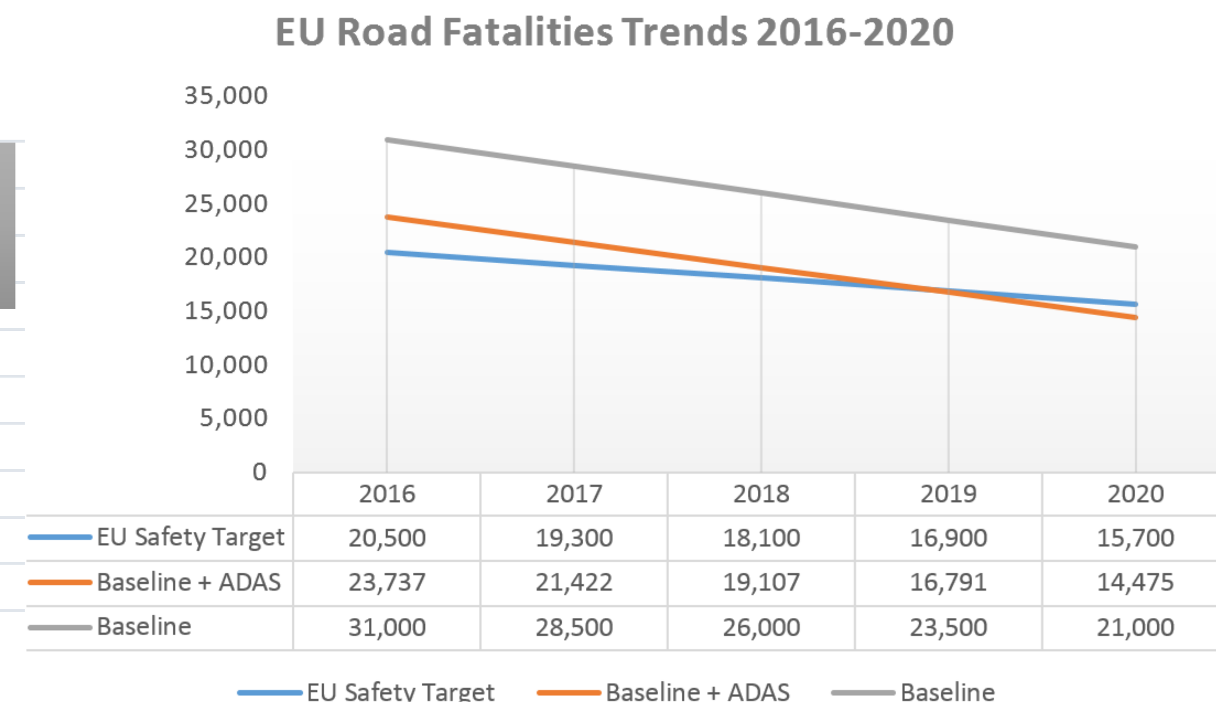

FIGURE 5: Estimated Road Fatalities Trends 2016-2020

ADAS assessed include: Electronic Stability Control (ESC), Adaptive Cruise Control (ACC), Automatic Emergency Braking (AEB), Pedestrian Avoidance System (PAS), Lane Change Assistant with Blind Spot Warning (LCA), Lane Departure Warning (LDW), Night Vision (NV), Driver Attention Alert (DAA), eCall (ECA), Intersection Safety System (INS), Wireless Local Danger Warning (WLD), and Speed Alert (SPE).

Based on Figure 5, the EU Road Safety Target 2020 could be realistically achieved, only if there is a constant growth in ADAS adoption. The baseline figure also takes into account improvements in road infrastructure and legal enforcements over the years, in a non-ADAS scenario that is based on 1991-2005 trend data. However, the figures for number of fatalities could be 17,500 in year 2020 given that there has already been ESC technologies implementation over the past 2 decades, pushing up baseline figures.

Negative Impact and Gaps in ADAS

- Driver's reliance on ADAS causes over-confidence in traffic situations and decreased alertness.
- Creates secondary tasks for the driver which increases the accident risks.
- Alcohol influence and fatigue lack an active system to address the issues of driving under influence.
- LDW and DAA only provide passive advice to drivers when it comes to lane departure and prompt driver to take a break, but it does not actively prevent drivers from taking risky actions while under influence.

Autonomous Vehicles (AV) and Future Solutions

Challenges associated with the operation of AV in a mixed-mode environment (autonomous and legacy vehicles) include:

- Inaccurate prediction in the behaviour of oncoming vehicles whilst exiting lane
- Vehicle approaching the AV from rear did not anticipate the sudden and unnatural stop, despite AV following all traffic rules
- Did not give way/ provide flexibility to other reckless road users
- Driver failed to react after retaking control of the vehicle.

In order for vehicle manufacturers to address these issues, this paper proposed the following solutions:

(i) Adapt driving styles base on smart data collection from approaching vehicles driver or local culture
(ii) Educate other road users on the likely behaviours of AV
(iii) Design the system to report its status and the traffic situations throughout the autopilot journey to allow driver to retake control being fully aware