PAsCAL
Enhance driver behaviour & Public Acceptance of Connected & Autonomous vehicles

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D 5.3 – Tested simulation-based training solutions and training modules

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Disclaimer

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Deliverable 5.3 – Tested simulation-based training solutions and training modules			
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Version History

Version	Date	Main author	Summary of changes
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0.6	18/03/22	all	Version sent to internal review
0.7	29/03/22	all	Post internal review version
1.0	30/03/22	all	Final version sent to EU

List of acronyms

Acronym	Meaning
ACI	Automobile Club d'Italia (IT)
LIST	Luxembourg Institute of Technology (LU)
RDS	Rds Driving Services Limited (UK)
NHTSA	National Highway Traffic Safety Administration

AR	Augmented Reality
SAE	Society of Automotive Engineers
Adas	Advanced Driver Assistance Systems
WP	Work Package
IIHS	Insurance Institute for Highway Safety
CAV	Connected and Autonomous Vehicles
L2/L3/L4/L5	Level 2/3/4/5 (for driving automation)
HSS	Home Study Simulator

Notice

This document complies partially with the European Blind Union's guidelines (http://www.euroblind.org/publications-and-resources/making-information-accessible-all) in order to be accessible to anyone, including blind and partially sighted people, and at the same time and at no additional cost.

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Executive summary

PAsCAL is a user-centric research project funded under the "Horizon 2020" Research and Innovation program aimed at accelerating the user-friendly evolution of connected, cooperative, and automated vehicles and transport systems, by addressing important issues relating to the role of humans in this evolution, in particular appropriate interactions of the autonomous vehicle with different road users including non-drivers.

Work package 5 deals in particular with training aspects that contribute among the factors influencing the driver's understanding of autonomous vehicles and impacting their behaviour and acceptance of autonomous vehicles.

While deliverable D5.1 focused on simulator requirements definition and competency, cognitive and affective models related to CAV drivers and deliverable D5.2 presented a description of the training modules proposed for the simulator-based training sessions, this deliverable D5.3 reports on how the experimented training sessions were carried out in the two driving schools' partners in Italy and in UK.

It first presents the context of the Home Study Simulator tests carried out during the experiment phases. It explains in particular how to install and configure the simulator, what was the generic approach taken to conduct the training session tests, and the characteristics of tests undertaken in Italy and in UK.

Then it summarises the main elements that emerged from the experiments considering data collected during the sessions, feedbacks from driving instructors' workshops in Italy and UK.

It continues with sections explaining the reasons why urban and motorway scenarios are both important as well as the need for complementary practical tests in protected area and on public roads.

This deliverable also mentions additional training needs resulting from the training tests for professional drivers, experienced drivers and trainers, and suggests some requests (useful in the context of training) to be made to other actors involved in CAV as builders, legislator or notifying bodies.

Findings from the work and activities done in WP5 will be incorporated as a series of recommendations in the Guide to autonomy developed in WP8.

1 Introduction

1.1 Purpose and organization of the document

WP5 aimed at investigating new "driver" training needs and certification requirements for new technologies/levels of automation, understanding how CAV users and non-users cognitively perceive and treat situations in CAV, developing and pre-testing training solutions to enhance driver's behaviour in different scenarios.

Following simulator requirements definition and hypothetical driver models (competency, cognitive and affective models) in D5.1, and a description of the training modules proposed for the simulator-based training sessions presented in D5.2, this deliverable D5.3 reports on how the experimented training sessions were carried out in the two driving schools' partners in Italy and in UK.

After the introduction, section 2 of this document provides details of the simulation-based training tests carried out in the different driving-schools. It explains in particular how to install and configure the simulator, what was the generic approach taken to conduct the training session tests, and the characteristics of tests undertaken in Italy and in UK.

It then addresses (in section 3) outcomes that emerged from the training experiments and suggests additional training needs for professional, experienced drivers and trainers (in section 4). In section 5, it proposes some requests (useful in the context of training) to be made to other actors involved in CAV, such as builders, legislator or notifying bodies.

1.2 Intended audience of this document

The audience for this document is (1) the consortium members of the PAsCAL project, (2) researchers, driving schools and driver trainers/instructors and their Associations (e.g., European Driving Schools Association, Approved Driving Instructors National Joint Council (UK)) and all stakeholders with interest in CAV skills and development, and (3) the European Commission.

2 Home Study Simulator tests

2.1 How to install the simulator

The Simulated driving tests have been carried out with the Home Study Simulator (HSS) developed in purpose within the framework of the PAsCAL project based on requirements indicated in D5.1.

The procedure to install the HSS is described below.

2.1.1Prerequisites

The minimum hardware requirements to run the Home Study Simulator are the following:

For the client side:

- PC connected to internet

  - Number of vCPU: 2
  - Quantity of RAM: 8Go
  - Size of Application build: 8 Gigabytes
  - GPU: Nvidia 1060

- Logitech steering wheel set G29

For the server side:

- PC connected to internet

  - Number of vCPU: 2
  - Quantity of RAM: 4Go
  - Size of Disk: 80-100Go minimum

Please note that the use of computers that do not correspond to these minimum requirements, could lead to frame rate per second dropping very low and cause the system to become frozen or react in an unexpected way.

2.1.2 Download, install and setting up

The required driver software from Logitech must be downloaded from internet and installed.

The first one is “G HUB solution from Logitech”. Once downloaded at Logitech G HUB Advanced Gaming Software, RGB and Game Profiles , follow the instructions on screen to install it. The second one is the “Logitech Gaming Software for Windows”. Once downloaded at Logitech Gaming Software – Logitech Support + Download, follow the instructions on screen to install it.

After the abovementioned software has been installed, plug the steering wheel G29 into your Windows computer.

Open the “Logitech Gaming Software” on your Windows computer in order to parameter the following properties:

1. Set the “sensitivity” parameter to 75%
2. Enable the “Centering Spring in Force Feedback Games” parameter
3. Set the “Centering Spring Strength” parameter to 20%

The next step focuses on the Home Study Simulator itself.

Download the HSS client software at:
https://cloud.list.lu/index.php/s/k8kMYGPKTYEqY2b

If required, contact Joan Baixauli (joan.baixauli@list.lu) in order to obtain a granted access to the file.

Once downloaded, unzip the file and you will get the executable PascalProject.exe.

All the previous steps only need to be done once.

2.1.3 Login access

When you first click on the Home Study Simulator software (PascalProject.exe), you must enter your own credentials. If you do not have one already, contact Joan Baixauli (joan.baixauli@list.lu) to obtain a granted access (user Id and associated password).

2.2 Approach to Simulated Driving tests

Following the design of the preliminary version of the training modules (referenced in deliverable D5.2) and during the early stages of WP5 activities, RED and ACI developed and used the following trainer briefing format with regards to the implementation of the simulator testing as depicted in the steps of figure 1 below.

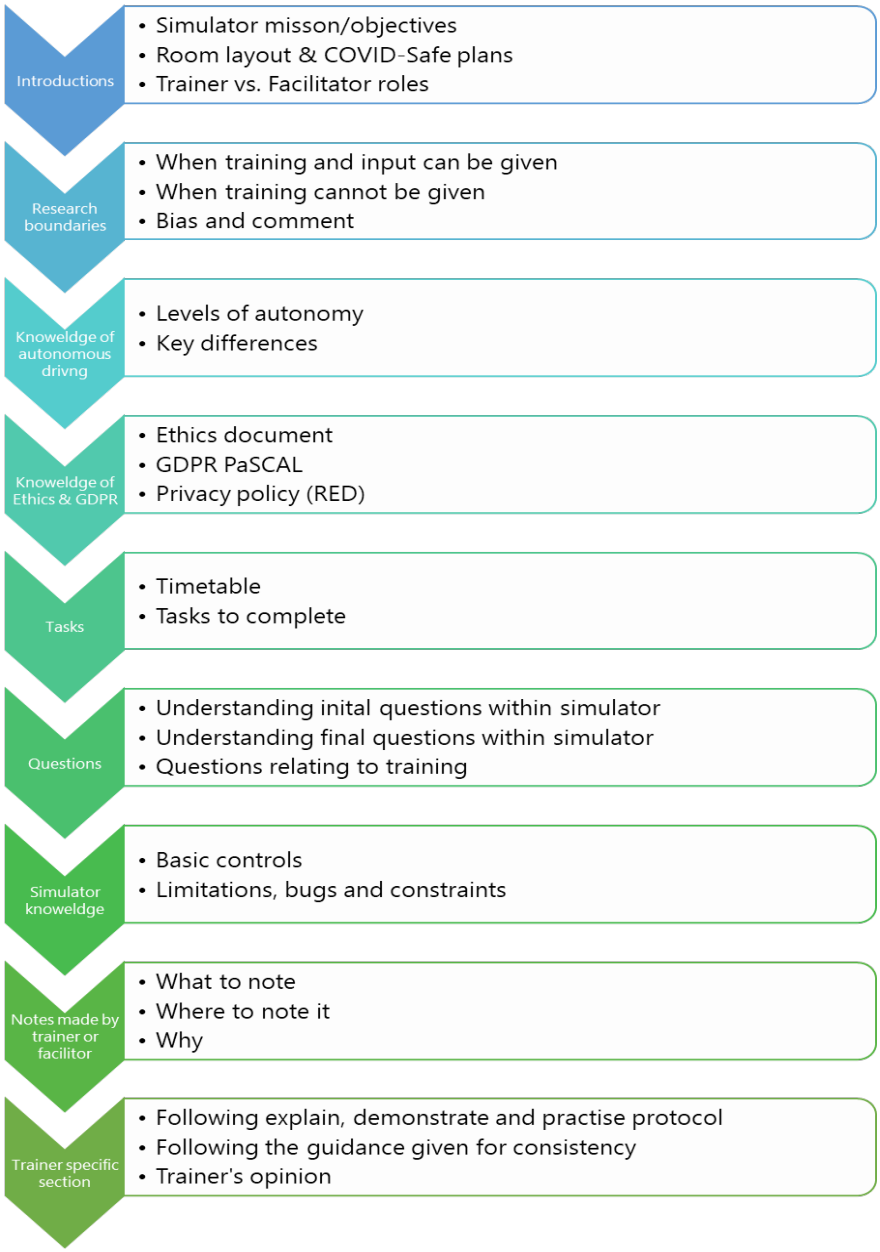

Figure 1 Steps followed for the trainers briefing

Each of these briefing steps is detailed below, displaying a project's participant point of view.

2.2.1 Introductions

As a starter, the aim of the PAsCAL project is presented. Then the WP5 focus of CAV acceptance and training effects and methodology are detailed.

According to the health context, ACI and the Ready2Go Network driving schools adopted a Covid 19 protocol, in compliance with the laws of the Italian State (see appendix 8.2). In a similar way, RED adopted a Covid safe protocol in compliance with the laws of the UK State (see appendix 8.3).

To conclude these series of introduction, the difference between trainer and facilitator are defined.

The trainer, where permitted, was asked to follow the procedures made in this document to achieve the goals. Trainers may complete both roles, so long as they do not intervene inappropriately when they are not authorised.

Facilitators must not offer training or guidance, except for those agreed in this document.

2.2.2 Research boundaries

2.2.2.1 When training and input can be given

Where training is given, the EDP (Explain, Demonstrate and Practise) technique is used (described later in this document). The reference to the EDP is backed up with comments given during a Trainer workshop organised by RED (see appendix 8.5).

Training/coaching should be tailored to the driver, initially asking:

- What they know about autonomous and connected vehicle technology.
- How much support they feel they will need?

Followed by:

- If required, a full explanation of the hand back to their input or vehicle control, with full guidance, throughout the first few attempts.
- Initially helping the driver pre-empt any hand-backs, risks or concerns and prompting the driver if required.
- Relevant levels of support and guidance, with a target to enable the driver to handle the later situations/hardbacks themselves.

The research is split into two broad groups: 1. non-trained session, and 2. trained session

Both groups received a briefing on the task and the basic controls. However, only group 2 'trained session' received coaching and guidance to assist with driving the CAV in the simulator.

2.2.2.2 When training input cannot be given

The non-trained group did not receive guidance or significant levels of assistance from the 'trainer' as it may influence the results. Nevertheless, individuals were authorized to ask specific questions about how the system works or provide qualitative feedback.

With or without training input, trainers were briefed to avoid personal comments or biased interpretations regarding their personal feelings and thoughts about CAVs or the system as this may influence the results. A one-to-one discussion with any trainer found breaching this condition was conducted in the presence of another staff member, to offer advice on how to remain within the condition. If the trainer behaviour did not change then they were asked to leave the trial.

2.2.3 Knowledge of autonomous driving levels

2.2.3.1 Levels of autonomy

Trainers assisted the participant to understand how to use the controls and allowed time for them to read the document on the different levels of autonomy as shown in figure 2 below.

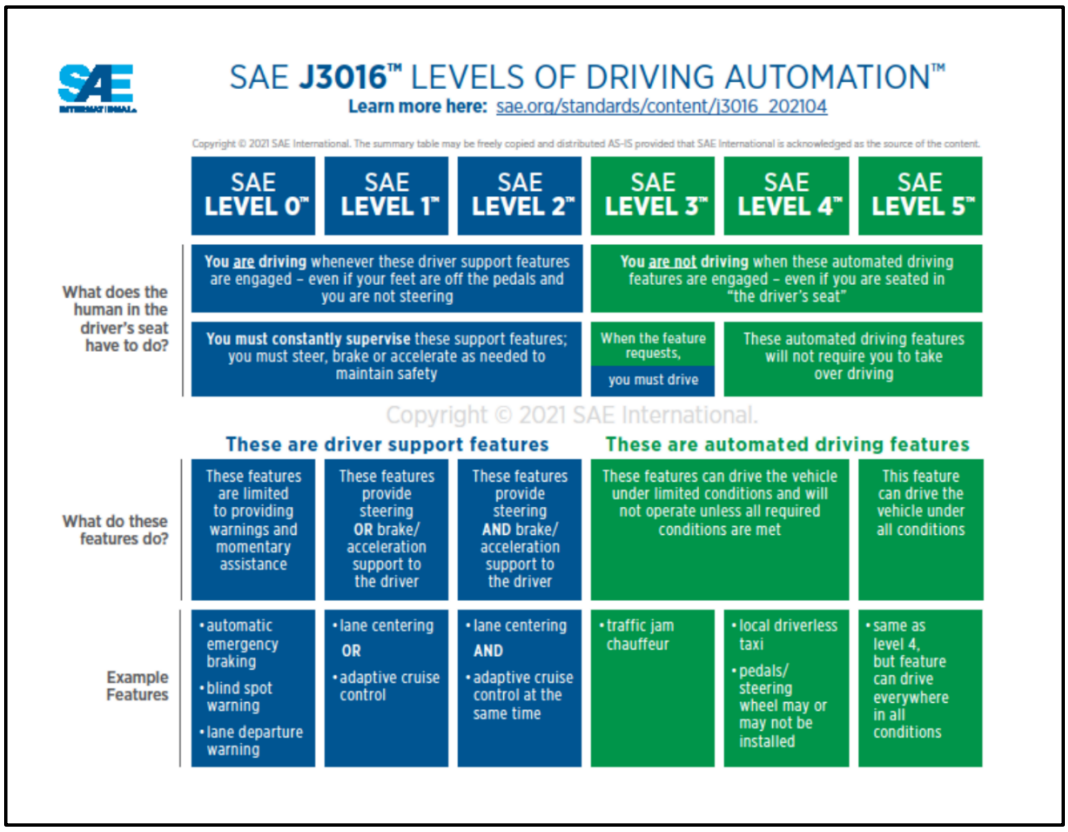

Figure 2 SAE Levels of Automation (SAE, 2021)

Trainers introduced the participant to the levels of automated driving specifically being used within the simulator, i.e., L3 and 4 referring to figure 3 below which is based on SAE level 3 and 4 definitions. Participants were encouraged to ask any questions they had to help their understanding of the levels to be used in the simulator.

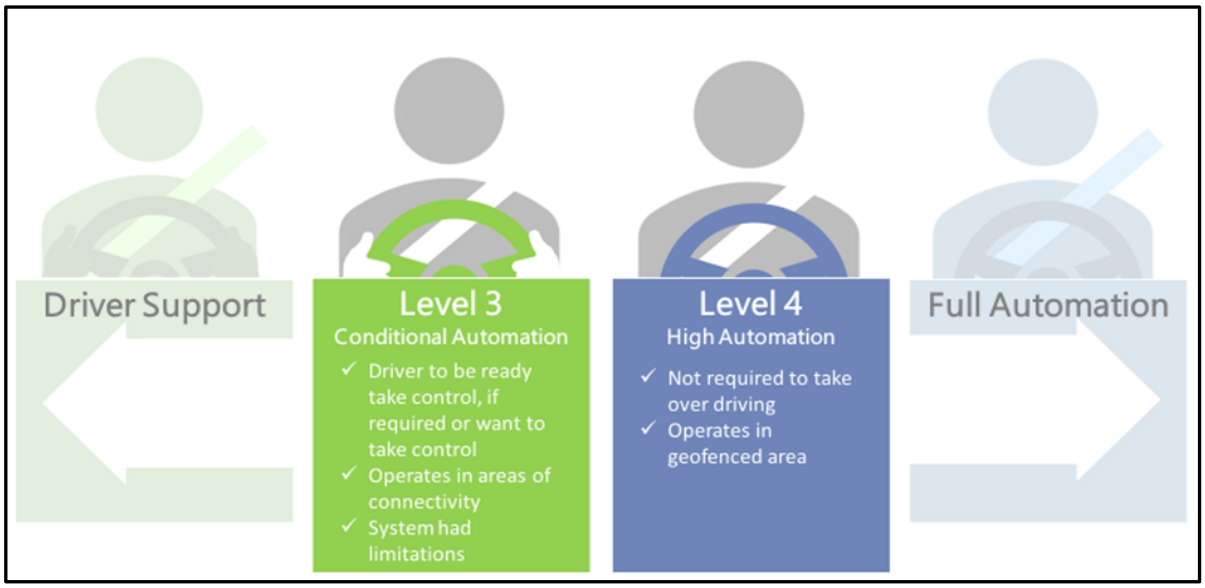

Figure 3 RDS summary of level 3 and 4 definitions. August 2021

2.2.3.2 Key differences

The trainer introduced the participants to the key differences between the two CAV levels they will be using during the simulator tests. This was an ideal opportunity to introduce how the on-board system indicates to the user when it is in each mode, i.e., automation on or off as shown in figure 4 below, and how the driver can interact with the automated driving in each of the two levels of CAV being used in the simulator.

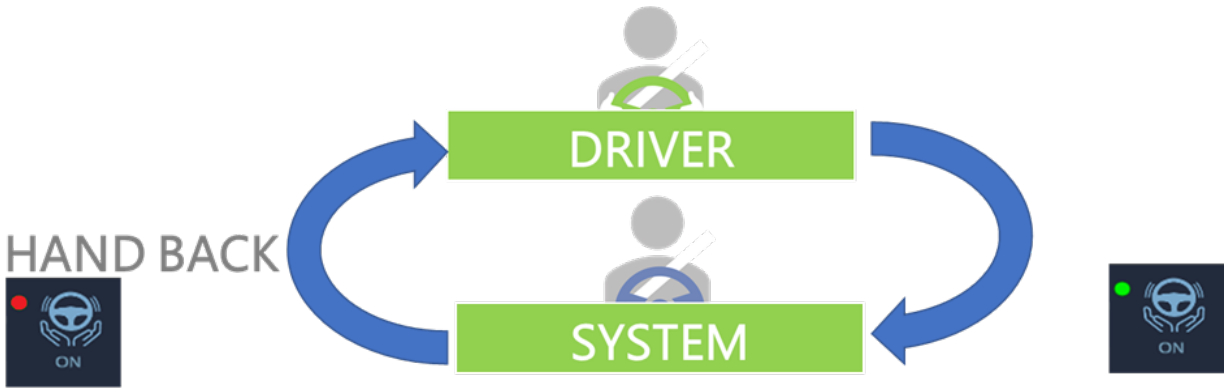

Figure 4 Driver hand back / automated cycle RDS definition - August 2021

Emphasis was placed on checking the participant was aware as the driver, of when or not, they can switch off the automated driving in each of the levels.

It is important to remember that there are differences in how much human interaction there is within the differing levels of autonomy for example:

a) Within level 3 when autonomous mode is available the driver can always override the system and take back control.

b) Within level 4 when autonomous mode is on, the driver cannot usually override the system, rather the driver must wait until the system decides when control needs to pass back to the human driver.

2.2.4Ethics and GDPR

All simulator tests were conducted in respect to and abiding by the approved PAsCAL Project Documentation for Privacy and Ethics Regulation Ethics.

All trainers participating in the study were provided a copy of the above document and had this discussed with their training manager prior to the study commencement in order to answer any questions they had.

Advice was provided to the trainers on how to handle any queries relating to ethics raised with them by a simulator study participant.

Trainers were also informed of how to maintain correct standards of handling participant information and how to handle any queries relating to GDPR raised with them by a simulator study participant. Details on how to process the appropriate participant consent forms was also provided.

2.2.5Tasks

Once a participant provided their consent to continue, then the trainer would proceed with providing a short introduction to the simulator tasks about to be undertaken.

At this point the trainer explained to each participant how many and which task(s) form the scenario table in figure 5 below they would be requested to participate in.

Scenario No.	Description & Duration	Participants
1	30 mins Urban driving **CAV Level 3/4**	30 Learner/novice
		30 Full licence holders
2	30 mins Highway driving **CAV Level 3/4**	30 Learner/novice
		30 Full licence holders

Figure 5 Scenario overview chart of the simulator study

Participants started the trial runs with the Urban environment, which allows them approximately 5 or 6 mins of non-CAV driving to become familiar with the controls and the simulator set up. During this period, it is possible to press the escape key and restart the simulation should the participant feel like they needed another run to become fully okay with using the controls and the steering wheel.

During this trial phase, trainers made checks with participants that they were not experiencing any feeling of sickness, somewhat similar to travel sick or vertigo. If this was noted within a participant, they were advised not to continue, and the trainer aborted that round of testing. The participant being allowed to leave the room. A welfare check on the participant's progress was made to ensure they soon started to feel better, prior to them leaving the simulator premises.

A timetable of participant visits was required and maintained a log of the user ID and password allocated to each participant. The records show how many tasks were completed by each participant.

2.2.6Questions

A survey questionnaire (designed in WP4 related to the PAsCAL simulators) was included within the simulator for each participant to complete, partly before use and then completed after the end of the session.

Prior to starting each simulator run, trainers explained to each participant that they will be expected to answer some short questionnaires at key stages.

General participant questions were asked at the start, prior to the first run in the simulator. Trainers guided participants on how to use the keyboard and/or steering wheel controls to complete the survey questions.

Then, once each simulator run ended, additional survey questions appeared on the screen which each participant completed as fully as possible. Trainers were on on-hand and available for supporting the participants in how to use the controls to complete the questions.

In addition to general and simulator questionnaires, if a participant had any questions related to being trained, trainers did their best to answer these, remembering to first consider the section *Research Boundaries* above, and if necessary, then utilize the trainer guidance notes in section below to complete an answer where possible.

2.2.7Simulator Knowledge

Once the participant arrived at the simulator, trainers guided them through the basic controls and how to use them. A diagram as in figure 6 below was placed clearly in view of the participant for them to cross reference at any time.

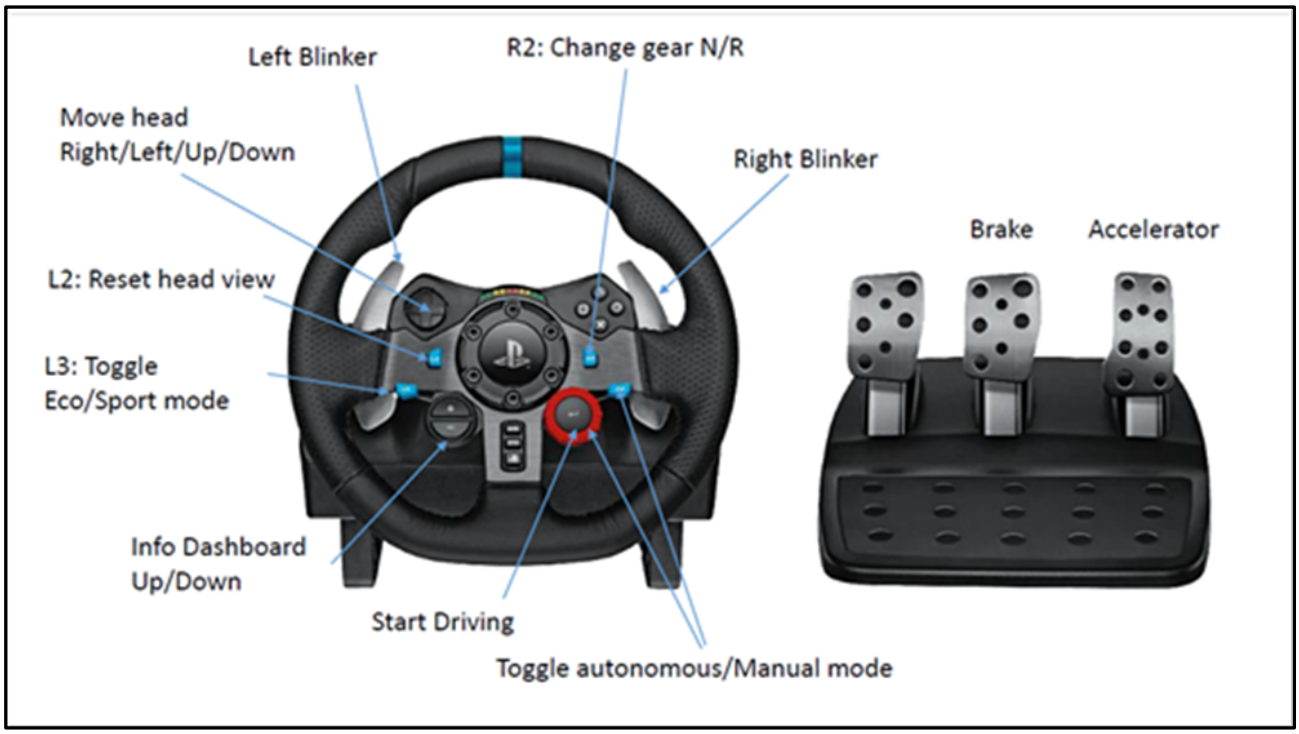

Figure 6 Simulator basic controls for use during testing

As a follow-up of controls explanations, trainers explained that the simulator has limitations and was not designed to fully replicate the working actions of an actual on-road connected autonomous vehicle or CAV. Rather the simulator has been designed to specifically allow the partners in the PAsCAL Project to better answer some important research questions relating to the future of driver training and general public acceptance of using a CAV at different levels of autonomy.

Due to some limited-power computers and potential bugs, the simulation may become frozen or react in an unexpected way, particularly if the frame rate per second (FPS) drops very low. The FPS is displayed on the top right of the screen usually in green text. Should this happen on a regular basis, it was suggested to trainers that they allow the participant to complete the run, but then restart the machine completely prior to any more runs on the simulator taking place.

2.2.8Notes to be recorded by trainer or facilitator if required.

2.2.8.1 What to note, where to note it and why it is important to record properly

During the use of the HSS, trainers were required to make notes regarding any participant comments, concerns, or opinions on the use of the simulator within the provided trainer notes section of the daily timetable, including where relevant, a reference to the participants allocated user number.

This would ensure that any relevant feedback can be considered during possible further development of the simulator and possibly prove useful in completing the trials.

2.2.9Trainer specific section

2.2.9.1 Following explain, demonstrate, and practise protocol ensuring trainer consistency across all participants in the study

An accepted goal of coaching/training is to:

- Increase self-awareness and reflection
- Increase knowledge

Within driver training this helps work towards safer and more efficient road use.

Guidance or coaching should only be provided for the 'training' section of the research, and no guidance or coaching should be given on the other parts.

Starting with the knowledge they have already. What do they know?

If required, and agreed with them, use the appropriate level of support:

1. Guided – Offer step by step instruction to help the participant complete the task
2. Prompted – Use a combination of question and answer to prompt the participant to remember prior training, backed up with occasional step by step instruction to fill gaps in participant knowledge.

3. Independent – Allow the participant to carry out the task under supervision, with occasional prompting to validate their understanding and cognitive recognition, ensuring skill transfer.

If required, the recommended approach technique shall be to use **EDP** – *Explain, Demonstrate, Practise*:

Explanation

Trainer starts by offering an explanation of the project objectives:

- Acceptance
- Training methodology and its effects

Next offer an explanation of certain specifics within the simulator:

- Explanation of controls.
- Explanation of Connected and Autonomous Vehicles (CAVs).
- Levels of Autonomy.
- Hand backs, expectations of the system and responsibilities.

Demonstration

The trainer should offer to demonstrate the Controls, the Autonomous Mode (How?) and the Hand back routine.

Trainer to agree the level of guidance/help offered to the driver, a short description of each level of possible support follows.

Full guidance or step by step instruction

Trainer *guides* the participant in using the simulator with full guidance on how to use the Controls, Autonomous mode and Hand backs.

Trainer *prompts* the participant in using the simulator through using timely prompts or reminders of how to use the Controls, Autonomous mode and Hand backs.

Trainer *observes* the participant in using the simulator independently and provides minimal support in how to use the Controls, Autonomous mode and Hand backs.

At any time required by the participant the trainer should recap:

- How to use the simulator controls.
- How to interact with the autonomous mode.
- How to follow the correct hand back procedure or CHAT.
- The levels of autonomy and key differences between level 3 and 4.

Practise

As the participant develops skills and confidence in using the simulator trainers should actively take a step back and allow the participant to practice whilst completing the remainder of the simulator runs.

The following list of suggested coaching questions is provided by way of support to trainers during the simulator trials, and for use with participants as necessary:

Prior to starting use on the simulator:

- What do you know already about the simulator kit you can see in use here, and do you have any prior experience in using it?
- Can you tell me any support you would require to help make using the simulator easier for you?

During use of the simulator

- Where is your focus currently whilst the car is in autonomous mode?
- How ready do you feel to use the CHAT procedure on take-over requests issued by the autonomous system?
- Would you require less or more help from me in using the system, or further help understanding the CHAT procedure?
- Would you say you are more alert, less alert, or equally alert as to when you drive a car yourself?
- Are you happy to park up for a moment? - if there is a 'safety critical' situation or a learning point and ask:
  - What interventions have you noticed the CAV done for you so far, and how has this benefited you?
  - Have there been any negative impacts of the autonomous interventions?
  - Would you have dealt with the hazard in the same way or differently?

At the end of a simulator run:

- Thinking about your regular journeys, would a level 3 CAV suit your needs do you think? OR…
- Thinking about your regular journeys, would a level 4 CAV suit your needs do you think?
  Whichever is appropriate.

2.2.9.2 Trainer's opinion

An important aspect to the success of the trial is the neutrality and professionalism of the trainers participating. It was expected that trainers should not express their own personal opinions regarding CAVs during the simulator trails when those opinions could influence the participants.

2.3 Characteristics of the tests conducted in Italy

Initially it was thought to carry out experiments with HSS in various Italian provinces (figure 1 - green and yellow colours) which could represent a significant sample of the population spread throughout the national territory (Northeast - Northwest - Center - South) also depending on the local presence of driving schools adhering to the ACI Ready2Go Network.

Unfortunately, the worsening of the epidemic over the months, the delays accumulated in the development of HSS, and the limited number of testing kits made available, forced us to reduce the number of geographical areas involved, which in the end were limited to three provinces (see figure 7 below, green colour), from which it was however still possible to collect participants from an even higher number of cities than envisaged by the project.

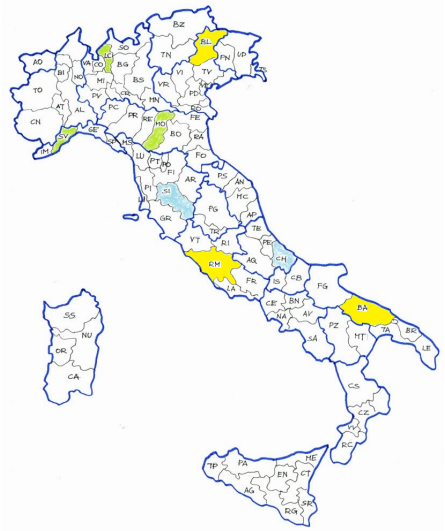

Figure 7 Italian areas involved in HSS tests (green colour areas)

135 tests were planned and 166 have been organized.

Regarding the number of professionals (see figures 8 and 9 below) and instructors' tests planned, respectively 37 and 27 have been organized (exceeding the 20 tests per category target defined).

From the overall number of tests targeted (175 tests), ACI managed to organize 230 tests.

Figure 8 Professional driver testing the HSS on a motorway scenario

Figure 9 Expert driver testing the HSS on a motorway scenario

2.4 Italy simulator study

The tests with the HSS began in June 2021 at the driving schools in the provinces of Savona, Modena and Lecco.

To make the simulation as vivid as possible, it was decided to use the chassis that currently houses the ACI-Ready2Go educational driving simulator so that the tester could fasten his seat belt, sit on a common car seat and had a 32" screen.

Once the PC was delivered and installed, the ACI Project Group for PAsCAL, dedicated itself to reiterating and emphasizing the purpose of the tests. Having done this, all the owners of driving schools, in possession of teacher and instructor certifications, were made to try the HSS in every configuration (eco/sport, urban/motorway).

At the end of the simulations with each driving school representative, the following points were studied:

1. Proposition of tests to instructors.
2. Proposition of tests to trainees.
3. Feedbacks about the software and possible developments of the scenarios.
4. Autonomous driving and compulsory training.

Findings from the surveys and observations made by the driving school instructors are the following.

According to Italian drivers' data, most of the drivers have, before their CAV experience, a positive (more than 50%) CAV confidence (see figure 10 below), except the oldest one (57+ years old).

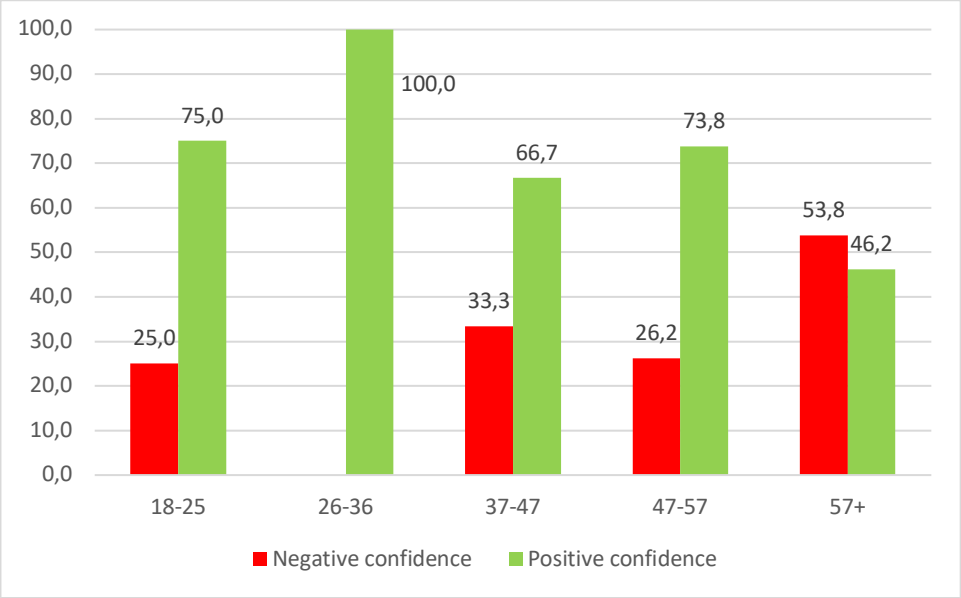

Figure 10 Pre-driving confidence (%) per driver's age categories in Italy

As the youngest drivers (from 18 to 36 years old, see figure 11 below) may "give" their confidence to CAVs due to their limited driving ability (which should increase thanks to experience and mileage), it is surprising to see that the two following age categories (37-47 to 47-57) showed also high levels of CAV confidence. Less surprising, the oldest drivers have the lowest score in terms of CAV pre-driving confidence.

Figure 11 Urban scenario with autopilot - novice driver

In the group of licensed drivers (drivers and professionals), a discrepancy emerged during the tests between what was thought and what was tested. If on the theoretical side, most of them showed interest and acceptance for autonomous driving, in carrying out the test, some drivers showed distrust in the CAV.

A survey carried out by the Mondial Ready2Go Driving School, with the professionals, suggested three subcategories of drivers: Sceptics, Curious and “Not Capable”:

1. The **Sceptics**: these testers have shown little attention to simulations with the belief that a computer can never replace the driver's activity, showing little commitment due to a certain sense of superiority. The attitude shown by this small number of participants denoted a certain lack of interest in the procedures to be followed, scarce attention to the commands to be activated and boredom during moments of autonomous driving, a phrase repeated on two occasions: “and what am I doing? ".
2. The **Curious**: this is the most numerous category. They were attentive, willing to experiment and precise in following the instructions. These are also those who most wished to want to test the situations experienced in simulation on the road. Some doubts have been expressed, but mostly related to the condition of the infrastructures (e.g., roads) which, in these conditions, do not facilitate the advent of autonomous driving.

3. Those participants considered as “**Not Capable”**: they are all those testers (very few) who, despite a deep commitment in facing the tests, have shown little skill in the use of the simulator or in any case a tool similar to a computer. This category is made up, in principle, of people over the age of fifty. They also expressed some doubts about their abilities when they were called to have similar performance in reality. It should be noted that, on other occasions, they have declared themselves unable to use the Adas present on the vehicles given by the company.

Compared to the category of non-professional drivers, instructors observed that, on average, testers between 30 and 40 years old (both males and females) approached the tests with a videogame attitude. Testers followed the instructions given and almost never have difficulty in managing them. But at the same time, they had almost all emphasized the repetitiveness of the situations and a certain boredom in the motorway, as, especially with L4 vehicles, the times were long, waiting for the emergency signal.

In general, two different ideas have emerged:

- Some of them have in fact that the "boredom", which among other things was a distraction, was only supported by the fact that it was a simulation, instead if it had been reality, the "boredom" would have left room for the possibility of enjoying the landscape or in any case the possibility of "enjoying" driving assistance.
- Most of the testers wanted to underline how in reality you cannot get bored or distracted, because any emergency situation could occur at any time and without warning.

Regarding these two "trends of thought", driving instructors consider that some testers felt a distrust in the actual ability of the CAV system to be able to “replace” a driver. Therefore, it highlights the need to follow with greater attention the evolution of situations during the autonomous driving phases, in order to be able to intervene safely when a problem arises.

At the same time, it reflects the following competencies needed to ensure safe CAV driving, enlisted in D5.1:

- 1.Knowledge of the capability and competence of the CAV.
- 2.Knowledge of automation procedures.
- 3.Knowledge of what is the purpose of each technology of the CAV.

- 4.Knowledge of the limitations and possible failure of the CAV technologies.
- 5.Knowledge of the legal constraints/traffic laws related to the driving of the CAV.
- 6.Supervise the CAV autonomous technology works well.
- 7.Knowledge of the practical implications of being In the Loop, On the Loop and Out of The Loop.

Considering the foregoing, it is therefore highlighted that the simulator, although a fundamental element of training, cannot be sufficient to prepare drivers for advanced levels of autonomous driving. Nevertheless, it is necessary that trainees get theoretical modules to acquire the knowledge of on-board electronic systems and through practical modules, that drivers experiment technologies by themselves.

The conclusions that emerged during the alignment calls with the driving schools on the criticalities encountered in the use of the simulator are also interesting.

First conclusion is that some testers, in the presence of other persons in the audience tend to underestimate the training dimension and exchange the didactic simulator for a simulator with game purposes. This would suggest it is better not to use the HSS within a group session rather candidates should use the simulator one by one.

This finding was already mentioned in the frame of WP4 experiments (deliverable D4.2) and confirmed at the ACI Vallelunga Safe Driving Center in Lainate (MI) during the course of the pilot foreseen in WP6 (reported in deliverable D 6.2).

The attendees who carried out the simulations tended, in front of their colleagues, to establish competitions on who was more able to maintain high speeds in the manual path and to resume the control in autonomous driving, ignoring warnings, signals and what is necessary for the management of the vehicle.

A second conclusion related to the use of the HSS was the boredom induced by repetitive scenarios and by a lack of perception of risk (attention), meaning

that some drivers considered the simulation as unable to make them focused enough when hazards or risk might happen.

2.5 Characteristics of the tests conducted in UK

Based out of its in-house training facilities within Donington Park Racing Circuit, conveniently located in the East Midlands area of England, enabled RED Driving School to satisfy a key objective of the project which was to canvas and draw participants from 5 varied towns and cities more easily to the simulator trials as shown in figure 12 below.

Figure 12 Map of the UK region showing training centre and cities used to draw participants for the trials.

Attendees were invited to attend the training centre via driving instructors located in all the local major towns and cities to ensure testers are drawn from at least 5 cities (Nottingham, Derby, Leicester, Loughborough, and Mansfield)

Unlike Italy, it is not general practice for student drivers in the UK to attend classroom-based theory studies or participate in using simulators for initial driver training of basic car controls. The solution to therefore ensuring we could persuade student and experienced drivers to attend the study was a series of open days planned over 6 weekends during the autumn of 2021 from September to early November.

In addition, a period of extended testing with trainers and student driving instructors was proposed to take place prior to the general public study group.

For the duration of the testing, two classrooms were given over to hosting the simulators and arranged as per the diagram in figure 13 below to ensure that the two control groups could be adequately separated within individual rooms.

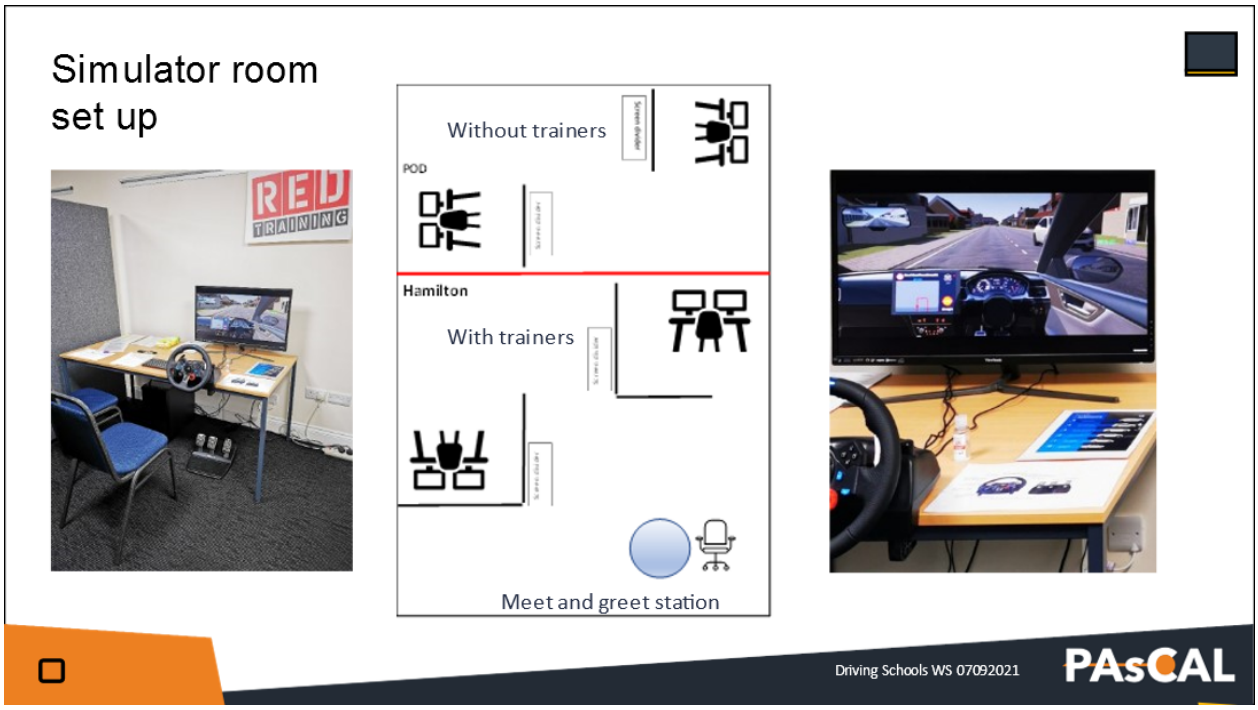

Figure 13 UK training centre simulator room set up

Having the dedicated two separate rooms ensured that group 1 participants - those without a CAV trainer - could not hear what was being said to group 2 participants who had a CAV trainer present with them during the simulator runs.

The next images (figures 14 and 15), show one of each group of participants using the simulator.

Figure 14 Control group participant independently using the simulator

Figure 15 Trained group during prompted training with a CAV trainer

The following program of testing was employed:

- May – through to August 2021: Trials and testing with 15 trainers and 20 student driving instructors.
- September and October 2021: 120 public test participants with 4 trainers on-site (4 Simulators set up).
- November 2021: Completion of any outstanding test phases.

The total number of tests performed is 124.

The total number of tests conducted was affected by server failures on the planned weekends of simulator testing as well as a percentage of no-shows of participants owing in part to the continuing Covid infection rate at the time within the UK. A total number of 199 simulation runs were performed broken down as

follows: UK based figures 74 participants recorded. Of these, 39 participants received coaching and guidance in addition to the task briefing and basic controls training. 35 participants received only the task briefing and basic controls training.

2.6 UK simulator study

During the testing phase of the implementation of the HSS within the driving schools, a series of exercises were proposed to be followed with participants in the study using the simulator. These were considered useful to understand the acceptance and trust that users could have towards autonomous driving of Level 3 and 4 in order to then acquire the correct attitudes and good practices to be adopted for safe driving.

For each of the tests conducted within the UK based simulator study the following three-part phasing approach was implemented.

- Phase 1 – Free Driving
- Phase 2 – Autopilot Urban Scenario
- Phase 3 – Autopilot Motorway Scenario

Each of the phases is explained in brief detail next.

2.6.1Phase 1. Free Driving

After having received the necessary training on the commands to use, the participant was requested to prepare for driving by adopting all the precautions (i.e., a correct driving position as if in a real vehicle, or as close to it as was possible given individual simulator build) and dedicate the first few minutes of the simulation to following the free driving portion of the track to become familiar with the pedals and steering controls.

All participants were encouraged to try to perform some braking near the stop lines placed before the intersections in order to be able to stop the vehicle accurately and with the correct braking action.

All participants were encouraged to drive roundabouts and turns initially at particularly moderate speeds to maintain the correct position on the carriageway considering that the simulator's steering has a very different sensitivity than a real steering wheel.

Having achieved a good driving experience, the participant was asked to follow the route proposed by the navigator to reach the moment when the autopilot function would be available.

2.6.2 Phase 2. Autopilot Urban Scenario

When the autonomous mode was engaged, the participant could try to rely on the system by having the opportunity to remove hands and feet from the controls.

Trainers observes and watched during this phase for the probability that some participants may have found it difficult not to intervene on the brake and steering in the case of critical situations listed below:

- Intersections with right of way, with giving way and with stop and giving way.
- Roundabouts with giving way and with stop and giving way.
- Pedestrian and / or cycle crossings.

2.6.3 Phase 3. Autopilot Motorway Scenario

After the simulation in the urban scenario, the participant was subjected to the simulation on the motorway where, relying on the autopilot, they would encounter the following situations:

- a vehicle occupying a lay-by.
- heavy traffic of trucks.
- an accident.
- reduction of lanes due to road construction.
- traveling through a tunnel.
- presence of an obstacle on the roadway.

Trainers observed and watched during this phase for the probability that some participants could have, following the experience gained during the simulation in the urban scenario, rely more completely on autonomous driving and become distracted.

At the end of the first run in CAV L3 simulation mode

At the end of the first simulation session, it was possible to administer another test by changing the automation levels (from L3 to L4 CAV).

During the tests in L4 CAV, trainers would once again observe how each participant engaged with the simulation to understand if the participant demonstrated more or less confidence in the simulator and any noticeable affect this had on the participant to underestimate the risk situations listed above.

At any point during each three-phase training cycle, the trainer provided support to all participants in the correct use of controls within the simulator, but ongoing provided addition driver training only to those participants in the 'with training' control group.

Any driver training was provided in line with the trainer briefing notes as detailed already in section 2.2.8 above.

According to the CAV pre-driving confidence, results (see figure 16 below) are not converging with Italian results.

If most of the drivers, whatever their age categories, have positive (more than 50%) pre-driving CAV confidence, as found in Italy, the lowest result is related to the 37-47 age category. More surprisingly, the highest scores in terms of confidence are related to the two oldest age categories (47-57 and 57+). Nevertheless, note that only 3% of the total sample of UK drivers compose this oldest category, which force us to great caution when analysing these results.

If some hypotheses could have been drawn according to different CAV maturity indicators[1], the small sample sizes used for the calculations forced us to avoid any speculation about any age category.

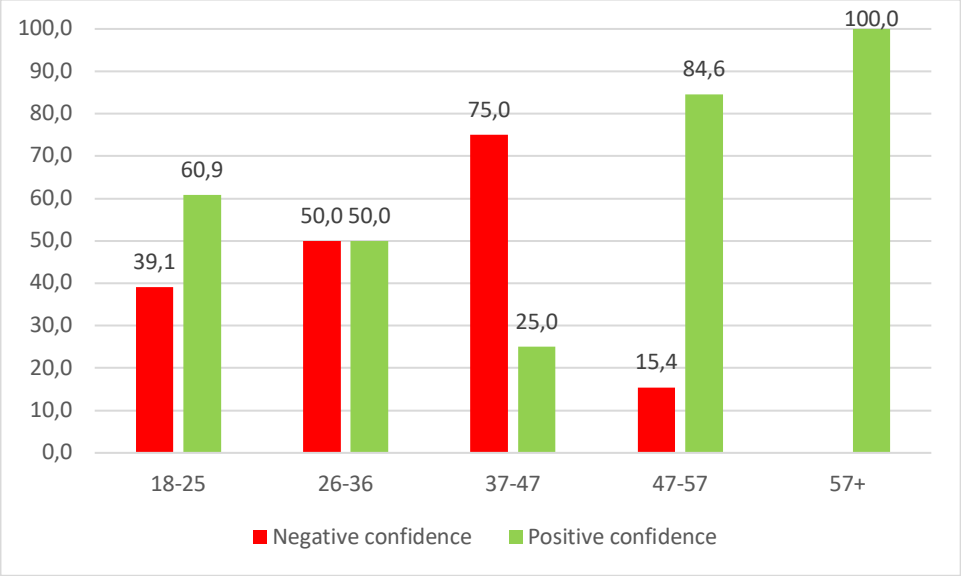

Figure 16 Pre-driving confidence (%) per driver's age categories in UK

[1] See the KPMG Autonomous Vehicle Readiness Index to compare UK (page 20) and Italy (page 35). Available at https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/07/2020-autonomous-vehicles-readiness-index.pdf

3 What emerged from the experiments using the Home Study Simulator tests?

The following is what emerged from the tests done in UK and Italia.

This section is broken down into six parts, as six various sources which helps to define the training needs of future CAV drivers.

As a first source of training needs, a first subsection is dedicated to objective and subjective data collected from the HSS telemetry and the various questionnaires done before and after the use of the HSS. A second subsection is dedicated to the driving instructors' workshop which happened at both driving school partners' premises.

Then a third and fourth subsections consider training needs specifically dedicated to the urban and then the motorway scenarios.

Finally, a fifth subsection deals with the reasons why, despite valuable hints, driving simulators are not enough and could not replace practical tests in protected areas and public roads (sixth and seventh subsection).

3.1 Training needs from the HSS telemetry data and questionnaires

3.1.1 HSS telemetry data

Several HSS variables have been collected: pedal use (accelerator or brake), reaction time after a takeover request, distance to centre lane, etc. See deliverable 4.1 for a full list of telemetry variables.

Using these variables, for each partner's country, a various range of statistical analysis (correlation, t-tests, etc) has been performed.

The overall conclusion is that unfortunately results are inconclusive.

In addition to the limited sample sizes, our main hypothesis for these results is that the individual (driver) variability is more important than the differences observed between individuals (if any). In other words, for one driver, there is a great variability in terms of behaviours between several driving sessions

(without homogenous trend, i.e., a safer behaviour at the last session) and even in a same driving session. Our hypothesis is that due to the dynamic nature of feelings, behaviours and the multiple factors of the context and its multiple facets that can impact CAV confidence, it is not possible (at least in our study) to draw general trends or rules for specific types of drivers or specific simulation tested. Independent variables as gender, age, driving experience, driver type (novice, professional, etc) seems to have limited or no measurable impact compared to the variance observed for the same individual.

3.1.2 Driver's questionnaire analysis

In addition to the HSS telemetry, the before and after HSS driving session answers, were considered to observe driver's behaviours and feelings, after each session Drivers did at least one session and maximum four sessions.

As designed in the project proposal, we hypothesized that several independent variables (age, gender, education, CAV experience, etc) may be predictors of CAV driving and CAV feelings or opinions. See appendix 8.1 to get an excerpt of descriptive statistics related to the UK and the Italian sample.

Although interesting when considered in isolation, the biographical variables have a greater interest when considered as determinants or predictors of behaviours or emotions. By comparing means and calculating presence or absence of link (correlations), we may be able to define trends or generalizable links between variables (e.g., younger drivers have a higher trust in CAV than older drivers) and infer therefore specific needs according to specific driver characteristics.

The most prominent results are related to the confidence expressed after a CAV driving session, the comparison between the overall feeling after the first and last driving session, and the qualitative summary of positive and negative points declared at the end of the last session.

3.1.2.1 Confidence after a CAV driving session

Regarding the UK and Italian sample, there are no significant correlation when trying to consider multiple biographical variables with the post-driving

confidence (overall, during autonomous mode, when changing modes, either urban or motorway scenario).

According to the post-driving confidence (question 23a in appendix 8.1), there are significant differences in terms of age.

In terms of post-CAV driving confidence, the figure 17 below displays the results for Italian drivers, which highlight that almost every Italian (except 26-36 years old drivers) driver felt confident during their CAV experience. According to the very small sample sizes of some categories, any hypothesis related to this surprising 26-36 age category result would be pure speculation.

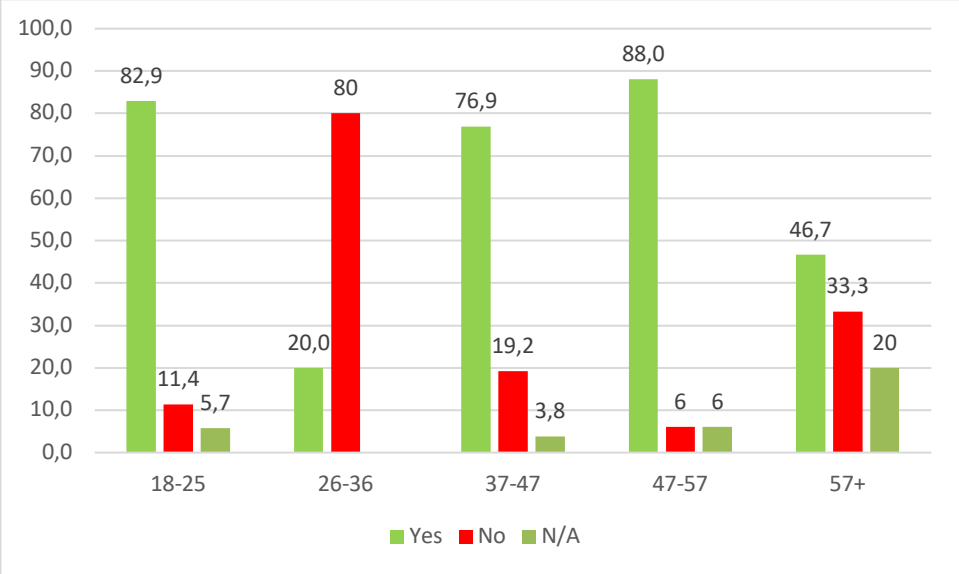

Figure 17 Post-CAV driving confidence in Italy

18-25 years old drivers were massively (around 88%, 21 out of 24 people) confident during their CAV experience. Categories which can include novice with and without licence.

26-36 years old drivers were massively not confident (80%) during their CAV experience, but great caution should be taken as this category includes only 4 drivers (3 drivers were not confident compared to 1 who was confident).

37-47 and 47-57-years old drivers were on average confident (respectively 7 confident drivers out of 12 – and 10 confident drivers out of 13) during their CAV experience.

The 57+ years old drivers' category was the one with the most balanced answers (7 confident drivers out of 15 and 5 not confident).

According to UK results (figure 18 below), even if some similarities are observed (majority of confident drivers during CAV driving, 18-25 and 47-57 age categories got the highest confidence scores), we also consider risky to draw hypothesis about specific results. As an example of this complex analysis process, it 'surprising to see that the lowest confident drivers (in terms of age) are quite at the opposite of the age spectrum (with young drivers – 26-36- and at the same time for the oldest age category). Similarly, to Italy, UK small sample sizes are also a big obstacle to relevant analysis and related hypothesis (e.g., only 2 people are included in the 57+ years old category).

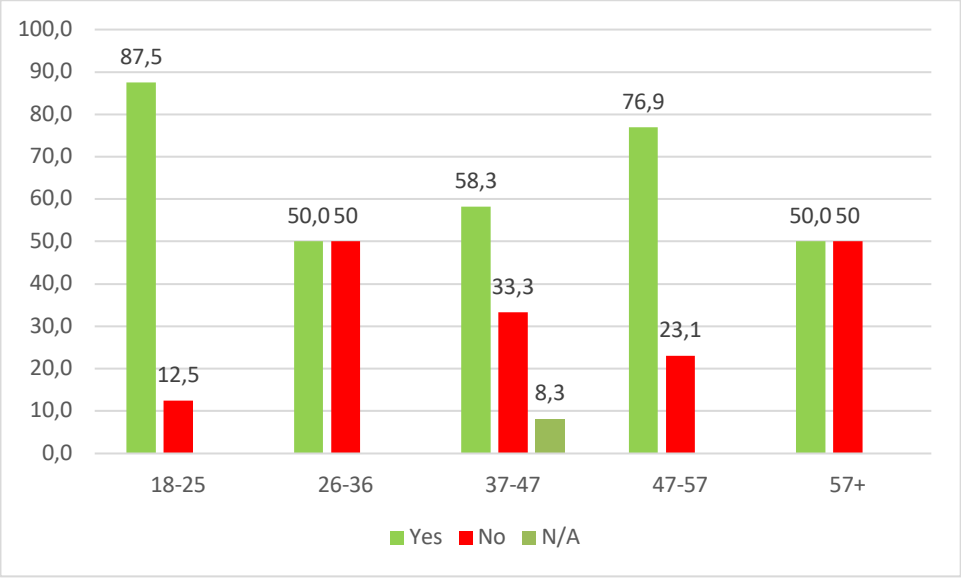

Figure 18 Post-CAV driving confidence in UK

In addition to the dichotomous question about post-driving CAV confidence (Yes or No), we also looked at the difference in terms of feelings expressed

(e.g., trustful, insecure, etc.) after the first and last session, taking into account biographical variables (e.g., age, gender, etc). No significant links or differences have been found. In other words, being a young or an old driver does not mean that they will respectively feel positive and negative feelings, after one or several CAV experiences.

3.1.2.2 Comparison between the overall feeling after the first and last attempt

Independent of the scenario selected - urban or motorway - one of the most interesting results to look at is related to several independent variables (age, gender, driving experience, etc.) and the post-driving question n° *13 - How did you feel while traveling in a CAV?* This question was asked, at least after the first and last simulated driving session.

In Italy, the results to this specific question show no clear pattern or significant correlations highlighting links/correlations between the age, gender of drivers or other dependant variables[2] with the feelings about CAV expressed after the first and last driver session. It may be considered as a surprising result, but one should not forget that feelings (either negative or positive) could be impacted by multiple variables that make generalization hard to draw. Another explanation of this absence of significant result could again be link to the limited sample sizes.

Neither, in UK, the results led to consensus.

This lack of consensus is also visible when drivers had to mention positive and negative points related to their CAV experience (see the following section 3.1.2.3). For example, several drivers felt mixed feelings in terms of safety according to the type of events or roads (appendix 8.7, table 33): "*It made me feel insecure about the control at sometimes but when driving constantly on a straight road it feels safe*".

Moreover, according to the specific question related to the feeling they experienced during the CAV's driving, UK testers results were also heterogeneous. Out of the 36 drivers who completed at least two sessions, at the end of the last session, 15 declared positive feelings (e.g., trustful, safe),

[2] E.g. including CAV experience, driving licence, educational level, etc.

19 declared negative feelings (e.g., careful, insecure, critical, nervous). Finally, two drivers declared they were curious or unaffected.

In terms of feelings evolution – an interesting consideration as experience could help to have more positive feeling – from the first to the last session –

- Out of 36 drivers, 9 declared more positive feelings at the last session (e.g., going from *nervous* feeling at first session to *trustful* feeling at the last session).
- Out of 36, 7 declared worst feelings after the last session (e.g., going from a safe feeling at first session to a nervous feeling at the last session).
- Out of 36, the most dominant result (20 out of 36) is the absence of evolution. When drivers declared a negative feeling after their first session, most of the time they also declared the same (close to) negative feeling after their last session. For example, drivers who were nervous after the first session, also declared they were nervous at the last (or a close negative feeling, like *insecure*, *critical*, etc.).

According to the feelings expressed at each session, there is no significant link in terms of gender, age, trained/untrained drivers or other variables.

Despite mixed results and absence of clear trend with the abovementioned variables, results to question n° 5 may rise some interest *(What kind of Connected and/or Automated Vehicle (CAV) have you tried before?).*

Out of 16 drivers,

- 50% of them declared they already tried one or several CAV features (GPS, driving assistance, ride sharing) but there is no clear trend in terms of feeling expressed, at the first or last session but also in terms of evolution from the first to the last session.
- The other half never tried a CAV. Interestingly, only 25% of this 50% who never used a CAV, felt positive or medium (“curious”) feelings at the last session. In other words, without neglecting the risks of this small sample, it seems that for drivers who never tried a car, they are most likely to have negative feelings about their CAV travel at the last session, almost independently of the feeling they got at the first session.

Despite these results, it is worth mentioning that the understanding of question 5 meaning may have been limited for some people, urging us to use these results with great caution. Indeed, surprisingly some people (especially young ones) answered they never tried a CAV (and the related technology), which means that, according to how this question was defined, they declared, by default, that they never tried a GPS, driver assistance, or any connected features that are though available in many cars today.

Indirectly, this potential misunderstanding of the meaning of what CAVs could be an additional reason to provide training modules related to the CAVs knowledge of drivers. As already stated in D5.1 and D5.2, theoretical training modules must consider the CAVs capabilities and limitations, what are the different levels of autonomy (SAE taxonomy) but also the detail of each ADAS which are and will be present in vehicles.

3.1.2.3 Summary of the positive and negative points of the HSS experience

Following the confidence question and feelings felt during an HSS experience, it is also interesting to consider a more qualitative focus related to the HSS experience. The post driving questionnaire consider the two following questions:

- Question n° 15 - What are for you all the positive points of this experience in the simulator?
- Question n° 16 - What are for you all the negative points of this experience in the simulator?

Even if there are some commonalities between each country's answers, some specific answers are worth highlighting.

3.1.2.3.1UK

Without looking for exhaustivity (see appendix 8.7, table 33 for the full results), here are the most important (in terms of occurrences or relevance) positive points felt during the HSS experience

- HSS is easy to use and allows to be relax thanks to autonomous mode.
- Efficacy of the autonomous driving.
- The HSS was interesting to try.

On the other side, several negative points have been declared regarding the HSS experience. Here are the main ones:

- Dissatisfaction with the HSS controls and system (steering, pedals, mirrors, display; etc).
- Limited trust in the autonomous mode due to lack of trust and/or desire to have full manual control.

3.1.2.3.2Italy

With regard to Italy's answers, here are the most important positive points felt during the HSS experience by Italian driver. See appendix 8.7, table 35, to get the full results.

- Relaxation and low level of stress allowed by the CAV.
- The test was a convenient way to test a CAV.
- CAV's curiosity satisfied.

On the other side, several negative points have been declared regarding the HSS experience. Here are the main ones:

- Low fidelity of the HSS.
- Limited trust in the HSS.
- Uncertainty and lack of safety felt.
- Too low level of stress as the other side of a previous positive point.

Following HSS data analysis focused on drivers' point of view (mostly inconclusive telemetry results and on average similar questionnaire results whatever the country), we will now consider the driving instructors' point of view to reveal the training needs.

3.2 Training needs from the driving instructors' workshops

In addition, and simultaneously to the HSS tests conducted with all types of participants, workshops were organized with the partners involved (ACI, RDS and List) to analyse together the results from the different points of view and define a shared training program.

3.2.1 Italian workshop

During the meeting of 8 October 2021, ACI presented the guidelines defined for the realization of deliverables D5.2 and D5.3. See an excerpt in figure 19 below and see appendix 8.4 for full details.

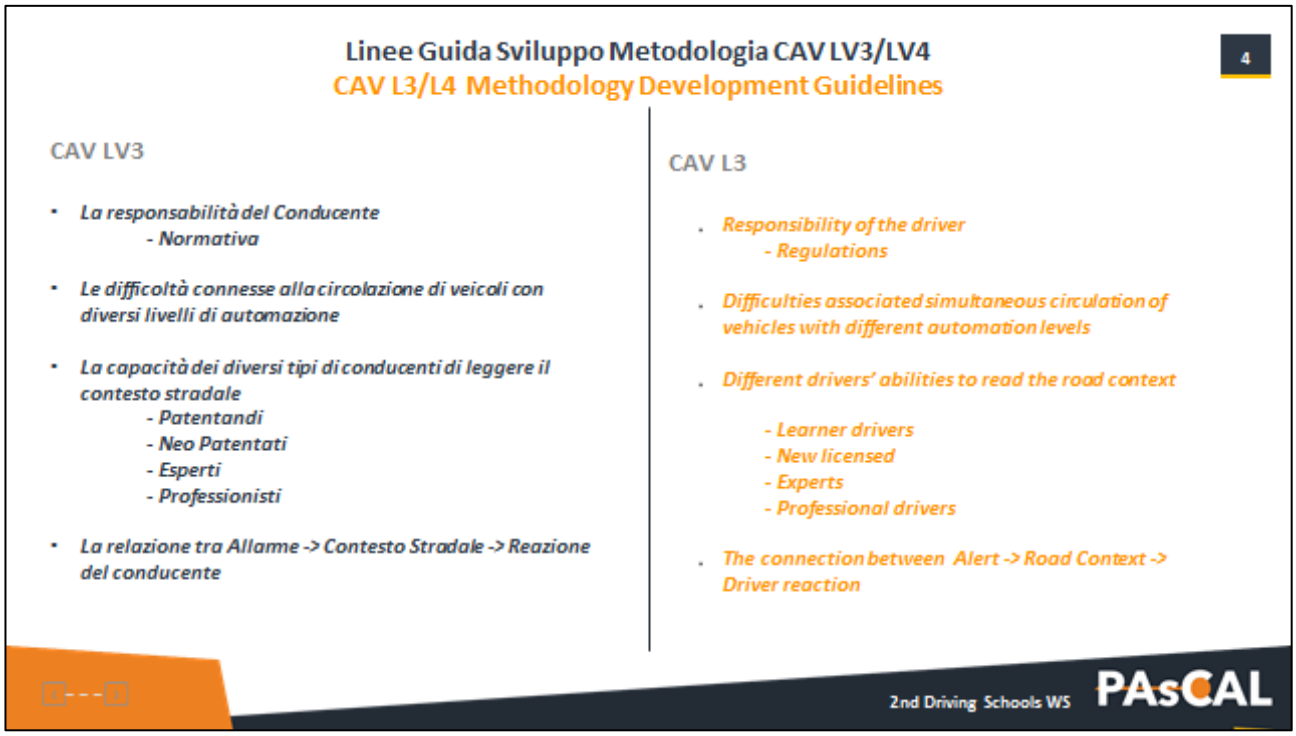

Figure 19 Excerpt from the presentation made during the 8/10/21 workshop with driving instructors

As the training aimed deals with a new type of vehicle, the basic training needs will be almost identical for all types of drivers (Trainers, Professional / experienced drivers, and novice drivers).

In the following paragraphs dedicated to Professional / experienced drivers and Trainers, however, the additional training needs foreseen for these categories of drivers will be highlighted.

Furthermore, considering the current regulations and technological knowledge available[3], no differences have been recognized, from the point of view of training needs, for automation levels 3 and 4. Moreover as already mentioned in D5.1, there also ongoing debates of what should be considered in L3 and L4 CAVs.

In addition to the October 2021 workshop, other meetings followed with the driving instructors involved in the experiments. Thanks to the feedback gained with the tests carried out on the HSS, driving instructors considered that the second simulator training step (initially foreseen) was no longer relevant. The decision was made by virtue of the need to test the situations of use of automated driving systems in a real-life environment with an actual CAV, in order to avoid the erroneous acceptance of incorrect and potentially dangerous behaviours for the driver and, more generally, for the road users.

3.2.2UK Trainer's workshop

In parallel to Italian workshops meetings, a group of ten UK driving instructors were asked to discuss the challenges posed to driving instruction in a future where CAVs become more prevalent.

They were each provided with a list of prior research into CAV technology as well as several manufacturers produced YouTube videos of potential CAV L3 and L4 technology undergoing testing to watch, by way of preparation for the workshop. All items provided are detailed in appendix 8.8 PAsCAL Project UK Trainers Workshop – Pre attendance preparations.

[3] In fact, to date (March 2022), there are no specific national regulations for Cav 3-4 road traffic and the manufacturers, to date, do not disclose the technology of their L3 and 3 CAV experimental cars.

Once preparations were completed and prior to attending the physical workshop, a brief questionnaire was completed by all trainers which included the following questions listed here:

1. How would you as trainers discover available CAV technology?
2. How would trainers best introduce CAV technology to a Novice Driver?
3. How would trainers best introduce CAV technology to an Experienced Driver?
4. What do you think the key features of CAVs are to communicate to a Driver?
5. How would trainers best educate the risks that may require intervention to a Driver?
6. How often would you as a driver trainer check for new technology? and How would you educate a driver to check for new technology?
7. What objections could driver trainers face to CAV technology acceptance and adoption? How would trainers respond to these objections?
8. What tools would help driver trainers with all the above?

During the workshop session all their answers to the questions were used and considered against their current role as driving instructor trainers. The aim was to consider devising a common approach to dealing with the pending changes posed by the introduction of higher levels of automation within driving.

At the end of the workshop a combined summary of findings against each of the 8 questions listed above was agreed and are detailed in appendix 8.5.

Below is a summary of the main findings according to each question.

How would you as trainers discover available CAV technology?

A common theme across the trainer responses was through research on the internet, through various car related websites (Auto Express) and keeping up to date with developments in the driver training industry via association meetings and training events.

How would trainers best introduce CAV technology to a Novice Driver?

Some trainers felt this could be challenging as quite often the younger novice driver tends to find initially the level of input and multitasking needed to control the vehicle and be aware of what is happening around the vehicle can be overwhelming.

It was felt that as instructor's, we can combine the benefits of this technology in a way that improves vehicle safety without putting an extra burden on the driver, we can demonstrate it as a positive benefit.

All trainers agreed for the need of a prior theory training module to be added to the syllabus to aid pupil progress in this area during in-car training. This would possibly need to incorporate some form of interactive material regarding behavioural change. Also considered important for any theory module were the following key points; HMI training, risk perception, understanding vehicle automation, drivers' responsibilities and providing guidance on best practice.

How would trainers best introduce CAV technology to an Experienced Driver?

Many of the trainers felt that experienced drivers may present with some resistance to change that would have to be recognised and considered during the training. Experienced drivers who may not have had any driver training since first passing their driving test to acquire a licence, may have had negative experiences trying to use CAV L2 technology.

Engaging with the experienced driver through effective training of existing Adas systems first was seen as the best link towards CAV L3 and L4 training.

What do you think the key features of CAVs are to communicate to a Driver?

Trainers felt that it was of prime importance to start with the safety benefits first. If the technology is tried, tested, and trusted it takes the human element out of

road safety. There would be less for the driver to be involved with, so a journey could be less stressful.

As with experienced drivers, all the trainers felt a linking of technology training would probably assist in communicating the new key features. For this to work, trainers would first introduce all the existing on-board technology, but use it as a way of linking to what higher CAV L3 and L4 vehicles might have in the future.

In all cases the trainers agreed that particular attention during training should be made to the possible risks of over-reliance and complacency on CAV L3 and L4 technology, for example if a driver was to allow themselves to engage in other activities such as using a mobile phone or watching a film, reading a book etc is a risk; remaining attentive is crucial.

Detailed training and practice of the recommended CHAT (check-assess-take over) procedure was encouraged during any proposed training of experienced drivers.

How would trainers best educate the risks that may require intervention to a Driver?

Trainers agreed one potential approach would be to include some form of safe learning experience similar to the HSS simulator being used within the PAsCAL research, linked to the theory training module.

Trainers felt an important first step to engage any driver with a safe process of risk intervention it would be a good idea to discuss with the driver, using various possible scenarios and how different CAV level technology may impact the drive and the sharing of risk responsibilities between system and driver. This would be a link back to the theory element of the training program.

In lieu of any simulator-based training, the trainers also felt that an element of any future in-car training would have to take the form of a demonstration drive, with the trainer driving a pre-planned route and highlighting the risks that could

potentially cause a hand-back request to the driver in a future CAV L3 or L4 vehicle. This would help prepare the driver to then drive the same route in manual driving mode without using technology, and the trainer questioning the driver on which risks are they seeing, and which would they think the system would request to hand back to the driver.

How often would you as a driver trainer, check for new technology? How would then also educate a driver to check for new technology?

Trainers all agreed that as part of their job, it is necessary to maintain the highest levels of knowledge relating to all aspects of the driver training program. To this end they regularly keep up to date with industry information and have daily email alerts from various motoring journals and industry regulators (e.g., the DVSA).

Trainers also felt that a good practice for driving schools to follow going forward would be to become as early adopters as possible of higher CAV level vehicles as soon as they come onto the market.

Trainers did feel that auto manufacturers should also be encouraged to shoulder more of a technology training role when selling new higher level CAV vehicles, which could prove especially useful as drivers consider upgrading their vehicle.

What objections could driver trainers face to CAV technology acceptance and adoption? How would trainers respond to these objections?

Trainers felt a driver's negative prior experience of using Adas and in particular ACC, with its limitations, may be put off and this could negatively impact on their view towards accepting and engaging with higher levels of autonomy as they become available.

For this reason, it is necessary to ensure during training that limitations of Adas systems such as ACC are fully explored to ensure adoption and use of Adas

systems as a way to persuade experienced drivers that advancement in CAV level of technology is a positive. The proposed training modules content cover this aspect in detail and will help improve acceptance of Adas systems in general, but CAV's in particular as good as a person, it might go wrong.

Fortunately, trainers believe that novice drivers, starting from a blank canvas perspective as it where, could be more easily persuaded to the benefits of Adas and higher level CAVs through training during licence acquisition.

What tools would help driver trainers with all the above?

Trainers felt the new module being added to the syllabus was the most practical approach to providing trainer resources such as videos, statistics, legal and Highway Code published literature.

Trainers also felt that more support and training for them was essential going forward and made the suggestion that better links to the auto manufacturers could be sorted to facilitate open days for trainers to attend and learn about advances in the technology first-hand, prior to any public launch.

A proposal was put forward that RED could consider establishing a dedicated Adas and CAV training team at the national training centre in Donington where training days for driver trainers could be hosted with demonstration days from manufacturers for example. This could also provide a long-term base for the HSS which could be utilised during wider general instructor training at the venue.

3.3 Training needs from the Urban setting simulation

3.3.1 Why a driver simulation training must consider an urban scenario

Giving consideration to the implementation of the current educational system used in driving schools, one cannot ignore the urban environment and its peculiarities: road intersections (crossroads, roundabouts), horizontal / vertical signs, traffic lights, pedestrian crossings, public transport stops, different traffic volumes and types of road users. See deliverable D4.1 for greater details.

This need derives from the complexity of the many variables and stressors a normal driver faces in this scenario.

3.3.2 What to investigate

For the first simulator run it was agreed to concentrate the experimentation on measuring the degree of acceptance of autonomous driving systems with particular attention to the Level 3 CAV.

In fact, in this environment, driving instructors observed that the most experienced drivers, on the basis of the experiences and skills gained over time, tend not to rely on driver assistance systems, anticipating possible critical situations (intervention before the alert) and thus not exploiting the possible benefits of the CAV system.

Conversely, during the simulations with the CAV lv4 vehicle, driving schools involved with the HSS trial observed many participants having some difficulty in regaining control of the vehicle in time, largely due to three main factors:

- to distraction, after several minutes of non-driving, the attention of participants tends to decrease[4] or no longer be focused on the road ahead, other vehicles and surroundings.
- to difficulty in identifying the button for disarming the automatic system.
- to understanding the cause of the alert, which, despite its display was not always “seen and understood” by drivers. This lack of awareness and

[4] Excerpt of post-simulation questionnaire quote (see appendix 8.7): “When i had to take over sometimes i was not concentrating enough at the time”.

visibility of CAV feedbacks supports our call for better heads-up technology (see section 6.1.2).

For a novice driver, however, the urban scenario will always represent the first and most complex of the environments in which to learn to drive the vehicle owing to its particular features such as varied intersections, roundabouts, multiple and vulnerable road users along with 2-way traffic.

Even if results were mixed (or not statistically significant), novice drivers tend to demonstrate on one hand, a greater propensity to rely on driving automation (unlike an experienced driver). However, on the other hand, novice drivers seemed to have a difficulty in the timely evaluation of possible critical situations combined with a lack of confidence in implementing the correct interactions with the vehicle controls to continue driving the vehicle safely.

The inexperience in driving of this type of driver can therefore lead to a priori acceptance of the driving automation technology already during the use of a CAV lv3 vehicle, which does not, however, take into account the real understanding of the benefits and possible risks.

During the simulation with a L4 CAV, Italian novice driver showed a high propensity for distraction, in some cases conducting activities not related to driving, NDRT (e.g., use of the Smartphone), during the self-driving phases. It resulted in a delayed reaction with respect to the alert signal or in some cases a total non-reaction. These observations are drawn from the feedback received from the Italian driving school partners but not from the UK driving school.

3.3.3 Training Needs Emerged

The training needs described below are classified by categories crossing the type of drivers, the driving environment, and the CAV level.

For Expert Driver in an Urban Environment with a level 3 CAV

- Understanding of Automation procedures and CAV systems through a Theoretical module to be delivered in the classroom.
- Training through Simulated Guide in order to recognize the ideal conditions in which to rely on automation systems.
- Practical Tests in the Protected Area in order to consolidate the acceptance of automation systems.
- Training on public roads in accompanied driving in order to experience the advantages of automation systems in everyday driving.

For Expert Driver in an Urban Environment with a level 4 CAV

- Understanding of the limits of Automation systems through in-depth analysis in the Theoretical module to be delivered in the classroom, focusing on the cases and known causes of malfunction.
- Training through Simulated Guide in order to recognize possible critical situations for automation systems so as to be able to intervene in time and correctly in response to the alert signal.
- Practical Tests in a Protected Area in order to counteract some known phenomena of perceptual errors related to simulator driving only and to have the opportunity to train in safety by experimenting several times critical situations that may not occur during a limited number of hours in accompanied guide.
- Training on public roads in accompanied driving in order to consolidate the cognitive skills and analysis of the road context, gained in the previous phases.

For Novice Driver in an Urban Environment with level 3 and 4 CAV

- Understanding of Automation systems through a Theoretical module to be delivered in the classroom: operation, ideal conditions of use and possible critical situations.

- Training through Simulated Driving in order to: recognize the ideal conditions in which to rely on automation systems and any critical situations; improve vehicle alert reaction times; improve the quality of the manoeuvres to be carried out to bring the vehicle back to safe conditions.
- Practical Tests in a Protected Area in order to counteract some known phenomena of perceptual errors related to simultaneous driving only and to have the opportunity to train in safety by experimenting several times those critical situations that may not occur during a limited number of hours in accompanied guide.
- Training on public roads in accompanied driving in order to consolidate the cognitive skills and analysis of the road context, gained in the previous phases.

3.4 Training needs from the Motorway setting simulation

3.4.1 Why a driver simulation training must consider a motorway scenario

The motorway scenario is mandatory for several reasons.

First, given the "safe" nature of this type of journey, it is logical to expect that they will represent the first real field application of vehicles with CAV 3 and 4 technologies. Second, motorway driving can also be another important test bed for measuring the degree of acceptability of automated driving features such as lane changing, accelerating, and braking etc, strategies adopted by CAVs.

3.4.2 What to investigate

Given the monotony of the tracks and the long distances for which they are normally used, it is very likely that drivers at first rely more easily on automated driving, even in CAV lv3 cars. It will also be likely that in the event that the vehicle adopts driving strategies that are too “conservative[5]”, an experienced

[5] Average speed too low, excessive distance from the vehicle in front of the driver, excessive or early braking, low speed when cornering, etc.

driver may decide to give up using the system, due to the onset of boredom[6] and the dilation of travel times.

Conversely, if the driving strategy is too "sporty / aggressive[7]", it can trigger insecurities and fears such as to induce the driver to regain control of the vehicle (CAV lv3) or to a low degree of automation acceptance (CAV lv4).

Furthermore, for both categories of drivers covered by the study, it was important to measure the real ability to manage any unforeseen situations in which it is necessary to restore the manual controls; this need emerges by virtue of some factors:

- Despite being the safest roads, after several hours of autonomous driving on a motorway, the driver's attention will probably be lower.
- The higher driving speed involves a greater stimulation of the emotions of a driver in dangerous situations and less time available to implement any corrective manoeuvres.

The sum of these factors leads to an expansion of the reaction times with consequent, probable, loss of control of the medium.

The tests carried out confirmed the above, during the exercises there was also a difficulty in driving the vehicle correctly during the disengagement phase of the autopilot, due to an unrealistic rendering of the steering and brake response reported by the HSS simulator.

3.4.3 Training Needs Emerged

The training needs described below target Novice and Expert Drivers driving CAV level 3 or 4.

- Understanding of Automation systems through a Theoretical module to be delivered in the classroom: operation, ideal conditions of use and possible critical situations.

[6] Quote from the post simulation questionnaire (see appendix 8.7): "*Autonomous driving for ~20 mins is very boring*".
[7] reduced safety distance, speed of entering and cornering, accelerations and decelerations that are too strong.

- Training through Simulated Driving in order to: recognize the ideal conditions in which to rely on automation systems and any critical situations; improve vehicle alert reaction times; improve the quality of the manoeuvres to be implemented to bring the vehicle back to safety conditions.
- Practical Tests in a Protected Area in order to counteract some known phenomena of perceptual errors related to simultaneous driving only and to have the opportunity to train in safety by experimenting several times those critical situations that may not occur during a limited number of hours in accompanied guide.
- Training on public roads in accompanied driving in order to consolidate the cognitive skills and analysis of the road context, gained in the previous phases.

3.5 Why Simulated driving is not enough

As observed through the HSS experiments, simulated driving alone could lead to an underestimation of the risks associated with certain driving behaviours[8].

Simulated driving could also lead to the acceptance of incorrect and potentially dangerous behaviours, which if not denied and corrected through practical exercises with real cars, could consolidate bad habits with serious consequences on public roads.

Furthermore, during a real drive, even if in a protected area, the drivers can be assessed not only with the analysis of specific situations or with the management of the mechanical vehicle in possible critical situations, but above all with the understanding and management of their emotions (during a range of situations – normal, critical, new, “boring” situations, etc.).

For this reason, even if on the one hand the use of driving simulators is advisable for a first approach to specific situations, as it allows the learner to

[8] Illustration with a quote from the Italian sample: “ You relax… but real hazards on the road are not so predictable and obvious as in this videogame” (anonymous driver, 2021)

learn with limited stress some good practices related to driving CAs, it cannot be the only practical moment in terms of training.

In order to provide a complete preparation of the L3 and 4 CAV driver, practical training is required to be carried out in a "safe area" closed to traffic, where to test the Adas and emergency manoeuvres, should the system ask to regain control. Once the participant has completed several laps within the "safe area" and therefore has knowledge of on-board systems and their functioning, it will be necessary to accompany the participant to urban roads and extra-urban roads to introduce them to a "real world" setting with all its variables and particularities.

3.6 Practical tests in a protected area

As with all aspects of driver training, it is necessary to consider how to safely link the 'theory' knowledge to 'practical' application. In this case, whilst the HSS can help us with improving the 'theory' knowledge of drivers in relation to CAV's, it cannot alone help with the link to the 'practical' application. An additional step is required to assist with this process and is described next.

As seen in the previous section, a simulator exercise alone, could create cognitive and perceptual errors in the learner, in addition to the acceptance of incorrect behaviours. This emphasises the need to introduce in the training module a part of practical experimentation, aimed at understanding the operation of on-board systems, experimenting with possible critical situations, and exercising in the management of the vehicle.

The opportunity to carry out this type of training in a protected area in a first phase is linked to the risk of misreading a critical situation on the road and the probability that such situations will not occur during a limited number of hours in accompanied driving.

The didactic purpose of practical tests is manifold:

- the achievement of a good acceptance of the CAV.
- the experimentation of some critical situations of the Adas devices.

- the training in the practical application of the protocols provided in the theoretical module and already tested through the simulated driving, through exercise in the car.

The location needed to perform these exercises must allow to recreate those situations in which the automated driving systems can pass from an ideal operating situation (acceptance) to a critical situation (training). Specific automated driving paths will then be defined to recreate the previously analysed scenarios experienced in simulated driving.

The exercises hypothesized to date have been built by virtue of the current driving aid technology, present on the most advanced vehicles on the market. It is clear that these training modules will evolve in the future, following the technological advancement of vehicles on the road.

With regard to the exercises in the protected area, we have taken into consideration the safe driving centres. These centres allow the driver to test their skills in controlling the vehicle in critical situations such as: loss of grip, emergency braking, discarding obstacle, aquaplaning etc… in total safety.

Furthermore, to test the Adas L3 and L4 CAV's systems, it is necessary to have ample space to allow the cars to carry out all the manoeuvres and reach the necessary speeds. As stated above, it should be noted that the ACI Safe Driving Centre in Lainate (figure 20 below) was chosen for the WP6 Pilot 2.

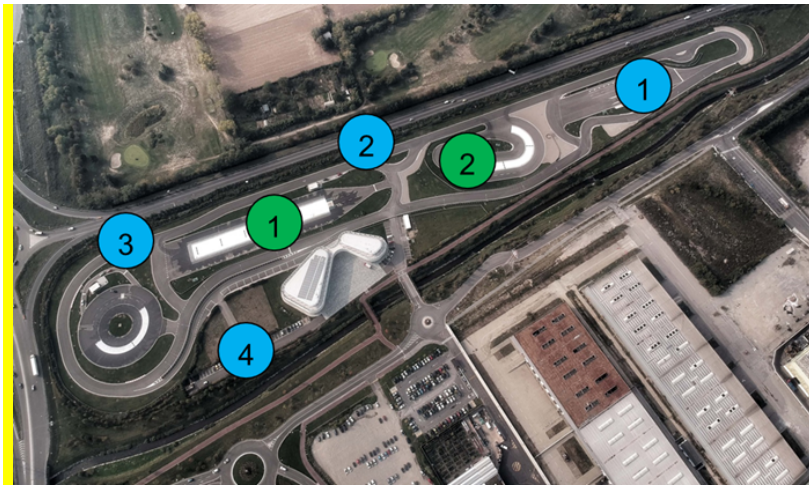

Figure 20 ACI Safe Driving Centre in Lainate (Milan)

1. "slide" area 1.
2. "ascent and descent" area 2.

1. "asphalt area" for Adas 1 "automatic braking".
2. Straightaway area for Adas 2 "Lane keeping".
3. Complete circuit area for Adas 3 "Adaptive Cruise control".
4. Parking area test for Adas 4 "Automatic parking".

Even if these practical areas are the ideal configuration to test and acquire specific skill, we could also consider these tests areas as future HSS events and situations to include in the next HSS software developments.

3.6.1Exercises

Skid control: The exercise involves the loss of grip caused by a laterally sliding metal platform that moves the rear end of the car on a road surface with artificially irrigated low-grip resin (see figures 21 and 22 below). In this area the student will learn to control the car in a situation of loss of grip on the rear axle**.**

This exercise is useful to simulate a request to regain the control (or Take Over Request) for the critical situation of loss of grip and the relative ability of the

driver not only to regain control, but also to manage the critical situation with the help of ESP.

Figure 21 "slide" AREA safe driving 1

Figure 22 "Skid Control" exercise

Curve setting: made on a curvilinear portion of the exercise area with low adherence resin, artificially irrigated**.** This exercise helps the driver to deal with the critical situation of emergency braking when approaching a bend which could trigger a loss of grip on the front axle resulting in a lack of direction of the car.

In this exercise (see figures 23 and 24 below), the driver will experience the functioning of the ABS which also simulate the request to regain the control for the critical situation

Figure 23 "ascent and descent" AREA safe driving 2

Figure 24 "Curve Setting" exercise

3.6.2Adas test number 1 «Automatic braking»

In the area made of asphalt, a roadway is reproduced, in which the participant will drive a car equipped with Adaptive Cruise Control and Automatic Emergency Braking System at a speed between 30 and 50 km / h.

An approved shape of a car (see figure 25 below) will be positioned on the roadway.

Figure 25 Emergency braking test with a vehicle silhouette

The participant will have to simulate a distracted driving situation and the system should intervene in its place by stopping the car before impact.

A "failure" of the automatic braking system will also be simulated by simulating the obstacle with a wall of water.

In this situation, the participant will have to intervene to regain control of the vehicle and drive the vehicle safely through an emergency braking manoeuvre with obstacle avoidance.

NB: For Expert drivers, Professionals and Trainers, the same exercise will have to be carried out in its advanced form: inserting an additional training element relating to the correct perception of vehicles arriving through the use of rear-view mirrors, in order to identify the safest escape route to carry out the obstacle avoidance manoeuvre**.**

3.6.3Adas test number 2 «Lane keeping»

On a straight section of the circuit, approximately 800 meters (see figure 26 below), a three-lane carriageway is reproduced, the participant will drive a car equipped with the Cruise Control Adaptive and lane keeping systems. Simulating a lateral movement, he will wait for the intervention of the system that will bring him back into his lane.

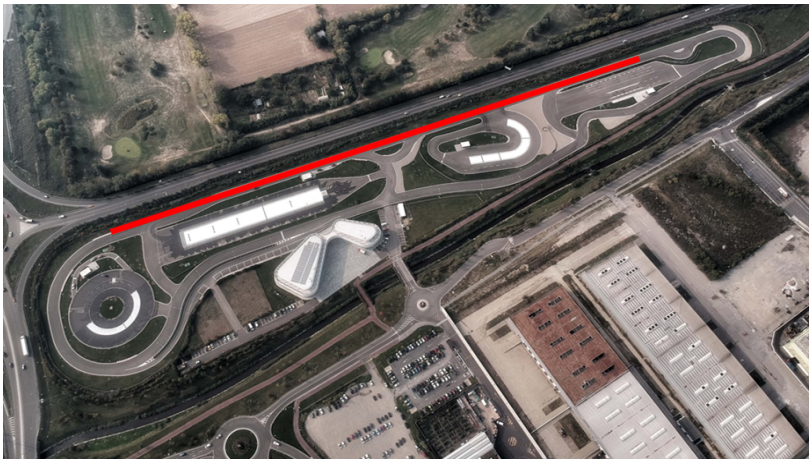

Figure 26 Straightaway test Adas 2 “Lane keeping”

A "failure" of the system will be simulated, by positioning cones along the route, which will recreate a narrowing of the carriageway type "road construction site".

3.6.4Adas test number 3. «Adaptive Cruise Control»

Using the entire circuit (1,500 meters, see figure 27 below), an instructor will drive a car at variable speed, also making stops and restarts while the participant will drive a car equipped with Adaptive cruise control and will follow the other car. By activating the system, only in straight sections (green areas), the car driven by the instructor will always maintain the distance set from the car in front. The system will also manage the restart after any shutdown.

A common critical situation of the on-board system will also be experienced, due to the temporary “release” of the vehicle in front of us, during a curve (red zones).

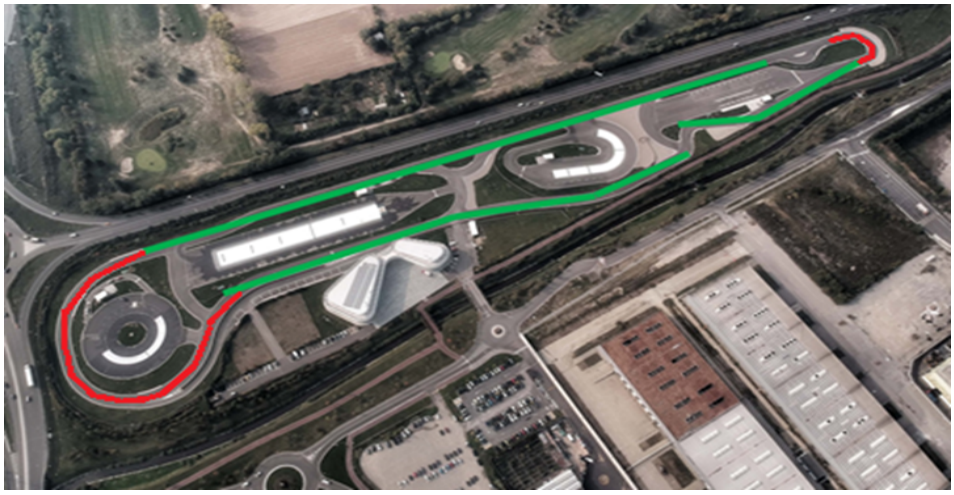

Figure 27 Operating area map with adaptive cruise control

3.6.5Adas test number 4 «Automatic parking»

In a parking area, the participant will use a car equipped with autoparking. Thanks to this system, the car recognizes a suitable parking area and helps the driver park the car by managing the manoeuvre almost completely.

This exercise is aimed at the acceptance of the vehicle's self-driving systems.

3.7 Practical tests on public roads

This phase can be divided into two different moments. For the realization of the first step, it is necessary to identify, in the various sites, a standard route, of about twenty kilometres, where some critical conditions could occur, object of the theoretical program, for example: inaccurate or suddenly missing horizontal signs, blind curves, differences in height with very pronounced bumps etc ... In this way the instructor will be able to observe the autonomy of the learner in dealing with critical situations, the nature and position of which is already known (by the trainer).

Another objective of this exercise is to make the driver aware of the real reaction times and ways of the vehicle. The final phase of the method involves, for the purpose of verification, facing a free and random path, on public roads, to verify the level of autonomy achieved.

3.7.1 Phase 1. Exercises on urban roads

The instructor will propose courses like those experienced during the simulator exercises by imparting the instructions proposed in the teaching grid used in section 2.2.8

The instructor must be able to contextualize the explanation in relation to the infrastructures of the area where he exercises his profession.

During the exercise, the participant must achieve a good level of confidence in the Adas and the instructor must in turn avoid resuming commands before the possible alert.

While the vehicle is moving autonomously, the instructor will explain to the student to concentrate on observing the road context in order to evaluate the possible disengagement of the autopilot.

3.7.2 Phase 2. Exercises on suburban and / or motorway routes

The instructor's objective on an extra-urban route will be to lead the student to keep the autopilot engaged for several kilometres and to experience the following situations using the instruction grid:

A. traveling around curves with good road markings.
B. traveling around curves with missing or poorly traced road markings.
C. traveling a stretch of road following a vehicle.
D. traveling along a stretch of carriageway with three lanes in each direction of travel, occupying the central lane and following a vehicle.
E. overtaking a heavy vehicle during a curve on a carriageway with two lanes in each direction.

Table 1 Critical situations and expected driver response behaviour while driving on public roads

Driving on public roads	
SITUATION	**EXPECTED DRIVER RESPONSE BEHAVIOUR**
A) traveling through curves with good road markings	1) I monitor how the vehicle follows the track 2) I keep in mind that the trajectory may not be correct 3) if the curve setting is not correct, I disengage the autopilot
B) traveling around curves with missing or discontinuous road markings	1) I observe the position of the vehicle on the roadway 2) I check that the autopilot is not correctly reading the edge of the carriageway 3) I disengage the autopilot and continue with manual driving
C)traveling a stretch of a stretch of road following a vehicle	1) I monitor the behaviour of my vehicle, with particular attention to maintaining the distance from the vehicle in front of me 2) I try to set the different safety distances made available by the driving aid system 3) I choose the one that is most congenial to the type of route and the volume of traffic on the road
D) traveling along a stretch of carriageway with three lanes in each direction, occupying the central lane and following a vehicle	1) I observe how my vehicle maintains a safe distance from the vehicle in front of me 2) I try to set the different safety distances 3) in the event that a third vehicle, carrying out an overtaking manoeuvre, intends to pass between my vehicle and the one in front of me, foreseeing a possible incorrect reaction of the automated driving system, I resume manual control of the vehicle.

E) overtaking a heavy vehicle during a curve on a carriageway with two lanes in each direction	1) I start the manoeuvre with the autopilot engaged (lane change and approach to the vehicle in front of me) 2) while overtaking I keep in mind that the autopilot may not work properly when braking for no apparent reason 3) to avoid point 2 I overtake in manual driving

4 Specific training modules for professional, experienced drivers and trainers

For the purposes of this next section, we will consider three sub-categories of drivers who all have, by essence, a long driving experience:

Professional drivers – those who drive for a living, will usually have additional licence categories on their driving licence for which they have to undertake mandatory driver continuing professional certification (Driver CPC) training of at least 35 hours within every 5-year period. An example would be van delivery drivers or HGV/LGV[9] lorry drivers.

Experienced drivers – those drivers who have held a Category B Car driving licence and have driven regularly for several or more years.

Trainers – or instructors, those who are the most knowledgeable in driving, as they must be able to train any type of drivers, from the novice (without any driving experience) to the most experienced ones, including the professional drivers.

From the tests observed, driving trainers and instructors considered that some older people or more generally people with a larger amount of experience in terms of driving (e.g., driving many years and complete many miles), such as expert or professional drivers, tend not to fully trust the automation systems. They sometimes try to anticipate intervention on the controls, to regain control of the vehicle, before the system alerts.

Surprisingly, data collected from questionnaires did not confirm these behavioural differences between driver's types[10], for unknown reasons. Nevertheless, there are few doubts that a negative correlation between age (but the "cut-off" age is to be determined) or driving experience and acceptance would be confirmed again if we replicate our studies. Indeed it has already been shown that autonomous driving acceptance (and by extension the acceptance

[9] Heavy Goods Vehicle and for Large Goods Vehicle
[10] statistical t-tests comparing novice and other types of drivers

of autonomous mode versus manual mode) is negatively correlated with driving experience and age (Koul & Eydgahi, 2018).

Following these observations and taking into account the existing national laws and practices in terms of driving training, CAV training must be specifically designed for professional, experienced drivers and trainers.

4.1 Professional drivers

In Italy as in the UK, professional drivers must necessarily participate in periodic refresher courses which provide for the administration of 35 hours of training, every 5 years for the maintenance of qualifications[11]. It is also already possible to dilute these hours over 5 years (e.g., 7 hours per year).

These rules were defined with the Directive 2003/59/EC of the European Parliament and of the Council of 15 July 2003 on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers and have been accepted by all member countries.

To maintain a good ability to manage vehicles in all conditions, both ideal and critical, and to be able to correctly follow the technological evolution of automated driving systems, it is advisable to provide a training cycle for professional drivers.

A mandatory 8-hour training per cycle could include:

- A 2-hour theoretical session to deepen the knowledge of the new automated driving systems released by the manufacturers, as well as any regulatory adjustments introduced by the member states of the European Community.
- A 1-hour session on a driving simulator, for a first approach to the novelties presented in the theoretical session.

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1646310526682&uri=CELEX%3A02003L0059-20190726

- A 3-hour practical session in a protected area in which to carry out exercises aimed at managing critical situations and the correct use of the new self-driving driving systems.
- A 1-hour final accompanied driving session on public roads to verify the ability to apply the concepts learned in a real context.

NB: for Truck and Bus drivers, in theoretical modules, the Adas systems of the life-saving package provided exclusively for these types of vehicles will be studied in depth with respect to what is dealt with in the module dedicated to Novice Drivers, namely:

- Tire pressure monitoring (vans / trucks / buses).
- Detection and warning of front and side presence of other users (truck / bus).
- Greater pedestrian visibility (Truck / Bus).

4.2 Experienced drivers

Following feedback made by this sub-category during the HSS trials and from observations made therein by the trainers accompanying experienced drivers, it is deemed sensible to foresee a need for the introduction of standardised CAV driver training to help with acceptance and safe use of CAV L3 & L4 technology within this group of users.

A first compulsory training cycle is suggested, when it will be possible to circulate with CAV vehicles of L3 (or higher) on public roads once this becomes legal in each of the member countries.

At first, the training obligation could be linked with the time of purchasing a vehicle equipped with this technology. The same could then become compulsory periodic training for maintaining the driving license, with an 8-hour training session therefore could be envisaged, which coincides with the renewal of the license which to date, for drivers with a B license (qualification for driving "light" vehicles) takes place every 10 years and provides, in Italy, a visual check-up visit[12].

[12] It is important to note that the Cat B licence renewal at 10-year intervals in the UK is to update the driver's photo ONLY – no periodic mandatory training rules exist for Cat B licence holders within the UK and this would require a legislative change.

When we consider all the findings within this study (HSS and practical sessions in a protected area - WP6 Pilot 2); we recommend that this proposed training should be followed by all people purchasing a L2 CAV whether for novice or experienced drivers (including professional and trainers).

The training module to be provided to experienced drivers when first purchasing a L2 CAV or higher-level CAV should follow what has already been foreseen for Novice Drivers (see D5.2 section 2.2.2).

4.3 Trainers and instructors

Trainers and instructors of the driving schools are the first category of driver who will need training. They must acquire the necessary skills to be able to train the other types of drivers.

As previously mentioned, the basic training for trainers must include what has already been described for Novice drivers, as well as what is provided for experienced and professional drivers.

In addition to the abovementioned skills, trainers should dedicate an additional number of hours aimed at training the correct driver training techniques and knowledge related to the use of CAVs in public areas. In particular, trainers must be able to:

- identify suitable tracks for safe exercise with CAVs.
- clearly recognize ideal situations for the use of automated driving technologies.
- apply intervention procedures in the event of improper use of automated systems by the learner.

To achieve this level of competence, we hypothesize the need for an additional 30 hours of training compared to what has been provided for the other categories of drivers up to now.

These additional 30 hours could be divided as follows:

- a 6-hour theoretical session to deepen the knowledge of the new automated driving systems released by the manufacturers, as well as any regulatory adjustments introduced by the member states of the European Community.

- a 4-hour session aimed at teaching through the use of driving simulators.
- a 10-hour practical session to be carried out in a protected area in which to carry out exercises aimed at managing critical situations and the correct use of the new car driving systems.
- a 10-hour practical session to be carried out always in a protected area in which to carry out exercises aimed at teaching the management of critical situations as well as teaching for the correct use of the new car driving systems.

Once the first training cycle has been completed, it will be necessary to carry out periodic courses to maintain the qualifications for teaching.

This need is already contemplated by the current regulation. In Italy it is foreseen every two years (UK, 4 years[13]), but it should obviously integrate the new training needs related to CAV technology.

At specific times, depending on technological progress, it may be necessary to intensify this activity, anticipating its deadline and/or increasing the hours to be dedicated.

[13] Currently within the UK there is no legislation mandating ongoing instructor training. At this present time driving instructors within the UK just need to renew their licence to teach every 4 years.

5 What can other stakeholders do regarding safety and adoption of technology?

As training represents only one part of the solution, other stakeholders can also have a role in ensuring drivers adopt CAV technologies.

In this chapter we present some requests that should be made to these other stakeholders involved in the matter, aimed at the acceptance and correct use of on-board technologies, and safety.

The stakeholders referred to below are the manufacturers, the legislator, and the notifying bodies.

5.1 Manufacturers and legislators

5.1.1 Standardization of warnings and alarms

To assist with the delivery of training across the member countries and ensure ease of interpretation of the systems by all drivers, it is considered necessary that all warning lights and acoustic warnings relating to driving systems, even if only partially automated, must be uniquely identified for all vehicles and for all countries of the European community.

To allow a timely and unequivocal recognition of alert by a driver, acoustic warnings related to anomalies or warnings relating to automated driving systems should overwhelm any other sound inside the vehicle and should identify specific critical issues. As seen during the HSS experiments, some drivers were not fully aware of the meaning of alerts which negatively impact their driving performance and safety.

The same considerations are also valid for the warning lights and visual warnings relating to automated driving systems.

To summarize, a normalization of every type of warning will 1. Ease the design of training content which will be compliant with every EU warning system 2. allow the driver to be able to correctly manage any critical situations when using automated driving systems on any vehicle that is on the road, even if rented in other EU countries other than the one in which he has been licensed to drive.

5.1.2 Normalization of Head-Up Technology assisted by Augmented Reality

From the tests carried out, it emerged how important a correct reading of the context – awareness – is. It was already the case with non-CAV but it's even more true when attention is needed to safely respond to an Alert coming from a CAV which works on autonomous mode.

Regarding the post-driving questionnaires, it's interesting to see that despite unsafe driving behaviour (lack of mirror checks, low speed limit compliance, etc), only few drivers rate the screen layout, the ease to interact with the CAV screen, its size, were not optimal. For example, according to some UK sample results, out of 33 answers14 to the question dedicated to "visuals and layout", only 8 considered that the screen layout, the ease to interact with the CAV screen and its size was "not all good". Meaning also that 25 drivers ranked positively these elements (either sufficient or good).

As already proven in the literature dealing with the low ability of unskilled people to recognize their incompetence[15], some low-competent CAV drivers might not be the best judge of the (in)efficacy of a system they use.

Complimentary to existing Adas, Head-up technology, supported by Augmented Reality (AR), should become a standard feature of every vehicle.

This new technology could act as an intermediary to present information as part of an immersive experience, keeping the driver's eyes on the road and not on a secondary display on the dashboard (as in the HSS). An example of this technology is displayed in the figure 28 below.

[14] This limited number of datapoints was chosen to compare fully filled questionnaires.
[15] Kruger, Justin & Dunning, David. (2000). Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments. Journal of Personality and Social Psychology. 77. 1121-34. 10.1037//0022-3514.77.6.1121.

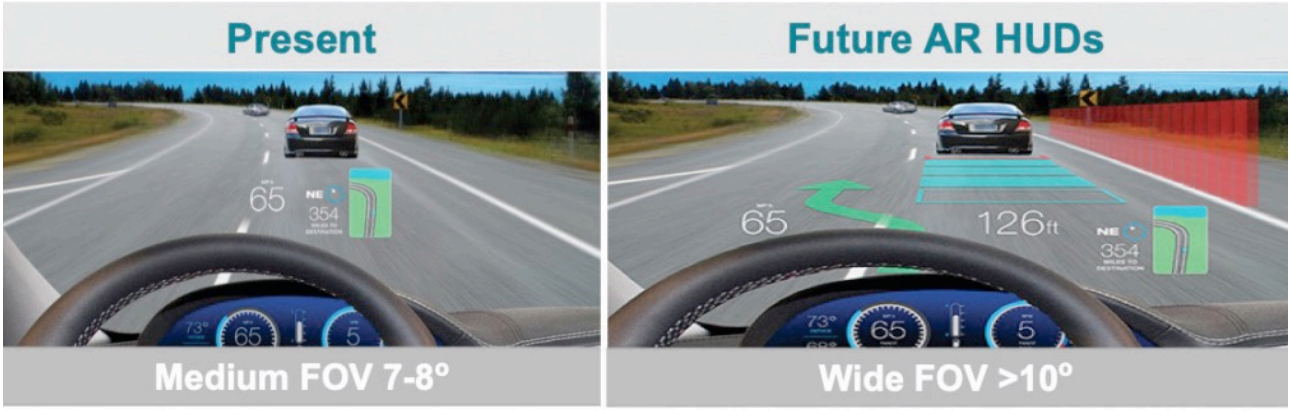

Figure 28 Current HeadUpDisplay and future HeadUpDisplay with AR allowing a wider Field of view (Firth, 2019)

New sensors capable of measuring depth provide more accurate information about objects in the environment (Langheim et al. 2001). AR can provide a natural way to convey spatio-temporal information aligned with the moving positions of objects relative to the driver's self-centred view. AR can display navigation aids which directly show routes in the driver's view (Frohlich et al., 2010; Harkin et al., 2005).

In addition to better awareness for “normal” drivers, (older) drivers with impaired vision (Wood and Troutbeck, 1994) could also benefit of an increase of relevance of important elements in the driver's view.

5.1.3 Dissemination of information relating to the operation of the technologies used for the Autopilot feature

It is considered appropriate that each manufacturer, at first, highlights in a special logbook, all the Adas installed, their specific operation and their criticalities (e.g.: reading angle of the anti-collision radar, maximum operating speed, etc).

This phase must be followed by a phase of homogeneity of the systems for which each vehicle must be equipped with driving aid systems with the same technical and operating characteristics. This homogenization will allow the realization of generic training content and consequently facilitate the training the use of identical on-board systems: Adas, warning lights, alarms, etc. This homogenization will produce greater safety linked to a greater awareness of

vehicle operation and a reduction in the risks associated with the recognition of any critical situations highlighted by warning lights and alarms.

5.2 Legislators and Notifying bodies

5.2.1Design a rating scale for Adas and Autopilot systems

In the United States, the number of accidents caused by the malfunction or misuse of partially autonomous driving systems by the driver is growing rapidly[16]. For this reason, the Insurance Institute for Highway Safety (IIHS), an organization financed by insurance companies with the aim of reducing road collisions and the number of injuries, a body comparable to the Euro NCAP, is developing a new classification program that evaluates safety measures partially automated vehicles use to help drivers stay focused on the road.

The system will use the same ratings of the resistance tests and the assigned ratings will be good, acceptable, marginal, poor.

To earn a good rating, the safety systems will need to make sure that the driver's eyes are directed towards the road and that their hands are on the wheel or ready to grab it at all times.

Increasing alarms and adequate emergency procedures will also be required if the driver does not meet these conditions. The IIHS plans to issue the first round of assessments in 2022.

IIHS President David Harkey states that:

“Partial automation systems may make long journeys seem cheaper, but there is no evidence that they make driving safer. In fact, it could be the other way around if the systems don't have adequate safeguards”.

The IIHS says these tests are not designed to assess the effectiveness of an advanced driver assistance system, but rather how well they monitor driver engagement. In fact, all partially automated vehicles available today require

16 https://www.repubblica.it/motori/sezioni/attualita/2022/01/26/news/sicurezza_sott_esame-335234708/?__vfz=medium%3Dsharebar

active supervision from the driver, which consists of monitoring how well the automation is doing its tasks and always being ready to take over if something goes wrong. Therefore, according to the IIHS, the driver monitoring system should not only use multiple types of alerts to remind the driver to look at the road and get their hands back, but those alerts should start and intensify quickly.

Furthermore, if the driver does not respond satisfactorily to the vehicle's requests, the system should slow down and stop the car safely and, once this condition occurs, it should prevent the use of the autopilot systems for the rest of the gear.

No vehicle should allow the use of its advanced driver assistance systems even if the seat belt is unfastened. The IIHS specifies that although most partial automation systems on the market today, from Autopilot, to Pilot Assist and Super Cruise, have some safeguards to ensure that drivers are focused and ready, for example using cameras, radar or other sensors to "see" the road, but none of them meet all the criteria proposed in this new series of tests.

This statement concerns partially automated vehicles circulating in the United States, but which could very probably also refer to those marketed in Europe.

Also, in the light of the above, we therefore believe that it is essential to adopt similar evaluation criteria also for the European Community, which help the drivers of tomorrow to make an informed choice when buying a vehicle, as is already the case for as regards the ability of a car to protect occupants and other road users in case of collision.

5.2.2Legislator / Training Centers

As mentioned in section 3.6.1, the space intended for driver training exercises must be equipped to recreate those situations in which the automated driving systems can pass from an ideal operating situation to a critical situation.

Specific automated driving paths should then be defined to recreate the previously analysed scenarios experienced in simulated driving.

A first experimentation of this specific training area is foreseen in the PAsCAL project within WP6, with the creation of "Pilot 2" (results to be written within WP6.2).

The exercises hypothesized to date have been built by virtue of the current driving aid technology, present on the most advanced vehicles on the market.

5.2.3 Mandatory initial training for driving CAV vehicles with periodic reminders

Legislators can further assist by writing into law the requirement for mandatory initial training for driving CAV vehicles with the associated need for periodic reminders (see sections 4.2 and 5).

5.2.4 Identification of protected areas for training in the use of CAVs

As already mentioned in section 3.6.1, the first space to be taken into consideration for carrying out this type of training is the systems destined for "Safe Driving". In fact, these structures offer both the adequate spaces for a safe test, and the surfaces and technologies necessary to recreate the dynamics that a vehicle would have at higher speeds, even at low speed (and therefore safely).

Keep in mind that in structures such as safe driving centres, as well as partially done for pilot 2 of WP6, it will be possible, if necessary, to recreate urban settings with intersections, roundabouts, bus stops etc.

Therefore, an ideal set-up for performing this type of test is described in the figure 29 below.

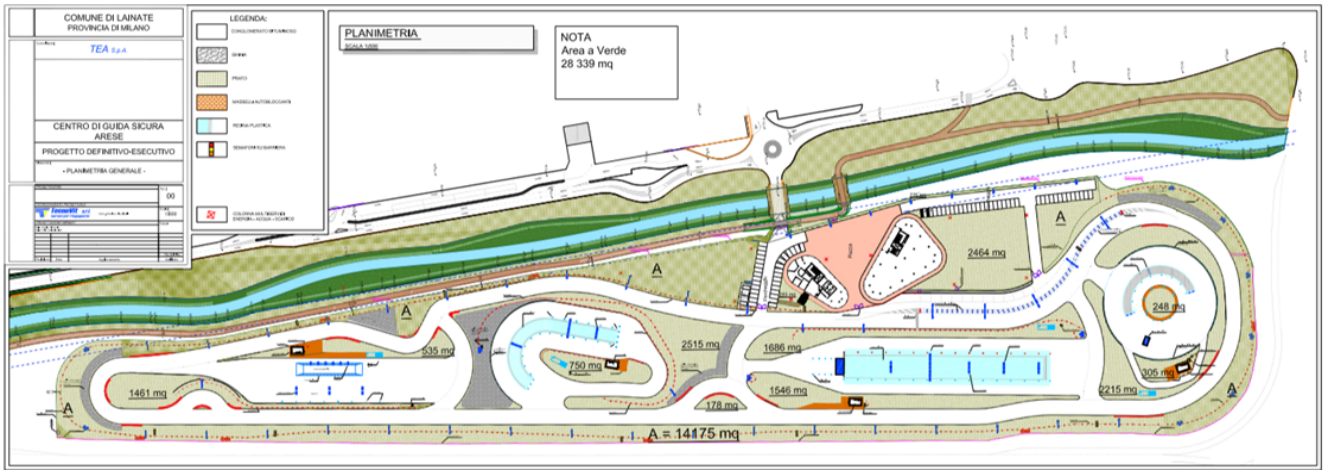

Figure 29 planimetry of ACI Safe Driving Centre in Lainate (Milan)

Track:

Track length without using both chicanes: 1,436.5 metres.
Track length with use of both chicanes: 1,450.5 metres.
Track length using 1st chicane: 1,447.5 m metres
Track length with 2nd chicane use: 1,444.1 metres.
Maximum straight length: 437 metres.
North hairpin bend radius (c / o aquaplaning area): 14.65 metres
South hairpin bend radius (c / o steering area): clockwise. First beam 44.5 metres. Second beam 50.5 metres.
Track width: constant 9 metres.

Safe Driving Area:

Resin wheelhouse: 396.6 m2 + 16.40 m2 with motorbike plate
Back resins: 737.5 m2
Slide / truck resins: 1916.15 m2.
Length of exercise areas:
Wheelhouse: external radius 32.5 m or Bump: 206.60 m of development of which 38 m on resins in a straight slope and 49.9 m on resins in curves o Slide / truck: 198.5 metres of total length of which 115.5 metres on resin or Aquaplaning: 162.9 m

6 Conclusion

In total, despite the challenges encountered in WP5 due to the pandemic situation (see appendix 8.9), 354 people experienced the simulation-based training sessions in Italy and UK. 199 unique simulator test runs were recorded UK and 230 unique simulator test runs were recorded in Italy.

The main findings that emerged from these tests are:

- findings from observation:

- Within the urban environment, experienced drivers, tended not to rely on driver assistance systems, rather anticipating possible critical situations (intervention before the alert) and thus not exploiting the possible benefits of the CAV system.
- During the simulations with the CAV lv4 vehicle, driving schools involved with the HSS trial observed many participants (of all categories equally), having some difficulty in regaining control of the vehicle in time.
- Novice drivers tended to demonstrate on the one hand, a greater propensity to rely on driving automation (unlike an experienced driver). However, on the other hand, novice drivers seemed to have a difficulty in the timely evaluation of possible critical situations combined with a lack of confidence in implementing the correct interactions with the vehicle controls to continue driving the vehicle safely. Although it should be noted that results were mixed or not statistically significant in terms of data collected.
- Simulated driving alone could lead to an underestimation of the risks associated with certain driving behaviours and could, in isolation, also lead to the acceptance of incorrect and potentially dangerous behaviours, which if not denied and corrected through practical exercises with real cars, could consolidate bad habits with serious consequences on public roads. Rather, following a period of simulator-based training and to complete the preparation of the L3 and 4 CAV driver, practical training is also required to be carried out in a "safe area” closed to traffic, where to test the Adas and emergency manoeuvres, should the system ask to

regain control. This should be followed with a period of supervised practice on public roads to complete the process.

- finding from the Home Study Simulator telemetry data and questionnaires

- Results from the analysis of the HSS telemetry data are not conclusive probably because of the small sample sizes and the high intra-individual variability which was higher than the inter-individual variability.
- Results from the HSS questionnaire (pre- and post-driving session) are mixed. Despite several variables that did not reach significance level, on average, the overall confidence after a CAV experience seems to be quite good. If it may help to ease acceptance, it is not a guarantee to safe driving.
- In any case, as lack of confidence, distraction, and more generally limited safety (despite trust feelings felt by some drivers) have been observed by driving instructors and sometimes confirmed by objective data, it is needed to consider that CAV driving can be challenging for any type of drivers. Whatever their nationality, their age, their gender, their CAV experience, their initial (before driving a CAV) confidence in CAVs, their post-driving CAV confidence, there are some individuals that cannot avoid extensive training. Either from a theoretical and from a practical (simulator and real CAV) point of view. Despite promising CAV technologies, the current CAV technologies and related ADAS are not yet a guarantee to overcome competency, cognitive and affective limitations of drivers, training and new investigation are for sure needed.

- complementary needs dedicated to different driver categories:

- In order to maintain a good ability to manage vehicles in all conditions, both ideal and critical, and to be able to correctly follow the technological evolution of automated driving systems, it is advisable to provide a training cycle for professional drivers envisaged as a mandatory 8-hour training per cycle (every 5 years) which could include a blend of theoretical, simulator based and practical driver training modules.

- Further it would be advisable to provide a first compulsory training cycle to experienced drivers when it will be possible to circulate with CAV vehicles of L3 or higher on public roads once this becomes legal in each of the member countries. To be provided to experienced drivers when first purchasing a L2 CAV or higher-level CAV and should follow what has already been foreseen for Novice Drivers (see D5.2 section 2.2.2).
- Trainers and instructors of the driving schools will represent the first category of driver who will need training. They need to acquire the necessary skills to be able to train the other types of drivers. As previously mentioned, the basic training for trainers must include what has already been described for novice drivers, as well as what is provided for experienced and professional drivers. In addition to the abovementioned skills, trainers should dedicate an additional number of hours (recommended 30), aimed at training the correct driver training techniques and knowledge related to the use of CAVs in public areas.

- requests to other stakeholders:

- In order to assist with the delivery of training across the member countries and ensure ease of interpretation of the systems by all drivers, it is considered necessary that all warning lights and acoustic warnings relating to driving systems, even if only partially automated, must be uniquely identified for all vehicles and for all countries of the European community.
- From the tests carried out, it emerged how important a correct reading of the context – awareness – is. It was already the case with non-CAV but it's even more true when attention is needed to safely respond to an Alert coming from a CAV which works on autonomous mode. Complimentary to existing Adas, Head-up technology, supported by Augmented Reality (AR), should become a standard feature of every vehicle. This new technology could act as an intermediary to present information as part of an immersive experience, keeping the driver's eyes on the road and not on a secondary display on the dashboard (as in the HSS).
- It is considered appropriate that each manufacturer, at first, highlights in a special logbook, all the Adas installed, their specific operation and their criticalities (e.g.: reading angle of the anti-collision radar, maximum

operating speed etc. ...) followed by a phase of homogeneity of the systems for which each vehicle must be equipped with driving aid systems with the same technical and operating characteristics. This homogenization will allow the realization of a common didactic and the awareness for the driver that the operation of the on-board systems is identical to each car he drives: Adas, warning lights, alarms etc.

- We recommend that the European Community adopt a rating scale for Adas and Autopilot systems similar to a model currently being designed by the US equivalent of Euro NCAP, which could help the drivers of tomorrow to make an informed choice when buying a vehicle, as is already the case for as regards the ability of a car to protect occupants and other road users in case of collision.

Findings from the work and activities done in WP5 will be incorporated as a series of dedicated recommendations in the Guide to autonomy developed in WP8. The same will apply for the results of training activities from the PAsCAL's sister projects[17] with which discussions and synergies are underway to contribute to feeding the Guide to Autonomy.

[17] https://www.suaave.eu/, https://h2020-trustonomy.eu/ , https://www.drive2thefuture.eu/

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8 Appendix

8.1 Excerpt of descriptive statistics of the UK and Italian sample

8.1.1 Uk Sample

Table 2 Gender statistics

		Frequency	Percent
Valid		1	1,6
	Male	37	59,7
	Female	21	33,9
	Other	1	1,6
	Prefer not to say	2	3,2
	Total	62	100,0

Table 3 Age statistics

		Frequency	Percent	Cumulative Percent
Valid	N/A	1	1,6	1,6
	18-25	24	38,7	40,3
	26-36	10	16,1	56,5
	37-47	12	19,4	75,8
	47-57	13	21,0	96,8
	More than 57	2	3,2	100,0
	Total	62	100,0	

Table 4 Q5a - Were you a passenger or/and a driver in the Connected and Automated Vehicle (CAV)?

		Frequency	Percent	Cumulative Percent
Valid	N/A	7	11,3	11,3
	A driver	12	19,4	30,6
	A passenger	5	8,1	38,7
	both	19	30,6	69,4
	N/A	19	30,6	100,0
	Total	62	100,0	

Table 5 Q5b - How many times have you ever used a CAV?

		Frequency	Percent	Cumulative Percent
Valid		8	12,9	12,9
	N/A	8	12,9	25,8
	Never	13	21,0	46,8
	Occasionally	17	27,4	74,2
	Rarely	10	16,1	90,3
	Systematically	6	9,7	100,0
	Total	62	100,0	

Table 6 Q7 - Do you regularly use a smartphone or a computer?

		Frequency	Percent	Cumulative Percent
Valid	N/A	1	1,6	1,6
	Yes	61	98,4	100,0
	Total	62	100,0	

Table 7 Q7b - Do you use one or several of the following applications?

		Frequency	Percent	Cumulative Percent
Valid	["No, I don't"]	6	9,7	9,7
	["Public transport application", "Routing and guidance application"]	2	3,2	12,9
	["Public transport application"]	2	3,2	16,1
	["Routing and guidance application", "Public transport application"]	18	29,0	45,2
	["Routing and guidance application", "Shared mobility application"]	3	4,8	50,0
	["Routing and guidance application"]	25	40,3	90,3
	["Shared mobility application"]	1	1,6	91,9
	N/A	5	8,1	100,0
	Total	62	100,0	

Table 8 Q8 - Do you have a full driving license?

		Frequency	Percent	Cumulative Percent
Valid	N/A	1	1,6	1,6
	["None"]	20	32,3	33,9

	["Valid for both, cars and motorcycles (A-B)", "Valid for trucks (C)"]	3	4,8	38,7
	["Valid for both, cars and motorcycles (A-B)"]	7	11,3	50,0
	["Valid for cars (Type B)"]	29	46,8	96,8
	["Valid for trucks (C)"]	2	3,2	100,0
	Total	62	100,0	

Table 9 Q9 - How long have you owned a full driving license?

		Frequency	Percent	Cumulative Percent
Valid	NA	1	1,6	1,6
	1-5 years	9	14,5	16,1
	10-15 years	2	3,2	19,4
	15+ years	24	38,7	58,1
	5-10 years	5	8,1	66,1
	I don't have one	21	33,9	100,0
	Total	62	100,0	

Table 10 Q10 - What educational level do you have?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		1	1,6	1,6	1,6
	A levels, high school diploma or other university entrance qualification	13	21,0	21,0	22,6
	Advanced Vocational Certificate of Education, vocational baccalaureate diploma, technical diploma	11	17,7	17,7	40,3

	Completed apprenticeship	4	6,5	6,5	46,8
	Elementary or lower secondary school qualification	1	1,6	1,6	48,4
	Middle School, High School or Secondary School or equivalent qualification	6	9,7	9,7	58,1
	Polytechnic degree, university of applied sciences degree, other university degree	16	25,8	25,8	83,9
	School finished without school leaving certificate	4	6,5	6,5	90,3
	Still at school	6	9,7	9,7	100,0
	Total	62	100,0	100,0	

Table 11 Q11 - What is your monthly net income approximately?

		Frequency	Percent	Cumulative Percent
Valid	N/A	1	1,6	1,6
	€ 1000 to under € 2000	9	14,5	16,1
	€ 2000 to under € 3000	16	25,8	41,9
	€ 250 to under € 1000	8	12,9	54,8
	€ 3000 to under € 5000	6	9,7	64,5
	€ 5000 and over	3	4,8	69,4
	I do not want to answer that	10	16,1	85,5
	less than € 250	9	14,5	100,0
	Total	62	100,0	

Table 12 Q12 - Which is your current occupation?

		Frequency	Percent	Cumulative Percent
Valid	N/A	1	1,6	1,6
	Currently not employed	1	1,6	3,2
	Full-time work (over 30 h a week)	34	54,8	58,1
	Other	4	6,5	64,5
	Part-time work (30 h per week or less)	5	8,1	72,6
	Student	17	27,4	100,0
	Total	62	100,0	

Table 13 Q12a - How often do you travel to work or to your place of education?

		Frequency	Percent	Cumulative Percent
Valid		2	3,2	3,2
	2-6 times per week	25	40,3	43,5
	Everyday	22	35,5	79,0
	Less than once a week	4	6,5	85,5
	More often than once a day	3	4,8	90,3
	N/A	3	4,8	95,2
	Once a week	3	4,8	100,0
	Total	62	100,0	

Table 14 Q13 (first session) How did you feel while traveling in a CAV?

		Frequency	Percent	Cumulative Percent
Valid	Trustful	5	8,1	8,1
	Careful	12	19,4	27,4
	Insecure	8	12,9	40,3
	Safe	14	22,6	62,9
	Nervous	10	16,1	79,0
	Curious	11	17,7	96,8
	Critical	1	1,6	98,4
	Unaffected	1	1,6	100,0
	Total	62	100,0	

Table 15 Q13 (last session) How did you feel while traveling in a CAV?

		Frequency	Percent	Cumulative Percent
Valid	Trustful	11	17,7	30,6
	Careful	7	11,3	50,0
	Insecure	4	6,5	61,1
	Safe	4	6,5	72,2
	Nervous	6	9,7	88,9
	Curious	1	1,6	91,7
	Critical	2	3,2	97,2
	Unaffected	1	1,6	100,0
	Total	36	58,1	
Missing	System	26	41,9	
Total		62	100,0	

Table 16 Q23c – Confidence in CAV when changing modes?

		Frequency	Percent	Cumulative Percent
Valid	Yes	40	64,5	65,6
	No	21	33,9	100,0
	Total	61	98,4	
Missing	System	1	1,6	
Total		62	100,0	

8.1.2Italian sample

Table 17 Gender statistics

		Frequency	Percent	Cumulative Percent
Valid	Male	100	76,3	76,3
	Female	28	21,4	97,7
	Male	1	,8	98,5
	Prefer not to say	2	1,5	100,0
	Total	131	100,0	

Table 18 Age statistics

		Frequency	Percent	Cumulative Percent
Valid	18-25	35	26,7	26,7
	26-36	5	3,8	30,5
	37-47	26	19,8	50,4
	47-57	50	38,2	88,5

	More than 57	15	11,5	100,0
	Total	131	100,0	

Table 19 Q5a - Were you a passenger or/and a driver in the Connected and Automated Vehicle (CAV)?

		Frequency	Percent	Cumulative Percent
Valid		16	12,2	12,2
	Passenger	45	34,4	46,6
	Driver	26	19,8	66,4
	Driver and passenger	20	15,3	81,7
	N/A	24	18,3	100,0
	Total	131	100,0	

Table 20 Q5b - How many times have you ever used a CAV?

		Frequency	Percent	Cumulative Percent
Valid	N/A	31	23,7	23,7
	Never	23	17,6	41,2
	Occasionally	29	22,1	63,4
	Only once	20	15,3	78,6
	Rarely	18	13,7	92,4
	Systematically	10	7,6	100,0
	Total	131	100,0	

Table 21 Q7 - Do you regularly use a smartphone or a computer?

		Frequency	Percent	Cumulative Percent
Valid	Yes	119	90,8	90,8
	No	11	8,4	99,2
	N/A	1	,8	100,0
	Total	131	100,0	

Table 22 Q7b - Do you use one or several of the following applications?

		Frequency	Percent	Cumulative Percent
Valid	N/A	18	13,7	13,7
	No, I don't	7	5,3	19,1
	Public transport application	4	3,1	22,1
	Public transport application and Routing and guidance application	12	9,2	31,3
	Routing and guidance application	80	61,1	92,4
	Routing and guidance application and Shared mobility application	4	3,1	95,4
	Routing and guidance application and Shared mobility application and Public transport application	5	3,8	99,2
	Shared mobility application and Public transport application	1	,8	100,0
	Total	131	100,0	

Table 23 Q8 - Do you have a full driving license?

		Frequency	Percent	Cumulative Percent
Valid	N/A	6	4,6	4,6
	No permit	17	13,0	17,6
	Moto	8	6,1	23,7
	Cars	51	38,9	62,6
	Cars and motos	14	10,7	73,3
	Truck	35	26,7	100,0
	Total	131	100,0	

Table 24 Q9 - How long have you owned a full driving license?

		Frequency	Percent	Cumulative Percent
Valid	No licence	18	13,7	13,7
	1-5years	18	13,7	27,5
	15+ years	1	,8	28,2
	5-10years	2	1,5	29,8
	10-15years	4	3,1	32,8
	15+years	88	67,2	100,0
	Total	131	100,0	

Table 25 Q10 - What educational level do you have? Please choose the highest educational qualification you have achieved so far

		Frequency	Percent	Cumulative Percent
Valid	School finished without certificate	1	,8	,8
	Still at school	19	14,5	15,3
	Elementary or lower secondary school	15	11,5	26,7
	Middle school, High or secondary or equivalent	46	35,1	61,8
	Advanced Vocational Certificate of Education, vocational baccalaureate diploma, technical diploma	3	2,3	64,1
	A levels, high school diploma or other university entrance qualification	2	1,5	65,6
	Polytechnic degree, university of applied sciences degree, other university degree	41	31,3	96,9
	N/A	4	3,1	100,0
	Total	131	100,0	

Table 26 Q11 - What is your monthly net income approximately?

		Frequency	Percent	Cumulative Percent
Valid	€ 1000 to under € 2000	8	6,1	6,1
	€ 2000 to under € 3000	6	4,6	10,7
	€ 3000 to under € 5000	3	2,3	13,0

	€ 5000 and over	3	2,3	15,3
	I do not want to answer that	89	67,9	83,2
	less than € 250	6	4,6	87,8
	N/A	16	12,2	100,0
	Total	131	100,0	

Table 27 Q12 - Which is your current occupation?

		Frequency	Percent	Cumulative Percent
Valid	Currently not employed	3	2,3	2,3
	Full-time work (over 30 h a week)	77	58,8	61,1
	Other	10	7,6	68,7
	Part-time work (30 h per week or less)	5	3,8	72,5
	Retired	6	4,6	77,1
	Student	30	22,9	100,0
	Total	131	100,0	

Table 28 Q12a - How often do you travel to work or to your place of education?

		Frequency	Percent	Cumulative Percent
Valid	2-6 times per week	16	12,2	12,2
	Everyday	93	71,0	83,2
	Less than once a week	2	1,5	84,7
	More often than once a day	4	3,1	87,8
	N/A	15	11,5	99,2

	Once a week	1	,8	100,0
	Total	131	100,0	

Table 29 Q13 (first session) - How did you feel while traveling in a CAV?

		Frequency	Percent	Cumulative Percent
Valid	Trustful	62	47,3	47,3
	Careful	14	10,7	58,0
	Insecure	11	8,4	66,4
	Safe	16	12,2	78,6
	Nervous	7	5,3	84,0
	Curious	12	9,2	93,1
	Critical	4	3,1	96,2
	Unaffected	5	3,8	100,0
	Total	131	100,0	

Table 30 Q13 (last session) - How did you feel while traveling in a CAV?

		Frequency	Percent	Cumulative Percent
Valid	Trustful	36	27,5	67,9
	Careful	3	2,3	73,6
	Insecure	2	1,5	77,4
	Safe	4	3,1	84,9
	Nervous	2	1,5	88,7
	Curious	6	4,6	100,0
	Total	53	40,5	

Missing	System	78	59,5	
Total		131	100,0	

Table 31 Q23c – Confidence in CAV when changing modes?

		Frequency	Percent	Cumulative Percent
Valid	N/A	9	6,9	6,9
	No	22	16,8	23,7
	Yes	100	76,3	100,0
	Total	131	100,0	

8.2 Guidelines for containing Covid 19 while using the HSS in Italy

Trainers are required to:

- Provide for the measurement of the learner's body temperature.
- Record the personal data (name, surname, email, telephone number) of the learner for the purpose of tracking in case of contagion.
- Provide the learner with personal protective equipment.
- For the common use of the simulator, the trainer provides cleaning procedures with suitable products, providing the simulator with a sanitation kit and arranging the appropriate ventilation between one test and the next.
- A minimum distance of at least 1 meter must be guaranteed between the teacher and the learner.
- A maximum of one learner can board the simulator.
- The learner must, immediately before boarding the simulator, disinfect their hands with hydroalcoholic sanitizing liquid, in order to minimize the risk of surface contamination.
- At the end of each test and in any case whenever the user has changed, the simulator and shared objects and tools must be cleaned. (keyboard, mouse etc)

- During the simulation the learners must wear the surgical mask or ffp2- During the simulations, learners waiting for their turn will have to stay in an organized environment avoiding the crowd of people. It will be the responsibility of each operator to keep up to date and comply with all present and future regulations regarding the methods to avoid contagion from Covid-19

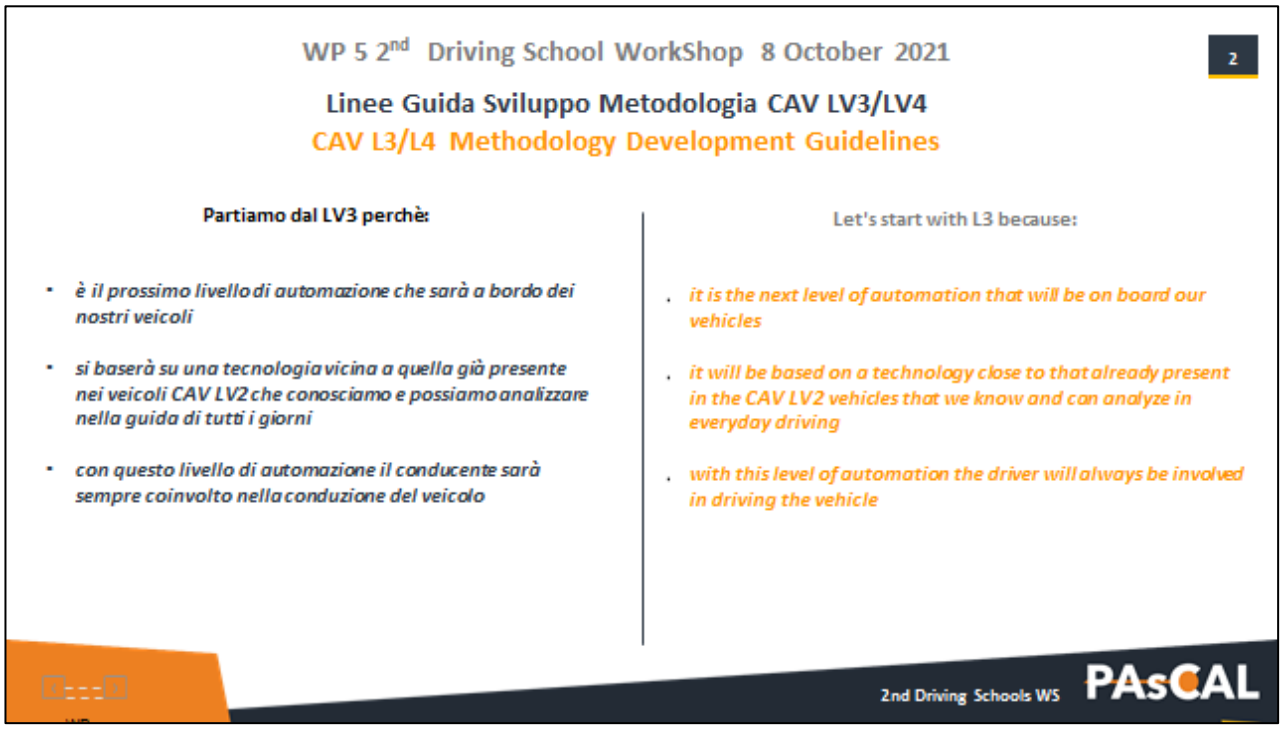
8.3 Red Covid 19 safe protocol

A short COVID-Safe questionnaire will be asked before starting:

- Have you had any symptoms of COVID in the last 14 days?
- In the last 14 days have you had any close proximity to anyone experiencing COVID symptoms?
- In the last 14 days have you had any close proximity to anyone who has tested positive for COVID?
- Have you been tested for COVID in the last 14 days? If so, what were the results?
- ***Any symptoms, close contact or positive test within the last 14 days, the driver will be turned away.***

- Each workstation, steering wheel, controls, door handles and worktop area will be cleaned with antibacterial and antiviral wipes between drivers
- Drivers will be asked to use antibacterial gel and/or wash their hands before entering the room
- Appropriate face-coverings should be worn by all throughout
- Good airflow will be maintained throughout the building
- Good social distancing should be maintained throughout
- Warning posters advising to keep your distance and wear a mask will be in place and policies by the facilitator/trainer; those not in compliance will be asked to leave the premises
- Existing fire exit processes will remain in place
- Communal facilities have their own control measures
- The room should have no more than the maximum number of people it is always approved for.

8.4 ACI Workshop: guidelines for the development of the teaching methodology for driving CAV 3-4 vehicles



Linee Guida Sviluppo Metodologia CAV LV3/LV4
CAV L3/L4 Methodology Development Guidelines

3

CAV LV3

Quando usare l'Autopilot?

- Situazioni Ideali
- Situazioni critiche

Cosa dovremmo indagare per definire queste due macro condizioni?

- Come funziona la tecnologia impiegata a bordo dei veicoli

- Individuare capacità e limiti della sensoristica
- Analizzare il tema dei « Falsi Positivi »
- Spie e Avvisi
- Integrazione di altri sistemi di aiuto alla guida per facilitare il lavoro del conducente
(Tecnologia HEAD UP fondamentale per mantenere l'attenzione sulla strada)

CAV LV3

When to use Autopilot?

- Ideal Situations
- Critical situations

What should be investigated to define these two macro conditions?

- *How does* on board technology work

- Identify abilities and limits of sensors
- Analyse the topic of « False Positives »
- Warning lights and (acoustic) warnings
- Integration of other driving aid systems to facilitate the driver
(HEAD UP Technology essential to keep the attention on the road)

2nd Driving Schools WS PAsCAL

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CAV L3/L4 Methodology Development Guidelines

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CAV LV3

- *La responsabilità del Conducente*
  - Normativa
- *Le difficoltà connesse alla circolazione di veicoli con diversi livelli di automazione*
- *La capacità dei diversi tipi di conducenti di leggere il contesto stradale*
  - Patentandi
  - Neo Patentati
  - Esperti
  - Professionisti
- *La relazione tra Allarme -> Contesto Stradale -> Reazione del conducente*

CAV L3

- *Responsibility of the driver*
  - Regulations
- *Difficulties associated simultaneous circulation of vehicles with different automation levels*
- *Different drivers' abilities to read the road context*
  - Learner drivers
  - New licensed
  - Experts
  - Professional drivers
- *The connection between Alert -> Road Context -> Driver reaction*

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5

CAV LV3

Una volta che avremo la risposta alla domanda "Quando usare l'Autopilot?" andiamo a definire

- *Situazioni Ideali*

  Le Buone Pratiche durante l'uso dell'Autopilote

  - Posizione di Guida
  - Cosa osservare sulla strada
  - Consigli per mantenere alta l'attenzione

- *Situazioni critiche*

  Gestione delle situazioni critiche

  - Riconoscimento Tempestivo degli allarmi
  - Identificazione di una o più procedure da attuare in determinate situazioni
  - Come prevenirle

CAV L3

Once there is an answer to the question "When do we use Autopilot?" we will define

- *Ideal situations*

  Best Practices while using Autopilot

  - Driving position
  - What to observe on the road
  - Tips to maintain attention

- *Critical situations*

  Management of critical situations

  - Timely acknowledgment of warnings
  - Identification of one or more procedures to implement specific situations
  - How to prevent them

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CAV L3/L4 Methodology Development Guidelines

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CAV LV3

Il ciclo Formativo

Al momento possiamo immaginare che questa metodologia andrà ad integrare la normale didattica già prevista per legge.

In funzione di quanto emerso nel corso del Workshop precedente, dove abbiamo analizzato I primi risultati delle sperimentazioni con l'HSS, dovremmo dare alla metodologia un funzionamento circolare:

- ***Teoria***
- ***I° Ciclo di Addestramento al simulatore***
- ***Test Drive in area protetta e attrezzata***
- ***II° Ciclo di Addestramento al simulatore***
- ***Test Drive Finale***

CAV LV3

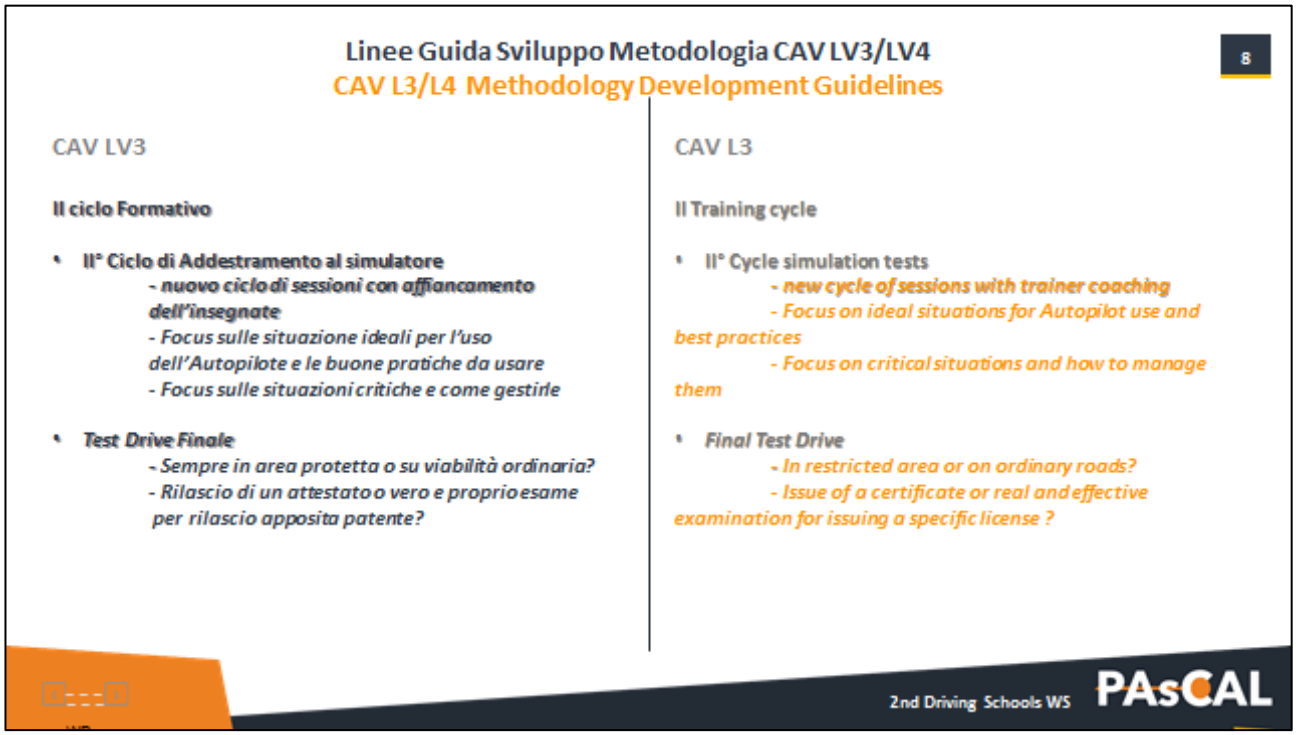
The Training Cycle

At this moment, we may suppose that this methodology will integrate the usual teaching provided for by existing regulations.

Basing on the results of the 1st Workshop, which analyzed the first results of tests with the HSS, methodology should be approached in a circular/cycling way:

- ***Theory***
- ***I° Cycle simulation tests***
- ***Test Drive in protected and equipped area***
- ***II° Cycle simulation tests***
- ***Final Test Drive***

2nd Driving Schools WS PAsCAL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CAV LV3
Il ciclo Formativo
II° Ciclo di Addestramento al simulatore
- nuovo ciclo di sessioni con affiancamento dell'insegnate
- Focus sulle situazione ideali per l'uso dell'Autopilote e le buone pratiche da usare
- Focus sulle situazioni critiche e come gestirle
Test Drive Finale
- Sempre in area protetta o su viabilità ordinaria?
- Rilascio di un attestato o vero e proprio esame per rilascio apposita patente?
CAV L3
II Training cycle
II° Cycle simulation tests
- new cycle of sessions with trainer coaching
- Focus on ideal situations for Autopilot use and best practices
- Focus on critical situations and how to manage them
Final Test Drive
- In restricted area or on ordinary roads?
- Issue of a certificate or real and effective examination for issuing a specific license ?
2nd Driving Schools WS
PAsCAL

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CAV L3/L4 Methodology Development Guidelines

9

QUESTION TIME

Dobbiamo usare differenze significative nell'approccio metodologico per le differenti tipologie di conducente?

- *Patentandi*
- *Neo Patentati*
- *Esperti*
- *Professionisti*

Quanto sarà Differente la metodologia per I CAV LV4?

Are there significant differences of methodological approach to different types of drivers?

- *Learner drivers*
- *Novice drivers*
- *Experienced drivers*
- *Professional drivers*

How much different will the CAV L4 methodology be?

Linee Guida Sviluppo Metodologia CAV LV3/LV4
CAV L3/L4 Methodology Development Guidelines

10

Cosa possono fare gli altri attori per noi?

Costruttori / Legislatore
- *Standardizzazione Spie, Avvisi e Allarmi*
- *Obbligo Uso Tecnologia HEAD UP*
- *Diffusione delle informazioni relative al funzionamento delle tecnologie utilizzate per l'Autopilota*

Legislatore / Ente Certificatore (EuroNCAP?)
- *Studiare una scala di valutazione per ADAS e Autopilote*

Legislatore / Centri di formazione
- *Istituzione Patente dedicata*
- *Richiami periodici per addestramento alla guida Manuale (da CAV4 in poi)*
- *Creazione Aree protette per l'addestramento all'uso dei CAV*

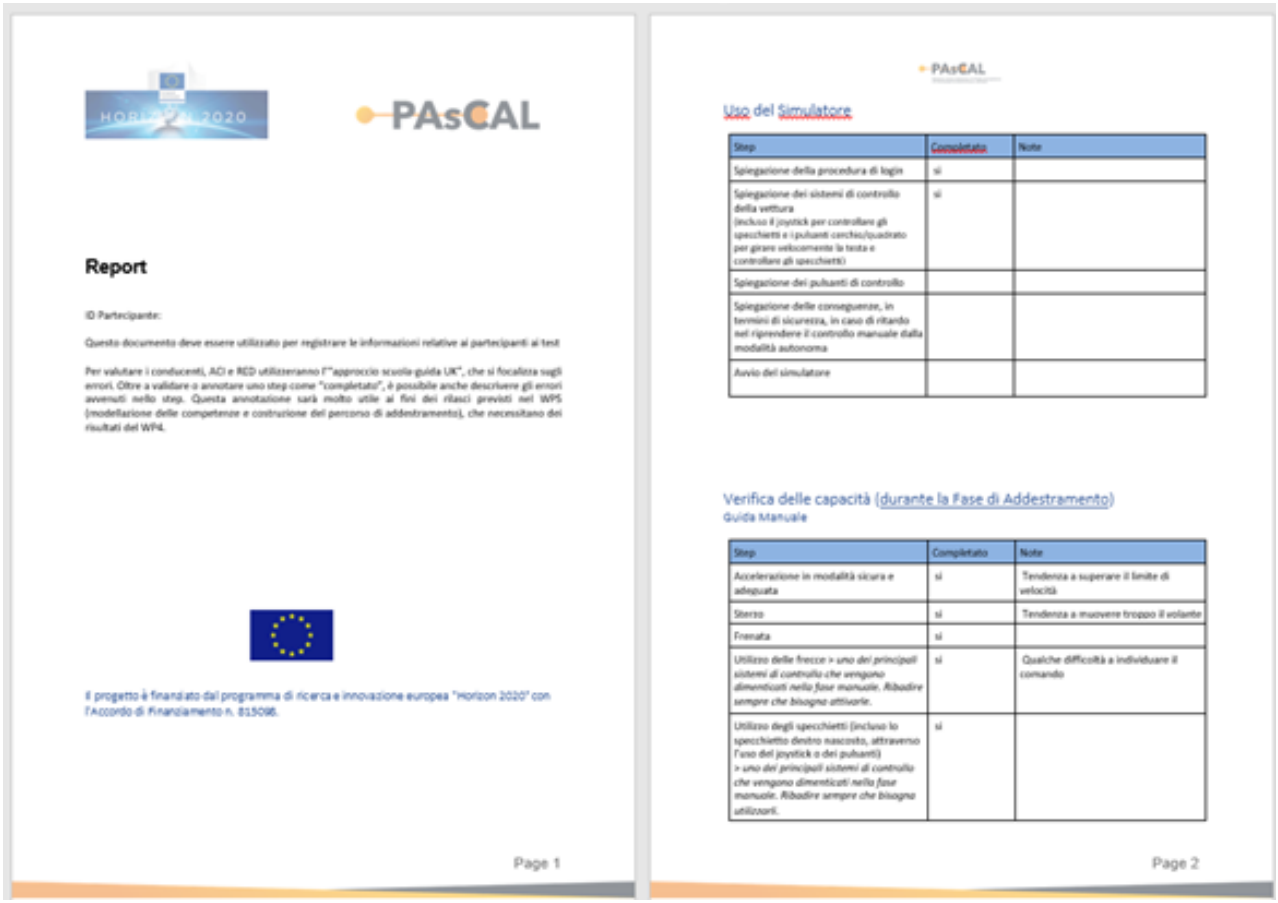
What can other actors/stakeholders do for us?

OEMs/ Decision-makers
- *Standardization of Indicators, Warnings, Alarms*
- *Obligation to Use HEAD UP Technology*
- *Dissemination of information on the functioning of technologies used for Autopilot*

Legislator / Certifying Bodies (EuroNCAP?)
- *Study a rating scale for ADAS and Autopilot*

Legislator / Training centers
- *Establishment of a dedicated License*
- *Periodic reminders for Manual driving training (from CAV4)*
- *Creation of restricted/protected areas for CAVs driving training*

FORM USED DURING THE TEST



Report

ID Partecipante:

Questo documento deve essere utilizzato per registrare le informazioni relative ai partecipanti ai test

Per valutare i conducenti, ACI e RCD utilizzeranno l'"approccio scuola-guida UK", che si focalizza sugli errori. Oltre a validare o annotare uno step come "completato", è possibile anche descrivere gli errori avvenuti nello step. Questa annotazione sarà molto utile ai fini dei rilasci previsti nel WP5 (modellazione delle competenze e costruzione del percorso di addestramento), che necessitano dei risultati del WP4.

Il progetto è finanziato dal programma di ricerca e innovazione europea "Horizon 2020" con l'Accordo di Finanziamento n. 815098.

Page 1

Uso del Simulatore

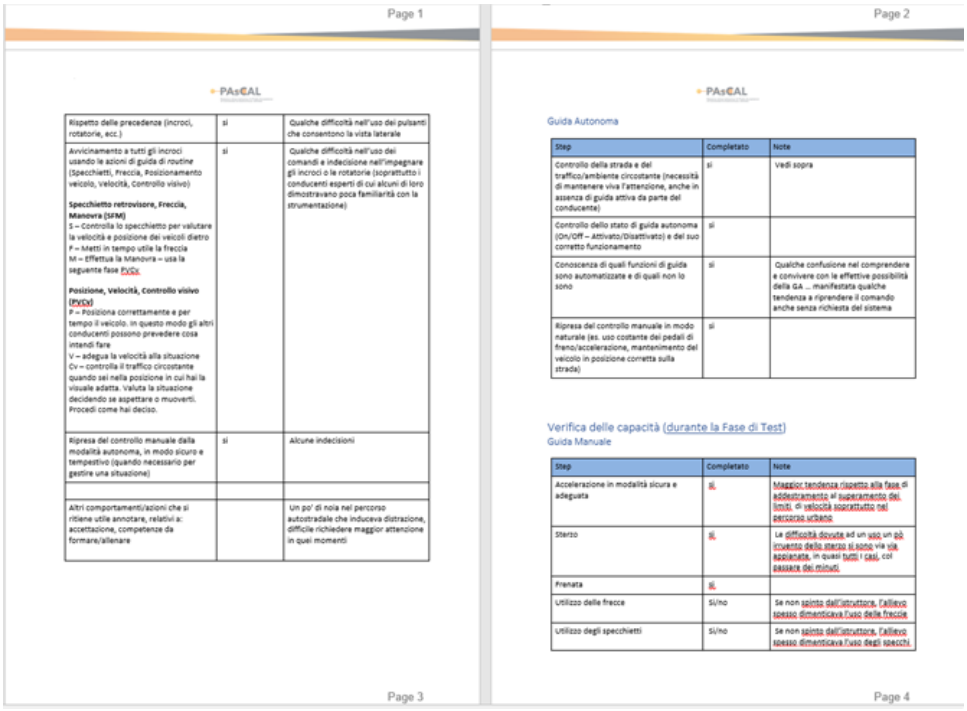
Step	Completato	Note
Spiegazione della procedura di login	si	
Spiegazione dei sistemi di controllo della vettura (incluso il joystick per controllare gli specchietti e i pulsanti cerchio/quadrato per girare velocemente la testa e controllare gli specchietti)	si	
Spiegazione dei pulsanti di controllo		
Spiegazione delle conseguenze, in termini di sicurezza, in caso di ritardo nel riprendere il controllo manuale dalla modalità autonoma		
Avvio del simulatore		

Verifica delle capacità (durante la Fase di Addestramento)

Guida Manuale

Step	Completato	Note
Accelerazione in modalità sicura e adeguata	si	Tendenza a superare il limite di velocità
Sterzo	si	Tendenza a muovere troppo il volante
Frenata	si	
Utilizzo delle frecce > *uno dei principali sistemi di controllo che vengono dimenticati nella fase manuale. Ribadire sempre che bisogna attivarle.*	si	Qualche difficoltà a individuare il comando
Utilizzo degli specchietti (incluso lo specchietto dietro nascosto, attraverso l'uso del joystick o dei pulsanti) > *uno dei principali sistemi di controllo che vengono dimenticati nella fase manuale. Ribadire sempre che bisogna utilizzarli.*	si	

Page 2



Rispetto delle precedenze (incroci, rotatorie, ecc.)	si	Qualche difficoltà nell'uso dei pulsanti che consentono la vista laterale
Avvicinamento a tutti gli incroci usando le azioni di guida di routine (Specchietti, Freccia, Posizionamento veicolo, velocità, Controllo visivo) **Specchietto retrovisore, Freccia, Manovra (SFM)** S – Controlla lo specchietto per valutare la velocità e posizione dei veicoli dietro F – Metti in tempo utile la freccia M – Effettua la Manovra – usa la seguente fase PVCv **Posizione, Velocità, Controllo visivo (PVCv)** P – Posiziona correttamente e per tempo il veicolo. in questo modo gli altri conducenti possono prevedere cosa intendi fare V – adegua la velocità alla situazione Cv – controlla il traffico circostante quando sei nella posizione in cui hai la visuale adatta. Valuta la situazione decidendo se aspettare o muoverti. Procedi come hai deciso.	si	Qualche difficoltà nell'uso dei comandi e indecisione nell'impegnare gli incroci o le rotatorie (soprattutto i conducenti esperti di cui alcuni di loro dimostravano poca familiarità con la strumentazione)
Ripresa del controllo manuale dalla modalità autonoma, in modo sicuro e tempestivo (quando necessario per gestire una situazione)	si	Alcune indecisioni
Altri comportamenti/azioni che si ritiene utile annotare, relativi a: accettazione, competenze da formare/allenare		Un po' di noia nel percorso autostradale che induceva distrazione, difficile richiedere maggior attenzione in quei momenti

Page 3

Guida Autonoma

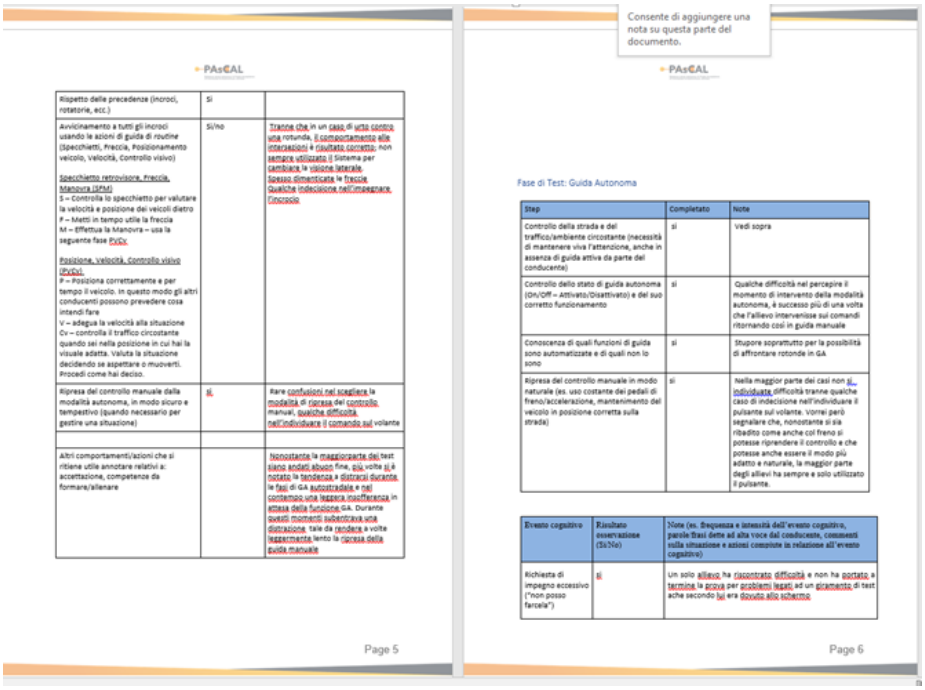
Step	Completato	Note
Controllo della strada e del traffico/ambiente circostante (necessità di mantenere viva l'attenzione, anche in assenza di guida attiva da parte del conducente)	si	Vedi sopra
Controllo dello stato di guida autonoma (On/Off – Attivato/Disattivato) e del suo corretto funzionamento	si	
Conoscenza di quali funzioni di guida sono automatizzate e di quali non lo sono	si	Qualche confusione nel comprendere e convivere con le effettive possibilità della GA ... manifestata qualche tendenza a riprendere il comando anche senza richiesta del sistema
Ripresa del controllo manuale in modo naturale (es. uso costante dei pedali di freno/accelerazione, mantenimento del veicolo in posizione corretta sulla strada)	si	

Verifica delle capacità (durante la Fase di Test)

Guida Manuale

Step	Completato	Note
Accelerazione in modalità sicura e adeguata	si	Maggior tendenza rispetto alla fase di addestramento al superamento dei limiti di velocità soprattutto nel percorso urbano
Sterzo	si	Le difficoltà dovute ad un uso un pò irruento dello sterzo si sono via via appianate, in quasi tutti i casi, col passare dei minuti
Frenata	si	
Utilizzo delle frecce	Si/no	Se non spinto dall'istruttore, l'allievo spesso dimenticava l'uso delle freccie
Utilizzo degli specchietti	Si/no	Se non spinto dall'istruttore, l'allievo spesso dimenticava l'uso degli specchi

Page 4



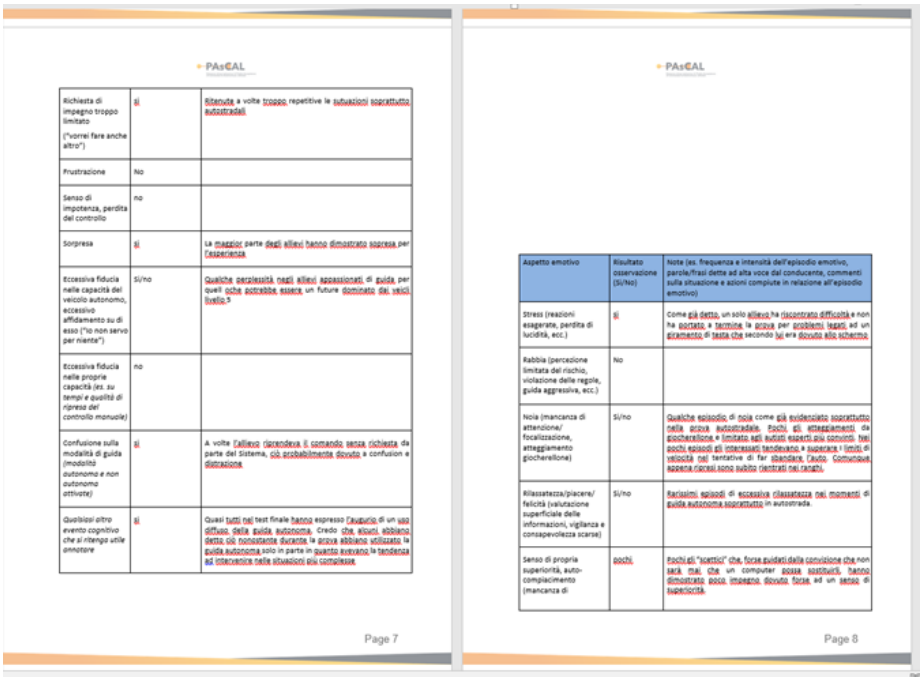
Rispetto delle precedenze (incroci, rotatorie, ecc.)	Si	
Avvicinamento a tutti gli incroci usando le azioni di guida di routine (Specchietti, Freccia, Posizionamento veicolo, Velocità, Controllo visivo) Specchietto retrovisore, Freccia, Manovra (SFM) S – Controlla lo specchietto per valutare la velocità e posizione dei veicoli dietro F – Metti in tempo utile la freccia M – Effettua la Manovra – usa la seguente fase PxCv Posizione, Velocità, Controllo visivo (PxCv) P – Posiziona correttamente e per tempo il veicolo. In questo modo gli altri conducenti possono prevedere cosa intendi fare V – adegua la velocità alla situazione Cv – controlla il traffico circostante quando sei nella posizione in cui hai la visuale adatta. Valuta la situazione decidendo se aspettare o muoverti. Procedi come hai deciso.	Si/no	Tranne che in un caso di urto contro una rotunda, il comportamento alle intersezioni è risultato corretto, non sempre utilizzato il Sistema per cambiare la visione laterale. Spesso dimenticata la freccia. Qualche indecisione nell'impegnare l'incrocio.
Ripresa del controllo manuale dalla modalità autonoma, in modo sicuro e tempestivo (quando necessario per gestire una situazione)	si	Rare confusioni nel scegliere la modalità di ripresa del controllo manuale, qualche difficoltà nell'individuare il comando sul volante
Altri comportamenti/azioni che si ritiene utile annotare relativi a: accettazione, competenze da formare/allenare		Nonostante la maggioranza dei test siano andati abuon fine, più volte si è notato la tendenza a distrarsi durante le fasi di GA autostradale e nel contempo una leggera insofferenza in attesa della funzione GA. Durante questi momenti subentrava una distrazione, tale da rendere a volte leggermente lento la ripresa della guida manuale

Consente di aggiungere una nota su questa parte del documento.

Fase di Test: Guida Autonoma

Step	Completato	Note
Controllo della strada e del traffico/ambiente circostante (necessità di mantenere viva l'attenzione, anche in assenza di guida attiva da parte del conducente)	si	Vedi sopra
Controllo dello stato di guida autonoma (On/Off – Attivato/Disattivato) e del suo corretto funzionamento	si	Qualche difficoltà nel percepire il momento di intervento della modalità autonoma, è successo più di una volta che l'allievo intervenisse sui comandi ritornando così in guida manuale
Conoscenza di quali funzioni di guida sono automatizzate e di quali non lo sono	si	Stupore soprattutto per la possibilità di affrontare rotonde in GA
Ripresa del controllo manuale in modo naturale (es. uso costante dei pedali di freno/accelerazione, mantenimento del veicolo in posizione corretta sulla strada)	si	Nella maggior parte dei casi non si individuate difficoltà tranne qualche caso di indecisione nell'individuare il pulsante sul volante. Vorrei però segnalare che, nonostante si sia ribadito come anche col freno si potesse riprendere il controllo e che potesse anche essere il modo più adatto e naturale, la maggior parte degli allievi ha sempre e solo utilizzato il pulsante.

Evento cognitivo	Risultato osservazione (Si/No)	Note (es. frequenza e intensità dell'evento cognitivo, parole/frasi dette ad alta voce dal conducente, commenti sulla situazione e azioni compiute in relazione all'evento cognitivo)
Richiesta di impegno eccessivo ("non posso farcela")	si	Un solo allievo ha riscontrato difficoltà e non ha portato a termine la prova per problemi legati ad un giramento di testa che secondo lui era dovuto allo schermo



Richiesta di impegno troppo limitato ("vorrei fare anche altro")	si	Ritenute a volte troppo repetitive le situazioni soprattutto autostradali
Frustrazione	No	
Senso di impotenza, perdita del controllo	no	
Sorpresa	si	La maggior parte degli allievi hanno dimostrato sopresa per l'esperienza
Eccessiva fiducia nelle capacità del veicolo autonomo, eccessivo affidamento su di esso ("so non servo per niente")	Si/no	Qualche perplessità negli allievi appassionati di guida per quell ache potrebbe essere un future dominato dai veicli livello 5
Eccessiva fiducia nelle proprie capacità (*es. su tempi e qualità di ripresa del controllo manuale*)	no	
Confusione sulla modalità di guida (*modalità autonoma e non autonoma attivate*)	si	A volte l'allievo riprendeva il comando senza richiesta da parte del Sistema, ciò probabilmente dovuto a confusion e distrazione
Qualsiasi altro evento cognitivo che si ritenga utile annotare	si	Quasi tutti nel test finale hanno espresso l'augurio di un uso diffuso della guida autonoma. Credo che alcuni abbiano detto ciò nonostante durante la prova abbiano utilizzato la guida autonoma solo in parte in quanto avevano la tendenza ad intervenire nelle situazioni più complesse

Aspetto emotivo	Risultato osservazione (Si/No)	Note (es. frequenza e intensità dell'episodio emotivo, parole/frasi dette ad alta voce dal conducente, commenti sulla situazione e azioni compiute in relazione all'episodio emotivo)
Stress (reazioni esagerate, perdita di lucidità, ecc.)	si	Come già detto, un solo allievo ha riscontrato difficoltà e non ha portato a termine la prova per problemi legati ad un giramento di testa che secondo lui era dovuto allo schermo
Rabbia (percezione limitata del rischio, violazione delle regole, guida aggressiva, ecc.)	No	
Noia (mancanza di attenzione/ focalizzazione, atteggiamento giocherellone)	Si/no	Qualche episodio di noia come già evidenziato soprattutto nella prova autostradale. Pochi gli atteggiamenti da giocherellone e limitato agli adulti esperti più convinti. Nei pochi episodi gli interessati tendevano a superare i limiti di velocità nel tentative di far sbandare l'auto. Comunque appena ripresi sono subito rientrati nei ranghi.
Rilassatezza/piacere/ felicità (valutazione superficiale delle informazioni, vigilanza e consapevolezza scarse)	Si/no	Rarissimi episodi di eccessiva rilassatezza nei momenti di guida autonoma soprattutto in autostrada.
Senso di propria superiorità, auto-compiacimento (mancanza di	pochi	Pochi gli "scettici" che, forse guidati dalla convinzione che non sarà mai che un computer possa sostituirli, hanno dimostrato poca impegna, dovuto forse ad un senso di superiorità.

8.5 RED Workshop with driving instructors

How would you as trainers discover available CAV technology?

A common theme across the trainer responses was through research on the internet, through various car related websites (Auto Express) and keeping up to date with developments in the driver training industry via association meetings and training events.

In particular several of the trainers mentioned referring on a regular basis to Gov.uk websites, for example the Centre for Connected and Autonomous Vehicles, or the wider Department of Transport main website.
Other notable reliable sources of information were considered to be; the RAC Foundation and Zenzic[18] who have brought government, industry, and academia together to develop a framework for UK Connected and Automated Mobility Roadmap to 2030.

Reading of related academic studies and reports, in addition to government publications and Industry/manufacturer literature were also mentioned as a necessary ongoing way to keep abreast of all future CAV developments. In addition, there may be useful film clips on YouTube showing the technology in use during trials for example, these too could prove useful. A note was made

[18] https://zenzic.io/

to ensure a copy of the final deliverables from PAsCAL WP5 are made available to those trainers who took part in the workshop.

In addition, many trainers felt it would also be good practice to review motoring publications, (magazines, websites, social media), the wider learner driving industry, as well as reviewing new user handbooks as they are provided by the vehicle manufacturer. These are often available freely online.

How would trainers best introduce CAV technology to a Novice Driver?

Some trainers felt this could be challenging as quite often the younger novice driver tends to find initially the level of input and multitasking needed to control the vehicle and be aware of what is happening around the vehicle can be overwhelming.
It was felt that as instructor's, we can combine the benefits of this technology in a way that improves vehicle safety without putting an extra burden on the driver, we can demonstrate it as a positive benefit.
At this stage most trainers seemed to agree that the best way to introduce CAV technology to a novice driver was gradually through all driving lessons as the need or opportunity presented itself.

One possible route to this might also be through the use of additional questions and via demonstration of each of the on-board systems.

Some trainers believed that a link to this could be forged by linking the environmental and cost benefits to the driver. Possibly building on any prior experience of engagement with new technology they have.

In all cases the general training principles of Explanation, Demonstration, and Practice should be followed by instructors thus not allowing the driver to become overwhelmed, whilst making maximum use of any suitable publications and on-line training materials.

In common with the training of other on-board technology such as the satnav, a possible approach would be to deliver any training via bitesize chunks, possibly introduce one item at a time so they get chance to use each one, then build up to using all available.

All trainers agreed for the need of a prior theory training module to be added to the syllabus to aid pupil progress in this area during in-car training. This would

possibly need to incorporate some form of interactive material regarding behavioural change. Also considered important for any theory module were the following key points; HMI training, risk perception, understanding vehicle automation, drivers' responsibilities and providing guidance on best practice.

Some of the trainers recognised that although not common within UK driver training, novice drivers in particular could benefit from a simulator type approach to introducing CAV technologies. It was felt that through computer technology in a specialist/classroom environment using a simulator with a trainer may provide the best start. This could then be linked through to 'on road' experience, with providing knowledge, understanding, risks and benefits, and allow opportunity to practise in a safe and controllable environment.

How would trainers best introduce CAV technology to an Experienced Driver?

Many of the trainers felt that experienced drivers may present with some resistance to change that would have to be recognised and considered during the training. This links back to our previous work regarding the study and training of Adas systems. Experienced drivers who may not have had any driver training since first passing their driving test to acquire a licence, may have had negative experiences trying to use CAV L2 technology.
Engaging with the experienced driver through effective training of existing Adas systems first was seen as the best link towards CAV L3 and L4 training.

One possible approach would be to 'sell' the benefits of CAV technology and in particular the safety gains.
To start the training of Adas systems gradually, trainers could use a questionnaire, asking drivers to explore their experience of Adas systems to date. This could be followed up by asking the driver to undertake a short assessment drive on a pre-planned route. Followed by the trainer demonstrating the same route using the available technology on board to its fullest. The driver's initial questionnaire can then be revisited to check if any noted concerns have changed. An individual training plan could then be drawn up. All the while using the available technology on board, the trainer should forge links to how they would change or improve as new CAV levels became available.

Other trainers recognised that when dealing with experienced drivers in the past, especially professional drivers, one angle to take with any new training is

to focus on risks and consequences. Financial and other possible benefits should also be used, as and when required depending upon the driver. Including how CAV L3 and L4 systems could greatly aid those who drive for their work.

In all cases the trainers agreed that particular attention during training should be made to the possible risks of over-reliance and complacency on CAV L3 and L4 technology, for example if a driver was to allow themselves to engage in other activities such as using a mobile phone or watching a film, reading a book etc is a risk; remaining attentive is crucial.
Detailed training and practice of the recommended CHAT (check-assess-take over) procedure was encouraged during any proposed training of experienced drivers, using the new module on Controlling a Vehicle (CAV).

All trainers agreed that during training a focus should be placed on encouraging and promoting driver self-assessment and development. After all, technology is moving so fast and the move towards higher levels of autonomy cannot be denied. For this reason, it is important that all drivers feel equipped to best self-learn and to continue their own driver development following any initial training period. One way may be to stage open discussions during training of experienced drivers around where to find out more going forward. For example, suggesting recommended publications and on-line materials that may be useful and also refer the driver to the manufacturer's advice.

What do you think the key features of CAVs are to communicate to a Driver?

Trainers in the study felt that it was of prime importance to start with the safety benefits first. If the technology is tried, tested and trusted it takes the human element out of road safety. There would be less for the driver to be involved with, so a journey could be less stressful.
CAV technology in EV's may also make cars more reliable and so not require as much garage maintenance, both an economic and time benefit to the driver.

As with experienced drivers, all the trainers felt a linking of technology training would probably assist in communicating the new key features. For this to work, trainers would first introduce all the existing on-board technology, but use it as a way of linking to what higher CAV L3 and L4 vehicles might have in the future.

The thinking being that by training into novice drivers the ability to trust, engage with and safely use all existing on-board Adas systems then the novice driver will start life with a driving licence already having the habit of using Adas.
This should then allow the experienced drivers of the future an easier transition to new CAV levels as they become available.

As well as safety, trainers generally felt it would be essential during the training of the new module Controlling a Vehicle (CAV). See 3.2.1 above, to ensure novice drivers understood the rules and regulations related to safe CAV use. These should be highlighted during any Adas key feature training.

In all cases the trainers agreed that particular attention during training should be made to the possible risks of over-reliance and complacency on CAV L3 and L4 technology, for example if a driver was to allow themselves to engage in other activities such as using a mobile phone or watching a film, reading a book etc is a risk; remaining attentive is crucial.
Detailed training and practice of the recommended CHAT (check-assess-take over) procedure was encouraged during any proposed training of experienced drivers, using the new module on Controlling a Vehicle (CAV). See 3.2.1 above

An important key feature that all trainers agreed should be covered during training is that the role of the driver is still important, the role of automated vehicles is to enhance during CAV L3 and L4 not replace the human driver.

How would trainers best educate the risks that may require intervention to a Driver?

Trainers agreed one potential approach would be to include some form of safe learning experience similar to the HSS simulator being used within the PAsCAL research, linked to the theory training module.
Although all trainers acknowledge that simulators are not commonplace within UK driver training. It was proposed a more interactive style approach is taken to the theory module currently being developed as part of WP9.

Trainers felt an important first step to engage any driver with a safe process of risk intervention it would be a good idea to discuss with the driver, using various possible scenario's and how different CAV level technology may impact the drive and the sharing of risk responsibilities between system and driver. This would be a link back to the theory element of the training program.

In lieu of any simulator-based training, the trainers also felt that an element of any future in-car training would have to take the form of a demonstration drive, with the trainer driving a pre-planned route and highlighting the risks that could potentially cause a hand-back request to the driver in a future CAV L3 or L4 vehicle. This would help prepare the driver to then drive the same route in manual driving mode without using technology, and the trainer questioning the driver on which risks are they seeing, and which would they think the system would request to hand back to the driver.

This could move to the next stage of the driver driving the same route, but with all available Adas systems in use, and with support of the trainer helping the driver to carry out the CHAT procedure effectively as each risk is identified.
This would allow the driver to continue to self-train into the future as further CAV levels become available.

This approach was considered suitable for both novice and experienced driver alike with the trainer making local safety assessments on the routes chosen for each.

In all aspects of the training, it was felt necessary to ensure links are promoted to driver behavioural training and encouragement to self-assess and continue learning.

How often would you as a driver trainer, check for new technology? How would then also educate a driver to check for new technology?

Trainers all agreed that as part of their job, it is necessary to maintain the highest levels of knowledge relating to all aspects of the driver training program. To this end they regularly keep up to date with industry information and have daily email alerts from various motoring journals and industry regulators (EG; the DVSA)
Trainers also felt that a good practice for driving schools to follow going forward would be to become as early adopters as possible of higher CAV level vehicles as soon as they come onto the market.

Trainers agreed they could use their own experience by way of best practice example to other drivers during training. IE; they felt trainers should, wherever possible, demonstrate signing up to relevant industry and regulatory bodies.

Something trainers acknowledge they already do with regards to encouraging and showing new drivers how to sign up for daily updates from the DVSA Highway Code for example.
In addition, part of any in-car training should be targeted at mastering the on-board infotainment system, which can prove useful in discovering over the air vehicle updates, and what they mean to the cars driving experience.

Trainers did feel that auto manufacturers should also be encouraged to shoulder more of a technology training role when selling new higher level CAV vehicles, which could prove especially useful as drivers consider upgrading their vehicle.

What objections could driver trainers face to CAV technology acceptance and adoption? and How would trainers respond to these objections?

Trainers in the study felt, as already highlighted earlier in the report, a driver's negative prior experience of using Adas and in particular ACC, with its limitations, may be put off and this could negatively impact on their view towards accepting and engaging with higher levels of autonomy as they become available.

For this reason, it is necessary to ensure during training that limitations of Adas systems such as ACC are fully explored to ensure adoption and use of Adas systems as a way to persuade experienced drivers that advancement in CAV level of technology is a positive. The proposed training modules content cover this aspect in detail and will help improve acceptance of Adas systems in general, but CAV's in particular as good as a person, it might go wrong.

Fortunately, trainers believe that novice drivers, starting from a blank canvas perspective as it where, could be more easily persuaded to the benefits of Adas and higher level CAVs through training during licence acquisition.

Other possible objections trainers may encounter and need to be ready to deal with were identified as a more general fear of being a 'passenger' to a computer; and an unregulated industry; being vulnerable to hacking; breakdowns; software malfunctions for example. Trust is obviously important in countering these types of fears, and it will be important for trainers to be equipped with all the facts and access to research etc.

Safety concerns around the technology, arguably not helped by the widely publicised Tesla crashes in the USA, could also appear as an objection from drivers trainers felt. This may lead to a reluctance to engage with Adas or higher-level CAV systems when fitted to vehicles. Through training and highlighting the regulatory steps being taken in the UK and EU to protect the public, may help overcome some of these rational fears.

Trainers also felt that some drivers may object due to a lack of understanding of the technology. A kind of “If I don’t know how it works, how can I know for sure it will work properly and does the CAV take into account the weather and how much a factor would the weather play in the CAV making a wrong decision while it was in control?” These types of trust issues should be able to overcome with effective and thorough training.

Lastly it was considered that some drivers may be suffering under the illusion of a human superiority complex. “No technology can ever be better than me, I am the best driver I know, human drivers will always be better. This could be one of the most difficult driver objections to CAVs a trainer might face, and it would require a lot of patience and skill on the part of the trainer to turn this type of driver around.

Similar to this will be those drivers who simply reject the advancements in technology outright as they fear Adas, and CAV systems just take away the enjoyment of driving.

What tools would help driver trainers with all the above?

Trainers felt the new module being added to the syllabus was the most practical approach to providing trainer resources such as videos, statistics, legal and Highway Code published literature.

Trainers also felt that more support and training for them was essential going forward and made the suggestion that better links to the auto manufacturers could be sorted to facilitate open days for trainers to attend and learn about advances in the technology first-hand, prior to any public launch.
This may well be linked to the regulator and include all the major driving schools, as well as driver trainer member bodies for example the DIA (Driving Instructors Association) or ADI NJC (ADI National Joint Congress).

A proposal was put forward that RED could consider establishing a dedicated Adas and CAV training team at the national training centre in Donington where

training days for driver trainers could be hosted with demonstration days from manufacturers for example. This could also provide a long-term base for the HSS which could be utilised during wider general instructor training at the venue.

8.6 UK drivers feeling and CAV experience summary

Table 32 UK drivers feeling and CAV experience summary.

From the first to the last driving session

Driver number	Q13 (**first session**)- How did you feel while traveling in a CAV?	Q13 (**last session**) How did you feel while travelling in a CAV?	Evolution No evolution: grey Positive Evolution: green arrow Negative evolution: red arrow	Question n° 5 - What kind of Connected and/or Automated Vehicle (CAV) have you tried before?
100	Nervous	Safe		Several features
2	Safe	.		
3	Careful	.		
4	Curious	.		
104	Insecure	Careful		Several features
6	Careful	.		
106	Safe	Trustful		
8	Safe	.		
108	Careful	Careful		
109	Curious	Insecure		Never
111	Trustful	Trustful		Never
155	Careful	Careful		Several features
156	Careful	Careful		Several features
14	Safe	.		
15	Curious	.		
16	Trustful	.		
17	Insecure	.		
18	Safe	.		
24	Critical	Insecure		Several features
25	Safe	Safe		Several features
21	Safe	.		
22	Careful	.		

30	Curious	Trustful		Several features
24	Insecure	.		
31	Curious	Curious		
26	Unaffected	.		
32	Nervous	Trustful		Several features
33	Safe	Trustful		Several features
29	Safe	.		
34	Careful	Trustful		GPS
35	Safe	Nervous		Never
36	Insecure	Insecure		Several features
38	Curious	Trustful		Several features
39	Nervous	Careful		Several features
35	Insecure	.		
40	Safe	Careful		Never
41	Trustful	Trustful		Several features
38	Safe	.		
39	Trustful	.		
40	Nervous	.		
48	Curious	Trustful		Several features
42	Nervous	.		
51	Trustful	Critical		GPS
44	Careful	.		
53	Insecure	Insecure		
70	Careful	Nervous		GPS
72	Safe	Safe		
48	Nervous	.		
49	Nervous	.		
77	Curious	Trustful		Several features
78	Careful	Careful		Never
79	Careful	Safe		Several features
83	Nervous	Nervous		GPS
54	Safe	.		
89	Curious	Nervous		Do not know
92	Curious	Nervous		Never
57	Nervous	.		
94	Curious	Trustful		Never
95	Insecure	Unaffected		Several features
60	Nervous	.		
97	Careful	Critical		Several features
99	Insecure	Nervous		Never

Total	N	62	36		

8.7 Positive and negative points considered after the experience of the HSS

The following tables display the results from the UK sample and then the Italian sample.

Table 33 UK answers to post-driving questions (CAV experience)

Question n° 15 - What are for you all the positive points of this experience in the simulator?	Question n° 16 - What are for you all the negative points of this experience in the simulator?
very reactive and level of detail is great.	sometimes in auto it pulled the car on the pavement.
highway driving is very relaxing and feels safe to a certain degree. Town driving is not the same as its very on and off.	Town driving is not so smooth of a transition between Autonomy and manual. Signal drops too often.
it was mostly accurate and was very careful and precise and provided a safe in enviroment most of the time in which a person can travel	the autonomous driving was sometimes unpredictable when there is bad signal and would sometimes put me in dangerous situations however this was only when bad signal occured and other wise is very predictable for pedestrians and the driver
Allowed me ti see the advantages and how it can be a positive for future road safety	Not being someone that plays computer games, I found the use of the steering wheel hard, as in over steering.
helped with following a sat nav	its hard to actually drive with the setup
can easily concentrate on hazards rather than driving	feel slightly out of control
its a great way to lean to drive for learners who have never been on the road	there should be a point system
great potential	I struggled with the steering column
future of automonous driving - learning new technology	screen a bit glitchy and steering sounded clunky
Being able to gauge how alert you need to be whilst the car is in autonomous mode and seeing how the car interacts with hazards	Cant see both side mirrors without moving around so distracts from the driving experience
assistance with the drive when its in auto mode	the screen navigation vision was limited due to computer software
Driving without having to worry about controlling the car	
Seemed confident in changing lanes. Maintained a good speed	Lack of ability to take over is disconcerting
Was very responsive when using the controls, fun to have a go. Liked the realness of the buildings	Was hard to keep in the correct lane, found it very responsive more so than it is in normal driving.
simple to use	didnt give much experience of the automation.

was very quick at takingover	very slow at moving off
Good for the experience of learners driving without the normal risks of the open road	Car undertook another car in Autonomous mode and didnt increase or decrease when manual controls were pressed.
that the car stayed within the speed limit	not totally realistic
none	**when i had to take over sometimes i was not concentrating enough at the time**
I didnt need to worry about the gears, and there were several pedestian crossings throughout the simulator which required me to always be aware.	some of the people in the simulation were wondering about and walking in the road.
enjoyable	autonomy dropped out unexpectedly, peripheral vision limited
The autonomous system seemed to be confident and drives well.	When control is handed back to the driver, the vehicle has a tendency to swerve and try to pull over.
Good way to experience what autonomous driving is like	No peripheral vision
helps with speed control in urban environment	car was not able to take control when cars were present on the right and i felt i needed to pay alot of attention when the care was in control
Was reaslistic, AI behaved naturally, felt comfortable when the autonomous driving kicked in and trusted it	Button layout was a bit awkward which affected signals on roundabouts, i think sounds from the car would of given valuable audible feedback
it kept the speed well	didnt spot hazards any quicker than me
Na	na
It was easy to use and helps keep you alert between switching from manual mode to automated mode	**I found myself at time wanting to correct the automated mode if it was getting too close to other cars**
very easy to relax and trust the system to deal with anything, felt safe	none
Not sure	Unsure when it was taking control
it was easy to use	i got confused at some points
	difficult to judge speed wanted to break at some points
good to see how it works	didnt like the way it just took over, quickly or let it drop to me with out warning
I was surprised with how the car reacted with other traffic on the road.	**It made me feel insecure about the control at sometimes but when driving constantly on a straight road it feels safe.**
none	everything
Reaction time of the auto mode, amount of modeling	field of view is limited, camera turning is slow
the vehicle seemed quite safe, although the motorway was never busy	the vehicle did not respond well to the fog, it did not slow down sufficiently or quick enough. It also did not allow for any of the vehicle not being autonomous.
very little input from me	none
It was good to see autonomous driving being performed in a safe way.	**Autonomous driving for ~20 mins is very boring.**
can see complex situations	very short time to take control

Dealt with cars pulling out well, and pedestrian crossings.	Too many manual changeovers at junctions.
the unexpected issues such as the broken down cars and you had to be observant to resolve the issue of passing it	the accelerator was extremly sensitive and so was the steering it also "broke up" alot and i assume lost signal
the possibility that the system could anticipate hazard	still uncomfortable to leave my decision to the system
	Not trustful, too sensitive steering wheel and gas pedal
i lets you take over when it has issues so you feel safe and in control	the amount of times we had to take over
the ease it had navigating in an urban enviroment, managing pedestrians and the traffic as well	i would like to see how it would cope in a super busy enviroment one like a big city at peak rush hour and see how it reacts to that
trying out something new .	dont trust this system.
not all of them were the positive experience	fast turnings and hard braking
Has made me think more about how it works and the input needed by the driver both good and bad	None
the self driving of the car worked well	the car did not feel like a car
The car providing an extra set of eyes	Having to take over too often
none	**all of it, I would rather be in full control**
the system seemed to know what it was doing-it took out the repetitiveness strain of driving	a lot of unnecessary lane changing, some situations it handed control to the driver and should have dealt with itself.
WAS FUN TO USE	FEELS QUITE DIFFERENT TO DRIVE AND LIMITED VIEW.
I like how its very guided and detailed.	none
could prevent accidents, the question remains about the actions of other drivers not in auto drive cars	not 100% affective, car can still be crashed in auto drive mode.
takes off some of the load/effort/stress of driving, especially when things were going really wrong for me	I have no idea what eco vs sport mode is. I didnt understand at first how to turn it on. Only when the light next to the autonomous driving - logo got green and the text changed did i understand how the autonomous vehicle part worked
the environment is well simulated with a good amount of unpredictability of other road users etc. without being too demanding. This allows you to explore the concept of the autonomous control well rather than all your energy being focussed on the road.	The autonomous driving was unpredictable, and I was unable to feel that I could fully trust whether the vehicle was going to cope with a given situation or not.
The autonomous driving appeared to work well, and warned you when to take over from it. The steering wheel and pedals responded quickly.	It was difficult to get used to the controls and feel like you are actually driving because of the limited field of view. Using buttons to look around made it take longer to do manouvers.
the delay in swaping lanes was logical, anticipation of hazards was good, speed control good safety distance between cars was good.	not knowing how the car will react to unexpected hazards
it was interesting to tried it out	vehicle was in control, not me, it is the main downside

Table 34 Italian answers (translated) to post-driving questions (CAV experience)

Question n°15 What are for you all the positive points of this experience in the simulator?	**Question n°16 What are for you all the negative points of this experience in the simulator?**
Greater safety	Confusing about sections regarding entering/leaving
To have the possibility to gradually learn about the automated driving	Excessive detachment between simulation and reality
curiosity	none
curiosity and willingness to take advantage in using it	none
much easier driving	some minor errors in driving
I HAD AN IDEA OF WHAT DRIVING MIGHT BE IN THE FUTURE AND GOT INTERESTED	I HAD A BIT OF FEAR AT THE BEGINNING AND LITTLE TRUST
I understood the meaning of autonomous driving	none
I experienced a new driving modality	Too detached from reality
Practising these exercises in the simulator was interesting	The simulator crashed 13 minutes before the end of the test
Vehicle's ability to prevent dangerous situations	none
Innovation	some uncertainty
The main positive point was to practise driving in a funny way and experience those situations which can happen when driving a vehicle (such as unexpected events, etc.)	no negative points
I amused myself and tried staying focused on the driving aspects.	It is a simulator, so I was not worried about the vehicle self driving
I rested	none
none	too unexpected and frightful noises
none	Uncertainty

none	I couldn't understand what autonomous driving in a city is for. It self drove for two seconds and then asked me to take control of the wheel.
none	imprecise system
No need to focus on issues such as giving priority to crossroads when the vehicle started operating autonomously	Despite the directions of the navigator device, the lack of road signs made it difficult to predict the various situations.
I didn't feel the driving stress	
I found nothing positive	The simulator was too predictable and repetitive in the events it proposed
I didn't find any	It made me feel insecure when we had an accident and I could not do anything to avoid it. It made me intervene when it was not needed while it did not permit me to take control of the wheel when I might do something.
It allows you to safely learn how to use the spaces occupied by the vehicle	Visibility is not always the best
I can be distracted while driving	I am not sure I might be ready in case of need
Practise the autonomous driving in a safe environment	I felt anxious and tense during all the track, because I did not trust autonomous driving and was continually about to take control of the vehicle when it might be needed. Then, when self driving went on for too long, I sometimes felt asleep...
I can experience a new sensation	insecurity
You feel a greater safety	No negative point
Very reduced reaction times to hazards	It is very difficult to make out the difference between speeds
You relax	You relax… but real hazards on the road are not so predictable and obvious as in this videogame
Leisure and safety during the journey	Except for too short acceleration and deceleration lanes, no negative point

8.8 PASCAL Project UK Trainers Workshop – Pre attendance preparations

Prior to attending and in order to participate in RED's trainer workshop to consider driver training in a CAV new world order, please complete the separate pre-attendance questionnaire having first followed these two important steps.

1. Click on the links below and read these 3 important research documents.

- Nottingham Trent University study paper on Training for automated vehicles.

69547 – RACF – NoU – Training for automated vehicles_AW.1.pdf (nottingham.ac.uk)

- The Department for Transport (DfT) Transport and Technology Public Attitudes Tracker wave 6 summary report.
  In 2017, the Department for Transport (DfT) commissioned Kantar's Public Division to conduct six waves of research to track public attitudes and behaviours relevant to transport and transport technology in England. This report focuses on the results from Wave 6 of the survey conducted in August 2020

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955253/DfT-Kantar-Transport-and-Transport-Technology-Public-Attitudes-Tracker-Wave-6-Summary-Report.odt

- University of Leeds - Computer Vision, Machine Learning, and Autonomous Vehicles
  PGR-RA-173 Expertise of research area Classification and Tracking; Driver Behaviour Monitoring; Road Perception; Self-driving Cars; Vehicle Automation; Computer Vision; Deep Learning; Intelligent Transportation Systems; Machine Learning

https://phd.leeds.ac.uk/research-area/173-computer-vision-machine-learning-and-autonomous-vehicles

2. Click on the links below and watch these videos.

- Road test of the 2019 CAV L3 prototype Audi A8 in Dusseldorf in a real world traffic jam scenario.
  https://www.youtube.com/watch?v=WsiUwq_M8IE
- 2021 Mercedes S-Class Self Driving Demo - New S Class DRIVE PILOT tested on restricted roads.
  https://www.youtube.com/watch?v=cH2SPE0_LkU

- Road test of a Renault Symbioz – a prototype concept CAV L4 car.
  https://www.youtube.com/watch?v=l3ELVACR2VY

Please complete the questionnaire with your thoughts and ideas for discussion, technology will continue to evolve so consideration will need to be given to a plan that can evolve with the vehicles.

Additional viewing you may also want to consider prior to attending:
Teaching autonomous cars to drive like humans | WIRED UK
What Is Lidar and How Does It Help Self-Driving Cars Make Decisions On The Road? | Defined | Forbes - YouTube
The Jonas Brothers React to Super Cruise | 2021 Escalade | Cadillac - YouTube

Attached questionnaire, featured these 8 questions with space for each trainer to complete their answers.

- How would you as trainers discover available CAV technology?
- How would trainers best introduce CAV technology to a Novice Driver?
- How would trainers best introduce CAV technology to an Experienced Driver?
- What do you think the key features of CAVs are to communicate to a Driver?
- How would trainers best educate the risks that may require intervention to a Driver?
- How often would you as a driver trainer check for new technology? and How would you educate a driver to check for new technology?
- What objections could driver trainers face to CAV technology acceptance and adoption? How would trainers respond to these objections?
- What tools would help driver trainers with all the above?

8.9 Challenges encountered

8.9.1 Covid-19 impact

Due to the crisis that has spread across Europe, the cities and businesses originally intended for the test have been varied based on travel restrictions, indoor social gathering bans and other preventative measures adopted or confirmed by the government and local authorities. This outbreak had a major impact on organisation of WP5 activities and had forced the project to delay all the activities involving the physical presence of external users.

The program planned before the pandemic for mid-2020, has undergone a major rescheduling, having to recognise and deal with both travel and simulation times with experienced drivers / students take longer.

The rescheduling of all project activities requiring the presence of external people during the pandemic (including in particular the experiments of WP4, 5 and 6) was the subject of a request for a 6-month extension of the project duration.

8.9.2 Other factors

In addition to the deviations directly resulting of the Covid-19 pandemic, WP5 activities have also suffered delays due to several technological factors.

First, the complexity of the simulator specific design and development tasks required numerous iterations between the designers/developers and the representatives of the driving schools to ensure and agree on the needs expressed for the training scenarios and the technical feasibility for develop them. The fact that these iterations could only be done through remote meetings, and not through a mix of intensive face-to-face work meetings (which should have taken place in normal times) led to delays between the iterations of the simulator prototype occurred between Fall 2020 and Summer 2021. Although preliminary versions were available to partially test the simulator features, the alpha version, resulting from 6 iterative development loops were available in July 2021.

Second, at the hardware level itself, the project had some setbacks:

On Italian driving-schools' side, it turned out after several tests and remote assistance sessions by LIST that some computers used in the driving-schools didn't meet the technical requirements prescribed to be able to run the Home Study Simulator. The partners decided to proceed with the sending of 3 fully configurated computers by LIST in Italy to effectively start the tests in the driving schools.

On UK side, driving school encountered problems connecting the server during some tests taking place at weekends. As not a seven-day operation, there was no online support available from LIST during these periods to check the server connection hosted by an external service provider. This resulted in 48 participants not being able to participate in the study. Efforts were made to reschedule these missed tests where possible and LIST were pre-notified of any out of hours testing which allowed support during these periods to facilitate 24 participants to revisit on new dates and subsequently participate over 2 additional weekends.

To counter some of the effects of these challenges faced, the following additional steps where undertaken:

- A Desktop based study of prior research linked to available manufacturer details of future planned level 3 and 4 possible systems was undertaken by trainers in the UK including two physical workshops to discuss and agree outcomes to contribute to the project.

- A series of trainer workshops, RED trainers in conjunction with Italian colleagues, where undertaken to consider the future training needs of CAVs.

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