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Advanced Driver Assistance Systems in the Driver Training System in Hungary

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Abstract

Automated driving systems can improve road safety, but also carry significant risks. Research has shown that automated features may predispose drivers to riskier driving behaviour, making them more careless, as many drivers over-rely on these systems. Incorrect expectations or insufficient knowledge about automated systems can also easily lead to inappropriate use of the technology or increased driver distraction. In the future, there will be an increasing number of vehicles with varying degrees of automation. These developments raise the need to review and adapt current driver training and testing procedures to increase the ability of users to use automated driving systems properly and be aware of their potential and limitations to take full advantage of their benefits. Although research and regulatory plans focus heavily on Level 3 automation, the management of lower levels of automation adds a new kind of extra task to the usual driving task, and may even complicate it, given that it significantly changes driver behaviour. A survey of driver trainers was carried out in 2022 to identify what safety systems were fitted in their vehicles, how and when they were taught in driver training, and their capabilities and limitations. With EU regulations promoting or requiring the use of safety technologies, it is even more important that driver training and testing include technological developments and guarantee the safe use of all levels of vehicle automation.

Keywords

automated driving systems, road safety, driver training, vehicle automation

1 Introduction

1.1 Automated driving systems (ADS) vs advanced driver assistance systems (ADAS)

Still in development, automated driving systems encompass SAE Levels 3 through 5. In its mature state, a vehicle equipped with ADS aims to sustainably perform the entire dynamic driving task within a defined operational design domain without driver involvement. While these vehicles are being developed and tested on public roads in limited capacities, they are unavailable for consumer purchase (Fig. 1.).

Level 2 advanced driver assistance systems provide both speed and steering input when the driver assistance system is engaged, but require the human driver to remain fully engaged in the driving task at all times (Hajdu and Lakatos, 2023).

1.2 Reports and research published in the United States

Most research on the link between advanced driver assistance systems and road safety was conducted in the United States. On the one hand, the country is a leader in integrating advanced technologies into the vehicle industry, and there is also more attention at the government level to assessing the effectiveness of these systems. This is reflected, for example, in the Standing General Order issued by the NHTSA (US National Highway Traffic Safety Administration) in June 2021, which requires car manufacturers and operators to report crashes involving a vehicle equipped with automated driving systems or SAE Level 2 Advanced Driver Assistance Systems (ADAS). Accidents must be reported for automated driving systems (ADS, SAE 3 to SAE 5) where the ADS system was active 30 seconds before the accident and resulted in property

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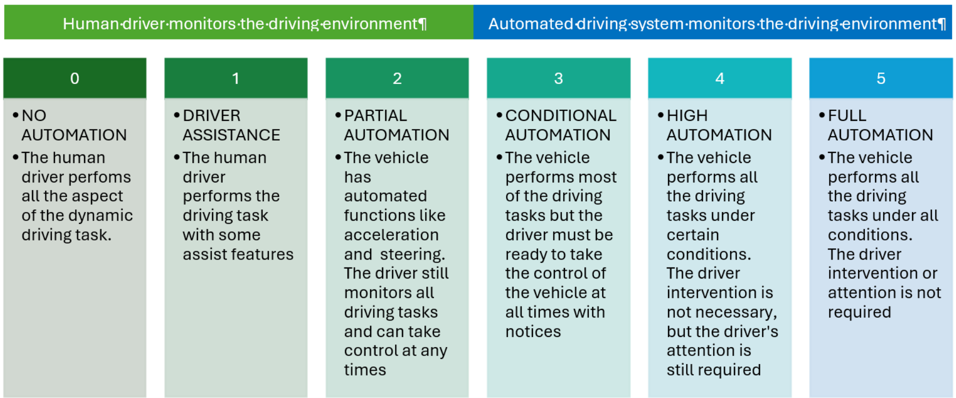

Fig. 1 SAE International Levels of Automation, 2018 (Source: SAE, 2018)

damage or injury. For vehicles using SAE level 2 systems (ADAS), accident data shall be reported if the ADAS system was active in the 30 seconds preceding the accident and the accident involved an unprotected road user, a fatality, an airbag deployment, or a person involved in the accident had to be taken to the hospital.

The data collected while the system was in operation was used to produce statements for vehicles operating an automated driving system (ADS) and ADAS (see Figs. 2–5) (NHTSA, 2025).

The highest proportion of collisions is with passenger cars and SUVs, but it is interesting to note the high proportion of collisions with fixed objects involving vehicles using ADAS. In the latter statistic, it is impossible to draw any firm conclusions due to the large number of unknowns, but the statistics are expected to provide a more accurate picture as the system becomes more operational over time. Most accident outcomes fall into the non-injury and minor injury accident categories, but the unknown category for ADAS vehicles is also very high.

Several studies have examined the impact of advanced driver assistance systems on road accidents in the United States. The PARTS (2022) study compared crash data

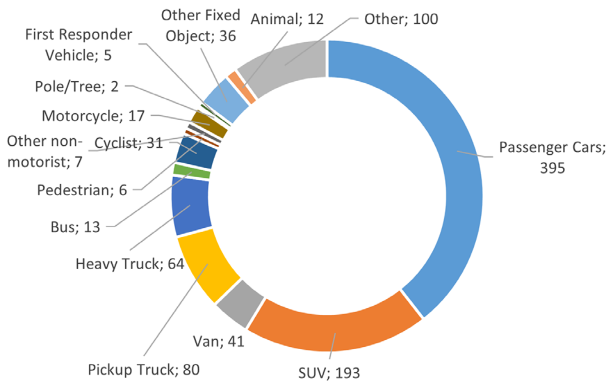

Fig. 2 Collision data of vehicles using automated driving systems with other road users (Edited based on NHTSA (2025))

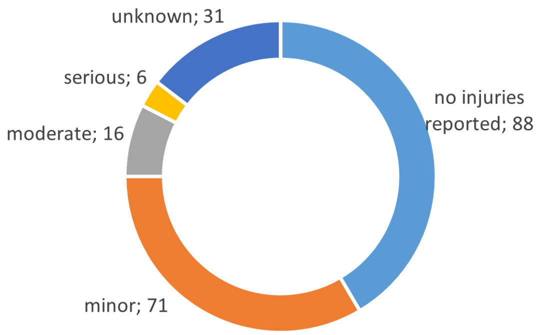

Fig. 3 Collision data of Level 2 ADAS vehicles collided with other road users (Edited based on NHTSA (2025))

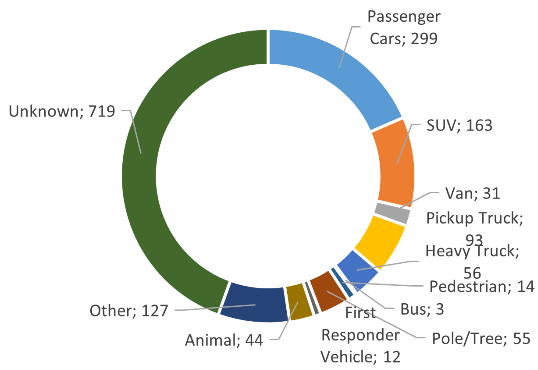

Fig. 4 Collision data of Level 2 ADAS vehicles collided with other road users (Edited based on NHTSA (2025))

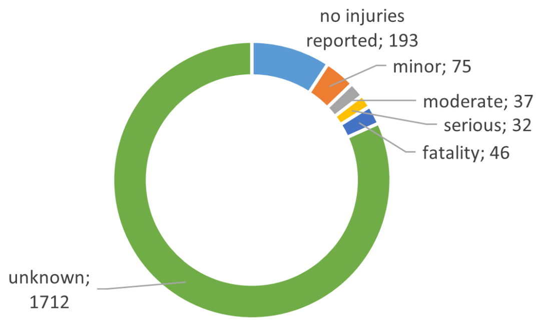

Fig. 5 Outcomes of accidents involving vehicles using ADAS (Edited based on NHTSA (2025))

recorded by the police in 13 states with data from 8 car manufacturers from 2016 to 2021. The data provided by the vehicle manufacturers was used to determine whether the vehicle involved in the crash had advanced driver assistance systems, and the level and type of systems they had. A total of 47 million vehicles were included in the survey, from which an accident database of 2.4 million vehicles was produced. It was found that vehicles with Forward Collision Warning (FCW) or Automatic Emergency Braking (AEB) had a 49% lower rate of rear-end collisions than vehicles without such equipment. A 16% reduction was found for vehicles equipped with only the forward collision warning system. Narrowed to personal injury accidents, the reduction was slightly higher (53%). Lane Departure Warning (LDW) and Lane Keeping Assistance (LKA) systems resulted in an 8% reduction in single-vehicle accidents. A similar 9% reduction in accidents was recorded for vehicles using Lane Centring Assistance (LCA).

Also, in a US study, Cicchino (2022) investigated the impact of emergency braking assist systems (AEB) on pedestrian hit-and-run crashes. The data source was real police-reported crash statistics collected from 18 states from 2017 to 2020. From the accident data, as well as data obtained from insurance companies, the presence of emergency braking assist systems in the vehicle was determined. A total of 1,483 pedestrian hit-and-run crashes were investigated. It was shown that emergency braking assist systems significantly reduced the accident rate by 25-27% and the personal injury accident rate by 29-30% (Cicchino, 2022). Pedestrian-sensing emergency braking assist systems have also been investigated in other studies, with Leslie et al. (2021) showing a 14% reduction in pedestrian accident rates and Spicer et al. (2021) showing a 16% reduction.

Several studies have investigated the effects of vehicles equipped with Intelligent Speed Assistance (ISA), including both prospective (using an estimation model) and retrospective (using accident data) studies. As part of the SafeCar project in Australia, Regan et al. (2006), collected data from 15 vehicles equipped with Intelligent Speed Assistance systems for 16,500 kilometres travelled. The authors estimate that in 60 km/h zones, ISA alone can reduce the number of serious injury accidents by 5.81% and fatalities by 7.68%. In road zones with a speed limit of 100 km/h, they estimate that serious injury accidents can be reduced by 2.84% and fatalities by 3.77%.

For Blind Spot Detection (BSD) systems, Cicchino (2018), analysing a police accident database from 2019-2015, found a 14% reduction in accident involvement for vehicles equipped with BSD.

1.3 Reports and research published in Europe

There are fewer European research and accident statistics than in the US, but some relevant studies are listed below. da Costa's (2023) research provided an in-depth analysis of the expected impact of advanced driver assistance systems in the EU. The author found that emergency braking assist could have the greatest impact, leading to a 5.6% reduction in crash rates by 2030, compared to the base year 2019. This is followed by intelligent speed assist, which warns of speed limits, with a reduction of 0.8%. Finally, lane-keeping assist is expected to reduce the accident rate by 0.4%.

Using a prospective approach, research in the UK has examined the impact of advanced driving assistance systems from different aspects. A total of 18 driving contexts and eight accident types were compared. It was found that the full implementation of the six most common driving support systems could reduce the total number of accidents by 23.8%, resulting in 18,925 fewer accidents per year in the UK. It was also shown that the two most common accident contexts (inland high visibility and outdoor high visibility) could achieve a combined reduction of 29% in the number of accidents, resulting in a reduction of 7,020 inland and 3,472 outdoor occurrences. Emergency Braking Assist would have the greatest impact, reducing the three out of four most common types of accidents: accidents at intersections by 28%, rear-end collisions by 27.7% and pedestrian hit-and-run accidents by 28.4% (Masello et al., 2022).

Also in the UK, Lai et al. (2012) conducted a study on Intelligent Speed Adaptation (ISA) involving 79 drivers over 6 months, for a total of 3,545,994 miles driven. Several speed-accident relationship models were applied. With a 100% market share, they estimated that advisory, supportive, and mandatory ISAs would reduce the number of personal injury crashes by 2.7%, 12% and 28.9%, respectively. On motorways, these reductions would be 4.6%, 9% and 18.1%, respectively, and on 30 mph (48 km/h) roads the reductions would be 1.3%, 11.7% and 33.6%, respectively.

Kullgren et al. (2023) studied the impact of automated emergency braking systems (AEB) on pedestrian and cyclist crashes in Sweden. They used a police accident database with a dataset from 2015-2020, analysing a total of 712 pedestrian hit-and-run and 1,105 cyclist hit-and-run accidents. Vehicles equipped with an emergency brake assist system reduced the risk of cyclist hit-and-run accidents by 21% and the risk of pedestrian injury accidents by a statistically non-significant 8%. The safety effects were higher in poor visibility conditions and at higher speed limits. In rain, fog and snow, vehicles equipped with emergency braking assist reduced the risk of cyclist hit-and-run accidents by 53%. On roads with speed limits between 50 and 120 km/h, the risk of accidents was reduced by 26%.

Sternlund et al. (2017) analysed the safety impact of Lane Departure Warning (LDW) and Lane Keeping Assistance (LKA) systems. The study was conducted in Sweden between 2007 and 2015 and used crash data from the STRADA database. The database can extract data on accidents involving at least one Volvo vehicle and personal injury. With the combined presence of lane departure warning and lane keeping assist, an overall 30% reduction in the accident rate was observed. On roads with no pavement markings and speed limits between 70 and 120 km/h, a 53% reduction was recorded.

2 Training for handling automated driver assistance systems in driver training

Managing Level 1 and 2 automation systems is also a new driving task requiring new skills and knowledge. From active operators, humans become passive supervisors of automated systems. However, the two roles require different training and skills. Driving vehicles equipped with automated systems requires supervisory and selective intervention skills. It is necessary to understand the capabilities and limitations of the automated function. The driver must also be able to take control of the automated system from Level 3 upwards if necessary. Automated driving systems are, therefore, clearly a means of increasing road safety and carrying significant risks.

Manser et al. (2017) summarised the recommended skills and knowledge that drivers should be trained on to drive and operate a vehicle with ADAS features safely (Fig. 6).

- Purpose of ADAS: Several factors, such as operators' attitudes toward automation, mental workload, level of trust in the system, confidence in self-skills, and level of risk, influence drivers' decisions on using an automation system. Drivers should be made aware of the consequences of ADAS-related decisions.

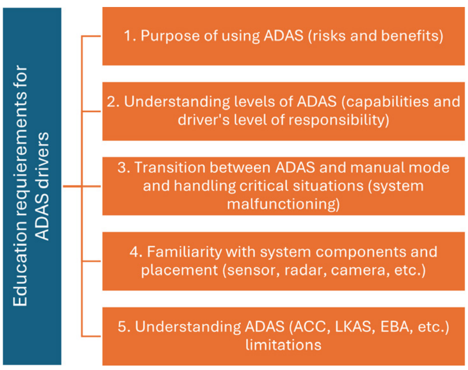

Fig. 6 Knowledge and skills taxonomy for ADAS-equipped vehicles

- Understanding ADAS. Education on the differences between levels of automation is probably the most important requirement of a training program. A lack of understanding of the differences between automation levels may lead to drivers being confused about their level of responsibility while transitioning between different levels of automation, when switching to another vehicle with a different level of automation or turning an automated subsystem on and off in the same vehicle. The issue becomes more problematic when a driver overly relies on the system at lower levels of automation.
- Transition between ADAS and Manual Mode. The transition between ADAS and manual control, as well as how drivers behave when they receive a takeover request from the system, is important. In this regard, drivers' performance and behaviour in reassuming vehicle control may vary based on driver characteristics such as age. Considering the variation in takeover behaviours among drivers could help develop specific training materials tailored toward different groups of drivers.
- Familiarity with System Components and Placement. Drivers need to be familiar with the main components of the ADAS and where they are located on the vehicle. For instance, many ADAS features utilise data collected from sensors and cameras to adjust speed or apply the brakes. If these sensors or cameras are blocked, they could produce inaccurate information.
- Understanding of Driver Assistance Systems. There is a low level of knowledge among drivers, not only about emerging safety technologies (e.g., adaptive cruise control [ACC], forward collision warning [FCW]), but also about commonly featured technologies (e.g., anti-lock braking and tire pressure monitoring systems) (McDonald et al., 2015, 2016). While drivers' familiarity with ADAS operation is important, that alone is insufficient. Drivers need to understand the capabilities and limitations of such systems as well. ADAS functions only under certain conditions (e.g., ACC limitations on winding and hilly roads).

3 Survey among Hungarian on-road driving instructors on the teaching practice for advanced driver assistance systems

KTI Institute for Transport Sciences, in collaboration with E-Educatio Information Technology Ltd., surveyed on-road driving instructors on whether they deal with the topic of automated driver assistance systems in their educational practice, and in what form and methods, and whether they would like to receive more information on the subject. The survey was carried out using an online questionnaire. The questionnaire was completed by 509 people between September and November 2022. The average age of the respondents was 51 years, and an average of 37 years had passed since obtaining their driving license.

3.1 Experience as a vocational instructor among respondents

Around half of the respondents have worked as a professional driver instructor for over 15 years, and 28.1% for less than 5 years (Fig. 7).

3.2 Age of training vehicles

There is a wide range of responses on the age of the vehicles used for training (Fig. 8), but around 40% of the training cars are less than 6 years old and those older than 16 years account for around 15% of the cars.

3.3 Availability of driver assistance systems in training cars

Based on the answers to the question on the driver assistance systems in training cars, almost all cars were equipped with ABS, or anti-lock braking systems. The majority of cars (59.8%) also had reversing assistance systems. In addition, a smaller proportion of cars also had the following driver assistance systems: Intelligent cruise control (26.7%), parking assist (23.3%), adaptive headlights (20.8%), blind spot monitoring (9.5%), forward collision warning (20.8%), automatic emergency braking (19.9%), automatic emergency steering (3.3%), lane keeping assist (17.8%), and fatigue monitoring (9%). Other driver assistance systems were found in only 1 or 2 cars surveyed.

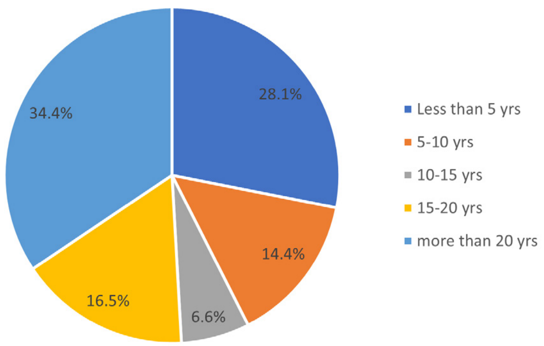

Fig. 7 How many years have you been working as a driving instructor? Distribution of answers to the question

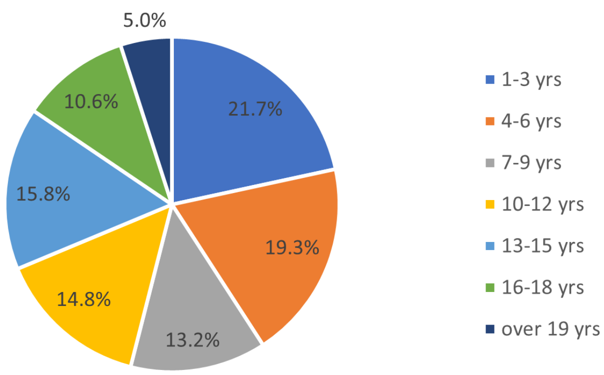

Fig. 8 At what age does the instructor use a car for teaching? Distribution of answers to the question

3.4 Training on driver assistance systems in practice

According to the surveyed trainers' responses, 50.2% of them cover driver assistance systems in their education, although almost half of them do not cover them at all or only to the minimum extent required (see Fig. 9).

Of those who do not address the issue in their training, 69.4% said that they do not because the instructor's car is not equipped with such technologies. Smaller proportions (25.4% and 23.4%) cited that the subject did not fit into the teaching time or was not covered in the exam as the reason. A small proportion (5.6% and 6.3%) did not consider the subject important or did not have enough information about it. Other answers often emphasized that it is more important for learners to be familiar with basic vehicle handling and to learn to drive safely on their own, as they frequently have little time to do so. Another common response was that using it in the test is impossible.

Of those instructors who deal with driver assistance systems in their training, 61.2% gave practical information about the specific systems: how to switch them on and off, what they can be used for. 51.4% also deal with the importance of safe driving behaviour (constant attention) when using the systems. 51.4% also cover the risk of getting used to driving assistive technologies, e.g., habituation or loss of skills. 42.7% of them also address the issue of over-reliance on automated driving assistance

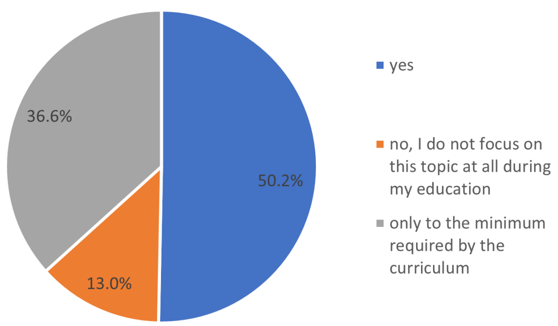

Fig. 9 What proportion of the teaching is devoted to driver assistance systems?

technologies, the importance of the driver being aware of the system's capabilities and limitations. In addition to the conditions of their use, including knowing when they are and are not recommended to be used.

3.5 Use of driver assistance systems in driving tests

The idea of using the driver assistance systems that the training car is equipped with in the driving test was agreed upon by 79.1% of respondents. Their answers often included adapting to a changing world: it is now a reality that drivers will encounter these systems.

3.6 Trainers' awareness/information on driver assistance systems

Most trainers obtain information on driver assistance systems from the Internet, and many of the answers also mention their experience and professional materials as sources. The vast majority of respondents consider these sources to be reliable.

When they were asked if they would like more information on automated driver assistance systems for their teaching activities, more than half of the trainers said yes: 56.7% of trainers would like more information on management support systems for their educational activities, 17.8% would not like more information on the subject, and 24.5% are not sure (Fig. 10).

3.7 Summary of the questionnaire

Around 40% of the respondents, who have more than 15 years' experience as trainers, work with trainer cars that are less than six years old. These are predominantly equipped with ABS and about 60% with reversing radar, the most common driver assistance systems encountered. In addition, 23-26% of cars have intelligent cruise control and parking assist.

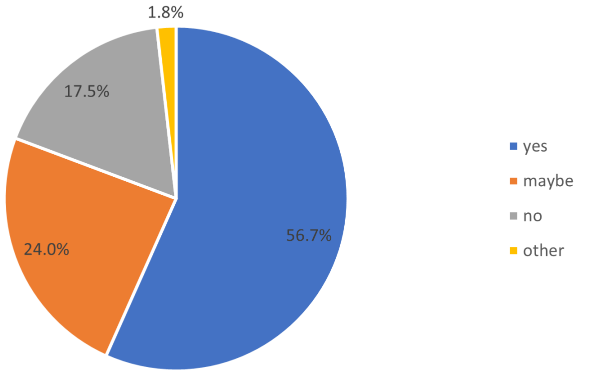

Fig. 10 Would there be a demand for more information on management support systems for educational activities?

Around half of all instructors cover the subject of driver assistance systems in their training. Those who do not usually cover it because they lack the necessary equipment in their car, it does not fit into their training time, or it is not included in the driving test. About half of those who do provide practical information, address the importance of constant driver attention when using the systems, the dangers of getting used to driver assistance technologies and the importance of the driver being aware of the system's capabilities and limitations.

Around 80% of instructors agree that using the driver assistance systems that the trainer car is equipped with during the driving test is important so that learners are familiar with these systems. In their opinion, since these systems are everyday encounters for drivers today, it is essential to prepare students to use them.

For their training, most respondents use the Internet, their own experience, or professional materials that they consider reliable. Nevertheless, more than half of them would like to receive more information about driver assistance systems for their educational practice.

4 Changes to the driver training system in Hungary from 2024 concerning automated driver assistance systems

According to KSH data, Hungary's vehicle fleet is also increasingly equipped with more complex driver assistance systems, making practical training of these systems increasingly important. The vehicles used for on-road driver training (as confirmed by the KTI survey) are getting younger and are therefore typically equipped with driver assistance systems.

EU legislation on the technical requirements for new cars and the ageing fleet of training vehicles has made it increasingly urgent to address the use of driver assistance systems in driver training and testing. As several driver assistance systems have been made mandatory in all new cars in the European Union since the beginning of July 2024, they have been included in driver training and testing in Hungary from 1 October 2024.

The current e-learning curriculum includes the curricula for the specific driver assistance systems, a reminder of the importance of constant driver attention and a thorough understanding of how to use the specific systems.

The modification in national driver training allows learners to keep electronic assistance systems on during the test: anti-lock brakes, ABS, electronic stability control (ESP), traction control (TCS), collision warning, lane change and turn assist. Only those electronic functions that do not directly intervene in the control of the vehicle may be kept switched on during the test. Direct intervention is defined as the ability to manoeuvre the vehicle in a continuous complex manoeuvre, but not as a mere assistance to the driver. Accordingly, fully self-driving functions and automatic parking assist are still prohibited. In the practical part of the course, the learner and the instructor can decide whether to use the systems allowed in the test. This also required training for examining officers and instructors on the operation of the automated systems, with further training taken place in September 2024.

5 Conclusion

There is a specific demand to investigate national accidents from the point of view of the operation of advanced driving assistance systems.

It is important that active drivers also receive appropriate training if required. Older drivers can be reached in the case of newly purchased passenger cars equipped with driver assistance systems, mainly through car dealers, where practical training can be linked to the purchase. These training courses can also be made available to drivers who feel that they are not sufficiently familiar with safely using their car's equipment.

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References

Cicchino, J. B. (2018) "Effects of blind spot monitoring systems on police-reported lane-change crashes", Traffic Injury Prevention,19(6), pp. 615–622. https://doi.org/10.1080/15389588.2018.1476973

Cicchino, J. B. (2022) "Effects of automatic emergency braking systems on pedestrian crash risk", Accident Analysis & Prevention, 172, 106686. https://doi.org/10.1016/j.aap.2022.106686

da Costa, A. F. (2023) "Safety Impact of Advanced Driver Assistance Systems in Europe", Master's Thesis, Aalto University. Available at: https://aaltodoc.aalto.fi/server/api/core/bitstreams/26bca9d9-9690-403e-b9a8-5e72568f72e9/content [Accessed: 14 January 2025]

Hajdu, C., Lakatos, I. (2023) "Calibration Measurements and Computational Models of Sensors Used in Autonomous Vehicles", Periodica Polytechnica Transportation Engineering, 51(3), pp. 230–241. https://doi.org/10.3311/PPtr.18453

Kullgren, A., Amin, K., Tingvall, C. (2023) "Effects on crash risk of automatic emergency braking systems for pedestrians and bicyclists", Traffic Injury Prevention, 24, pp. S111–S115. https://doi.org/10.1080/15389588.2022.2131403

Lai, F., Carsten O., Tate, F. (2012) "How much benefit does Intelligent Speed Adaptation deliver: An analysis of its potential contribution to safety and environment", Accident Analysis & Prevention, 48, pp. 63–72. https://doi.org/10.1016/j.aap.2011.04.011

Leslie, A. J., Kiefer, R. J., Meitzner, M. R., Flannagan, A. C. (2021) "Field effectiveness of general motors advanced driver assistance and headlighting systems", Accident Analysis & Prevention, 159, 106275. https://doi.org/10.1016/j.aap.2021.106275

Masello, L., Castignani, G., Sheehan, B., Murphy, F., McDonnell, K. (2022) "On the road safety benefits of advanced driver assistance systems in different driving contexts", Transportation Research Interdisciplinary Perspectives, 15, 100670. https://doi.org/10.1016/j.trip.2022.100670

Manser, M. P., Noble, A., Ghanipoor Machiani, S., Shortz, A., Klauer, S., Higgins, L., Ahmadi, A. (2019) "Driver Training Research and Guidelines for Automated Vehicle Technology", U.S. Department of Transportation, Washington, D.C., USA, Report No. 01-004. https://doi.org/10.13140/RG.2.2.31237.50401

NHTSA (2025) "Standing General Order on Crash Reporting", [online] National Highway Traffic Safety Administration. Available at: https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting#level-2-adas [Accessed: 14 Januray 2025]

PARTS Project Study (2022) "Real-world Effectiveness of Model Year 2015–2020 Advanced Driver Assistance Systems", [pdf] MITRE Corporation. Available at: https://www.mitre.org/sites/default/files/2022-11/pr%2022-3734-PARTS-real-world-effectiveness-model-year-2015-2020-advance-driver-assistance-systems_0.pdf [Accessed: 14 January 2025]

Regan, M. A., Triggs, T. J., Young, K. L., Tomasevic, N., Mitsopoulos, E., Stephan, K., Tingvall, C. (2006) "On-Road evaluation of Intelligent Speed Adaptation, Following Distance Warning and seatbelt Reminder Systems: Final Results of the TAC SafeCar Project", Monash University Accident Research Centre, Australia, Report No. 253. Available at: https://www.monash.edu/__data/assets/pdf_file/0020/217262/On-road-evaluation-of-Intelligent-Speed-Adaptation,-Following-Distance-Warning-and-Seatbelt-Reminder-Systems-final-results-of-the-TAC-SafeCar-project.pdf [Accessed: 14 January 2025]

SAE (2018) "SAE international releases updated visual chart for its levels of driving automation standard for self-driving vehicles", [online] Available at: https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-%E2%80%9Clevels-of-driving-automation%E2%80%9D-standard-for-self-driving-vehicles [Accessed: 14 January 2025]

Spicer, R., Vahabaghaie, A., Murakhovsky, D., Bahouth, G., Drayer, B., Lawrence, S. S. (2021) "Effectiveness of advanced driver assistance systems in preventing system-relevant crashes", SAE International Journal of Advances and Current Practices in Mobility, 3(4), pp. 1697–1701.
https://doi.org/10.4271/2021-01-0869

Sternlund, S., Strandroth, J., Rizzi, M., Lie, A., Tingvall, C. (2017) "The effectiveness of lane departure warning systems – A reduction in real-world passenger car injury crashes", Traffic Injury Prevention, 18(2), pp. 225–229.
https://doi.org/10.1080/15389588.2016.1230672