Do we trust self-driving cars?
Social acceptance of automated mobility

CINEA Lunchtime Session – 09/09/2021

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Project Officer

Sector C.3.4 – Automated Transport

Department C (Green research and Innovation) – Unit C.3 – Horizon Europe Transport

European Climate, Infrastructure and Environment Executive Agency

Opening

European Commission

Agenda

- *Opening - Patrik Kolar (HoD C)*
- Presentation about Automated Mobility - Pedro A. Perez Losa (PO C3.4)
- Social acceptance and Driver Behaviour - H2020 Project coordinators
- Discussion and Q&A
- Closing remarks - Marcel Rommerts (HoU C3)

CINEA and Automated Transport

European Commission

Automated Transport Team – Sector C.3.4

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Sector C.3.4 – Automated Transport

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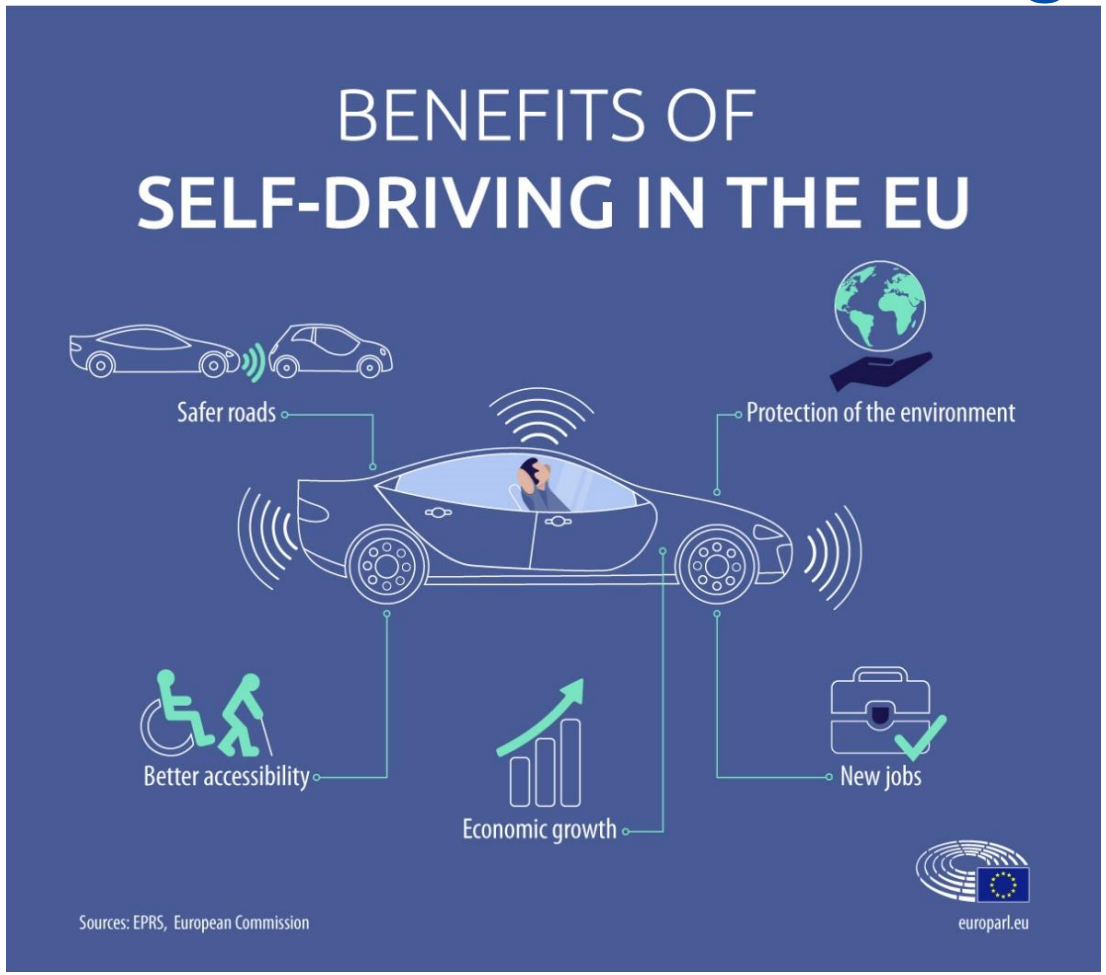
Benefits of self-driving cars



- **Safety** : Reduction of accidents and fatalities
- **Environment** : Reduction of transport emissions
- **Inclusiveness** : Mobility for all
- **Competitiveness**: Strength technical leadership

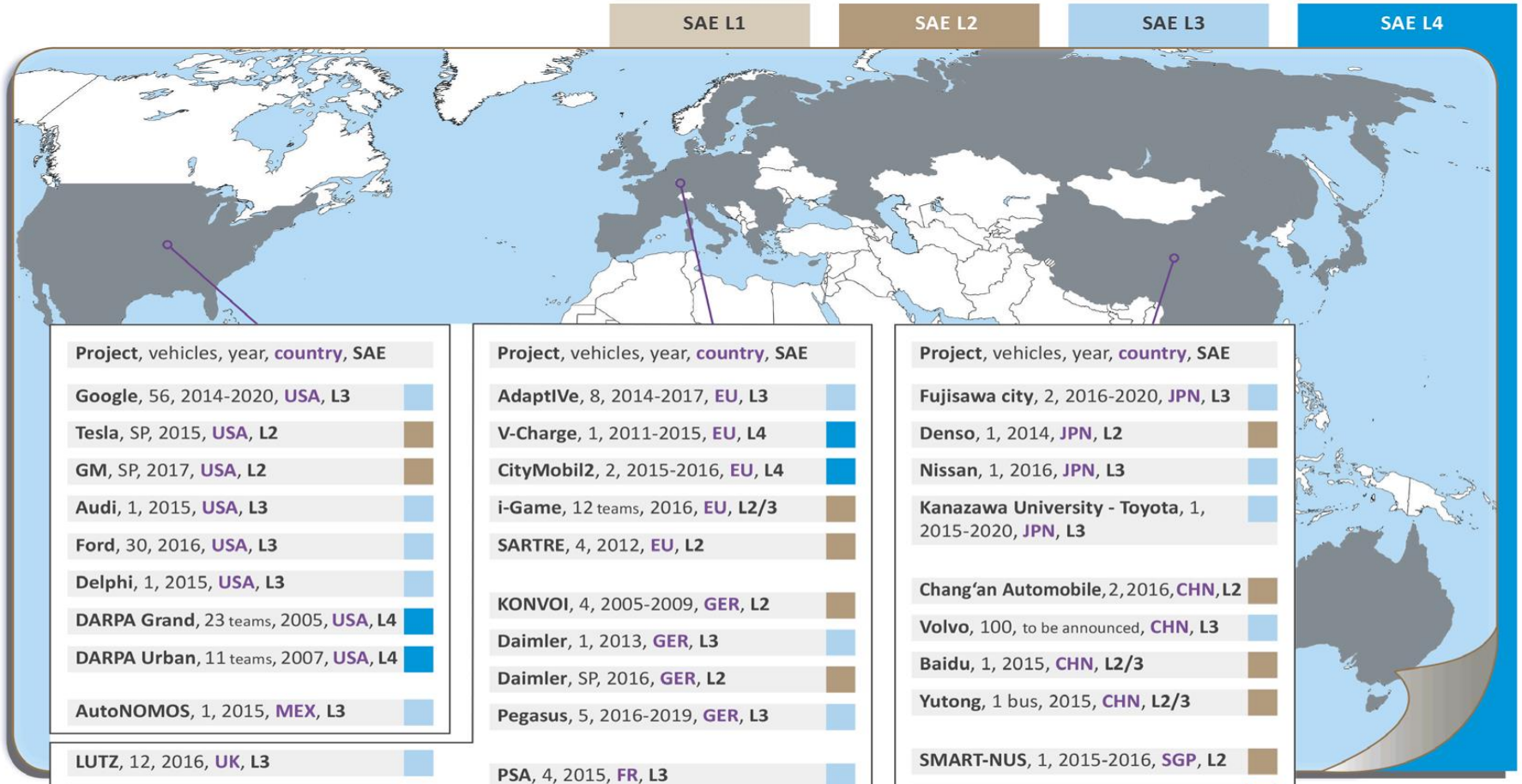
European Commission

What is an Automated vehicle? and CCAM?

- **Autonomous** : Self-aware (it makes its own choices)
- **Automated** : Vehicle follows our orders
- **Self-Driving** : Automated with human passengers
- **C**onnected, **C**ooperative & **A**utomated **M**obility (CCAM)
  - **CCAM** partnership

Levels of Driving automation

Worldwide AD tests on public roads



Project, vehicles, year, country, SAE
Google, 56, 2014-2020, USA, L3
Tesla, SP, 2015, USA, L2
GM, SP, 2017, USA, L2
Audi, 1, 2015, USA, L3
Ford, 30, 2016, USA, L3
Delphi, 1, 2015, USA, L3
DARPA Grand, 23 teams, 2005, USA, L4
DARPA Urban, 11 teams, 2007, USA, L4
AutoNOMOS, 1, 2015, MEX, L3
LUTZ, 12, 2016, UK, L3
VENTURER, 1, 2016-2019, UK, L3
GATEway, 8, 2016, UK, L4
Autodrive, 40, 2016-2019, UK, L3/4
WE-pod, 2, 2016, NL, L4
EU Truck platooning challenge, 15, 2016, NL, L2/3

Project, vehicles, year, country, SAE
AdaptIVe, 8, 2014-2017, EU, L3
V-Charge, 1, 2011-2015, EU, L4
CityMobil2, 2, 2015-2016, EU, L4
i-Game, 12 teams, 2016, EU, L2/3
SARTRE, 4, 2012, EU, L2
KONVOI, 4, 2005-2009, GER, L2
Daimler, 1, 2013, GER, L3
Daimler, SP, 2016, GER, L2
Pegasus, 5, 2016-2019, GER, L3
PSA, 4, 2015, FR, L3
VISLab, 2, 2010, ITA, L2
Drive Me, 100, 2017-2020, SWE, L3
KAMAZ, 5-10, 2017-2020, RUS, L3

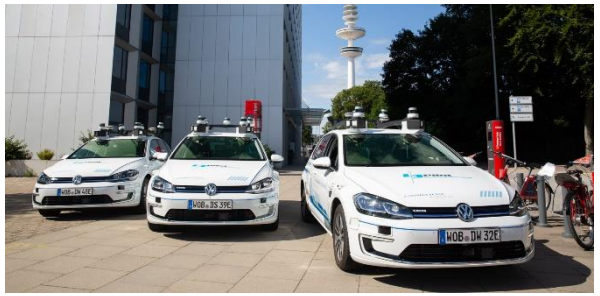
Project, vehicles, year, country, SAE
Fujisawa city, 2, 2016-2020, JPN, L3
Denso, 1, 2014, JPN, L2
Nissan, 1, 2016, JPN, L3
Kanazawa University - Toyota, 1, 2015-2020, JPN, L3
Chang'an Automobile, 2, 2016, CHN, L2
Volvo, 100, to be announced, CHN, L3
Baidu, 1, 2015, CHN, L2/3
Yutong, 1 bus, 2015, CHN, L2/3
SMART-NUS, 1, 2015-2016, SGP, L2
nuTonomy, 1, 2015-2016, SGP, L4
Hyundai, 1, 2016-2020, KOR, L3
Snuber, 1, 2015-2016, KOR, L2/3
Volvo, 1, 2015, AUS, L3

L3PILOT

European Commission

Flagship Automated Road Transport ‘Horizon 2020’ projects

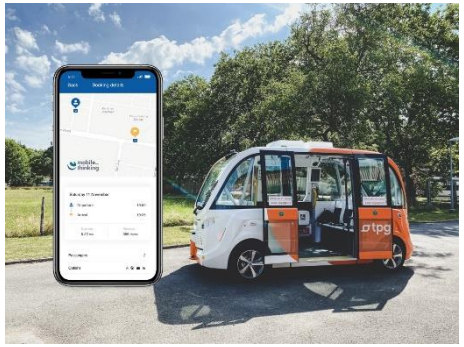
Projects’ Acronym



Large Scale Pilots
of automated driving systems for passenger vehicles

L3Pilot Driving Automation

HI-DRIVE



Fully automated urban road transport and shared AV fleets in urban areas

AVENUE

SHOW AUTOMATED URBAN MOBILITY

Multi-brand truck platooning
and autonomous real logistics operations

ENSEMBLE

AWARD Scaling autonomous logistics

European Commission

What is coming up?

Technology

Human-related aspects

Regulatory framework

CCAM projects
Social acceptance and Driver behaviour

European Commission

Importance of social acceptance

- **High** Awareness, **Low** social acceptance.
- Automated vehicle **with or without** any human operator supervision.
- Efforts are needed to **raise awareness** of the CCAM options and their implications.

Importance of driver behaviour

- Behaviour and reaction under **different** scenarios.
- **Transition of control** : Take the control of the vehicle.
- Drivers have to pay attention to the **actions** of the self-driving cars.

On-going projects

- Focused to **increase** social acceptance and **enhance** driver behaviour.
- These cover **all** transport modes as well as **multiple** scenarios.
- Results will **feed** into projects to be funded under Horizon Europe.

DRIVE2 THE FUTURE

PAsCAL

SUaaVE

TRUSTONOMY

European Commission

Questions addressed to our speakers

- How do **people react** on board an autonomous vehicle?
  Which are the most likely **issues** on board?
  How do **passengers/drivers respond** then?
- Which **factors** influence their reactions?
  - e.g. education/training, automation level, traffic scenario, …?
- What about **other people**? – e.g. **other drivers**, **passengers**, **pedestrians**, …
- What **surprised** you from the tests results?
- What **did not work** during the tests?
- Any **lesson learnt**?

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TRUSTONOMY

European Commission

Social acceptance and Driver Behaviour by H2020 Project coordinators

European Commission

Presentations

Lila Gaitanidou, CERTH/HIT

Drive2theFuture Coordinator

http://www.drive2thefuture.eu/

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement no 815001

Drive2theFuture at a glance

31 Partners
10 WPs
45 Deliverables
12 Pilot sites
3 Workshops
Duration: 36 months (May 2019 - April 2022)

Drive2theFuture develops

- training,
- HMI concepts,
- incentives policies
- other cost-efficient measures

to promote and then to comparatively assess

- several alternative connected, shared and automated transport Use Cases
- for all transport modes
- with all types of users (drivers, travellers, pilots, VRUs, fleet operators and other key stakeholders)

in order to

- understand,
- simulate,
- regulate
- optimize their sustainable market introduction

including

- societal awareness creation,
- acceptance enhancement
- training on use

Drive2theFuture's mission is to prepare "drivers", travellers and vehicle operators of the future to accept and use connected, cooperative and automated transport modes and the industry of these technologies to understand and meet their needs and wants.

Road

- **RO-1: Oslo (TOI)**
- **RO-2: Karlsruhe (FZI)**
- **RO-3: Versailles (IFSTTAR/VEDECOM)**
- **RO-4: Warsaw (PZM)**
- **RO-5: Vienna (AIT/WL)**
- **RO-6: Brussels (VUB/VIAS)**
- **RO-7: Rome (SWM)**
- **RO-8: Linkoping (VTI)**

Rail

- **RA-1: Linkoping (VTI)**
- **RA-2: Berlin (TUB)**

Maritime

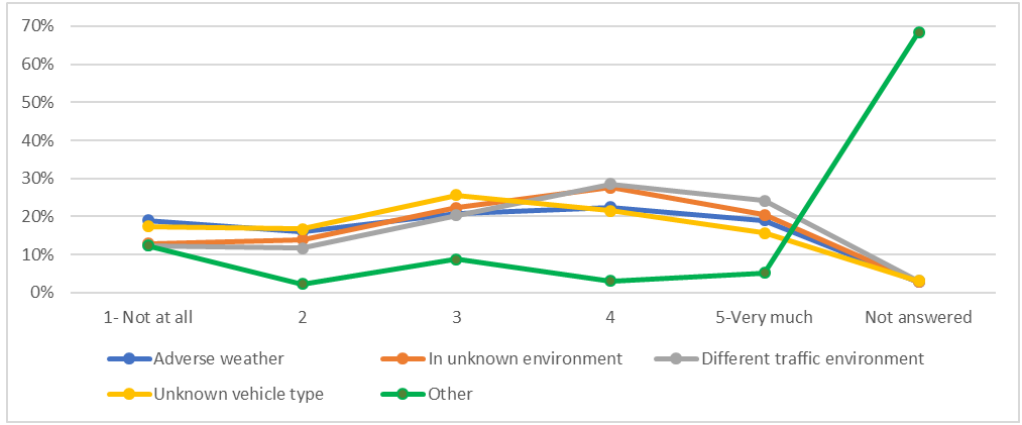
- **MA-1: Faaborg (TUCO)**

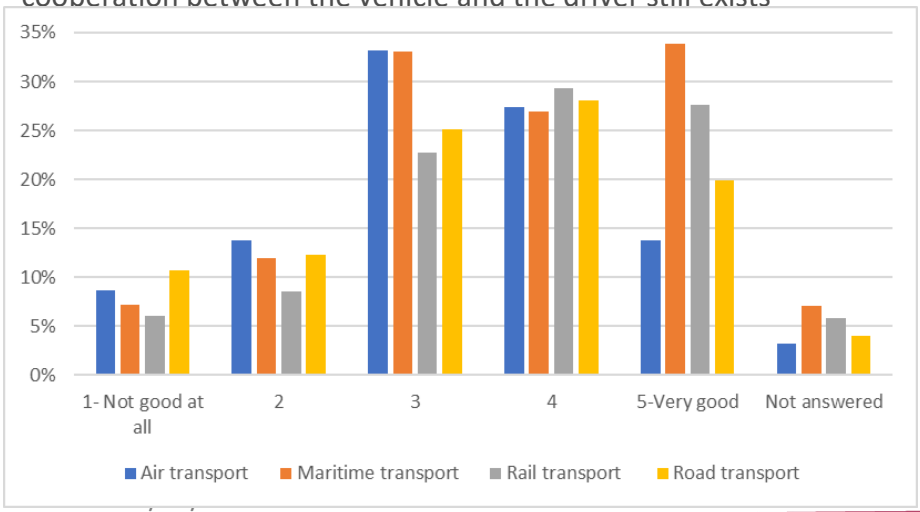
Aviation

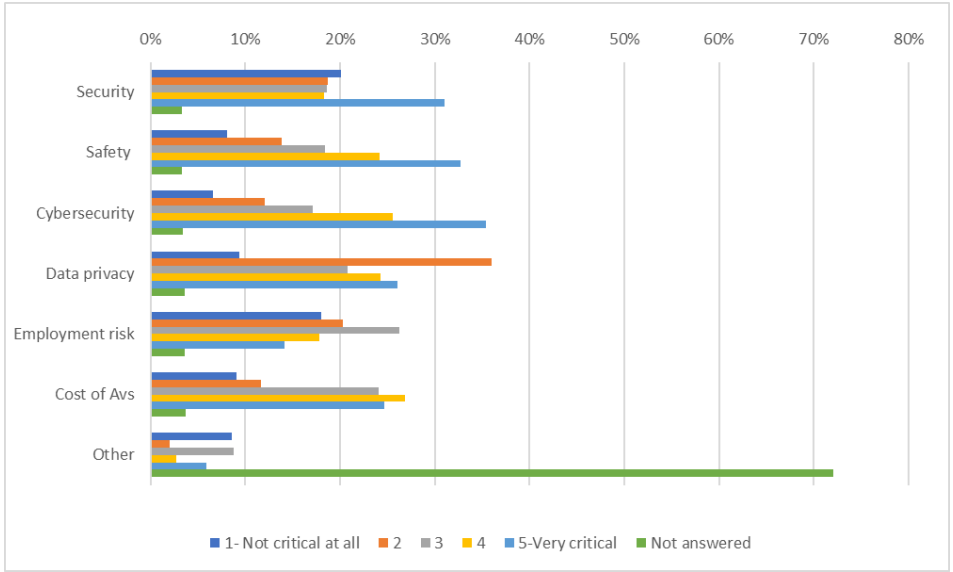
- **AV-1: Rome (DBL)**

Reaction to AVs

- 48% has a good or a very good opinion
- Level 3 most preferred (apart from L1)
- 52.7% would use automation in a ***different traffic environment*** (i.e. left or right driving), followed by ***unknown environments*** (i.e. foreign country, unknown city, rural area or countryside) with 48%
- 61% find cybersecurity to be critical or very critical. Safety is the next most important concern of the users (with 56.4%)
- 55% think speed limits should be the same, while 33% would like AVs to have speed restrictions
- Employment: 41.8% think automation will cause job losses in the road transport sector, 25.7% believe that automation will bring new jobs
- Comparing across modes, slight differences among them are noticed, with the respondents being mostly neutral in the case of air and maritime transport, while expressing a more positive opinion for the rail and road transport
  - Preferences on the automation levels of all modes, focused on the lower and/or middle levels, where cooperation between the vehicle and the driver still exists

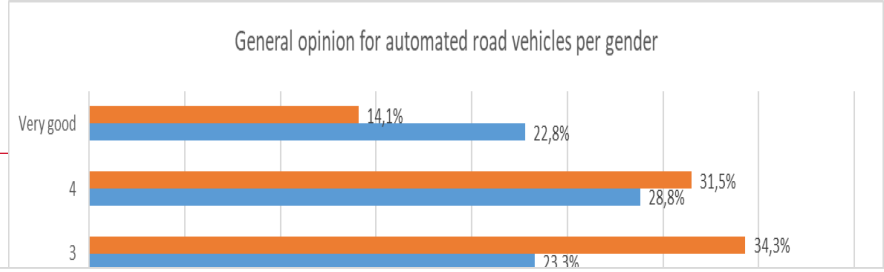


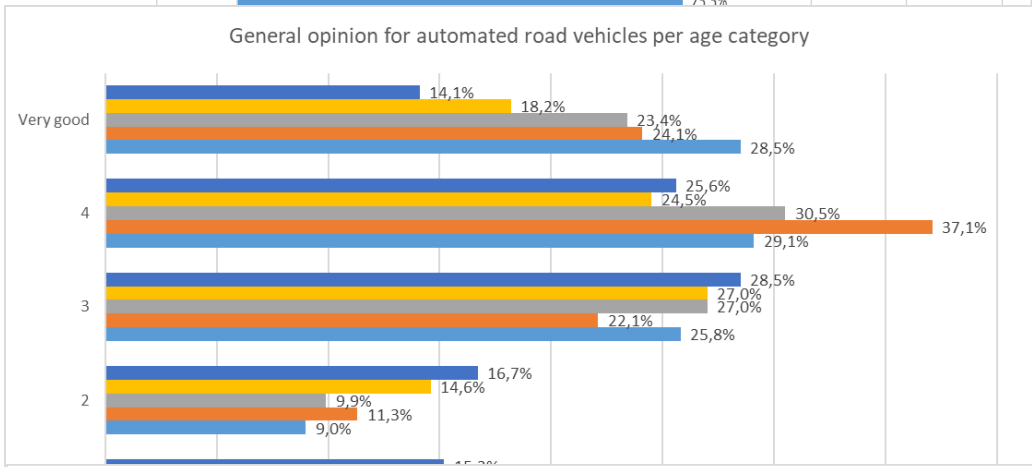


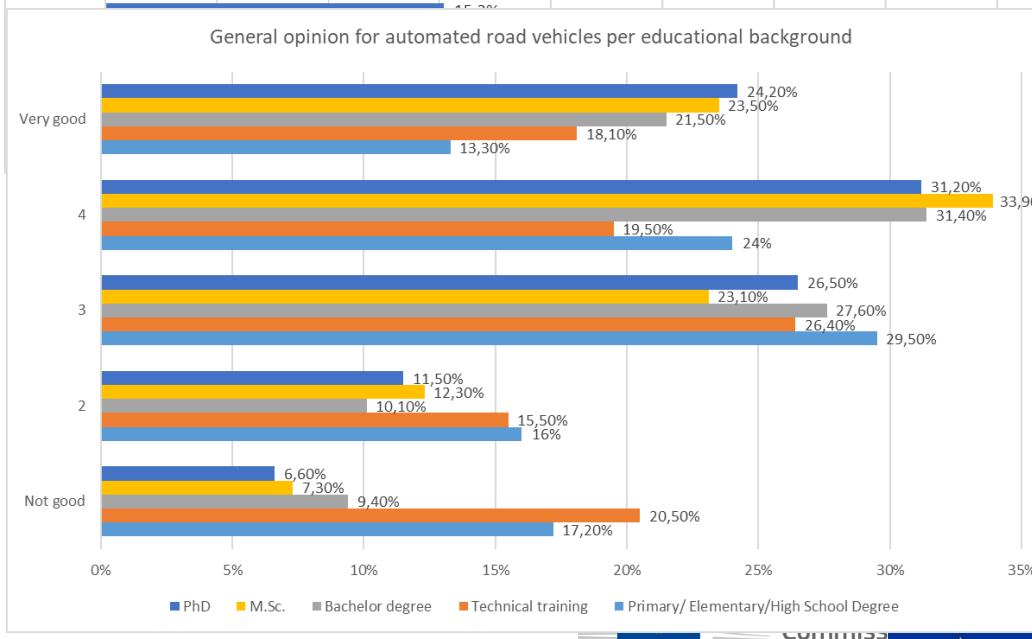


Factors influencing reactions

- Frequency of interaction with AVs (both for in-vehicle and other road users) – positive influence of acceptance by experience
- Gender and age the main factors
  - VRUs,
    - ✓ Females feel safer and their behaviour is influenced more with out of vehicle indication of status – Males usually ignore the signs
    - ✓ Younger people perceive better the enhanced safety of AVs
    - ✓ Elderly people ignore the indications of AVs operation mode
- Overall opinion on AVs
  - 45,6% of women and 51.6% of men have good or very good opinion on Avs, while 7.5% and 12.3 respectively have a not good one.
  - Younger people have a more positive view (about 60% for ages 18-45), while the elderly are more hesitant towards AVs (about same percentages for positive/negative views)
- Role in the traffic (driver/passenger/VRU)
- Education level
  - Bachelor degree or higher – significantly more positive opinion.







Other road users

- Cyclists vs AV Shuttle
  - More positive after interaction experience
  - 50% uncertain if it will stop
  - 1/3 cross as they know it will stop
- Passengers
  - Overall positive reaction
  - Feeling of safety & confidence (however, mainly due to low speeds)
  - Divided answers on the necessity of operator after experience. Before getting on board vast majority expressed the need of driver/operator
  - Positive on the usability and necessity of external HMI indicating AV operation
- Other drivers
  - Enhanced number of overtaking, due to AV low speed, may influence negatively road safety

Surprising findings

- Cyclists' answers were divided on whether they would provide right of way to AV shuttle or cross anyway trusting it will stop
- AV shuttle passengers divided answers on the necessity of an on-board operator – although higher percentage of accepting "no operator" after being on board.
- Tendency of increased of increased number of overtaking manoevres if AVs continue to operate at low speeds.

Shortcomings

- COVID-19 outbreak coincided with the beginning of the testing
  - Measures were taken to the maximum possible level to operate without risk
  - Delays in certain pilots due to national restrictions, pro the execution of the tests for extensive time period

Lessons learned

- Still not completely trusting the system – lower levels of autonomy preferred (preliminary preference over L3!)
- Conspicuity HMI desirable – mostly out of the vehicle, clearly indicating the operation mode
- Acceptance, trust and willingness-to-have raise with familiarisation
- Enhancement of AV operation speed may better integrate them in the traffic flow and reduce conflicts with surrounding traffic, but it may reduce perceived safety of passengers and VRUs.

DRIVE2
THE FUTURE

Thank you!

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European Commiss

HORIZON 2020

PAsCAL PROJECT

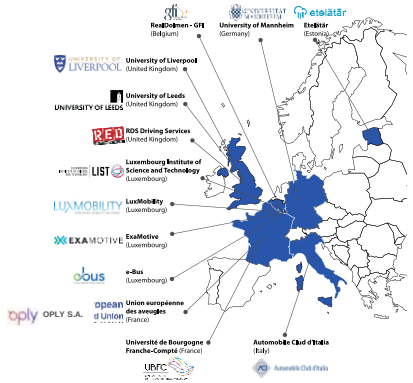
Enhance driver behaviour
and Public Acceptance
of Connected
and Autonomous vehicLes

WWW.PASCAL-PROJECT.EU

Luc VANDENABEELE

PasCAL project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No 815098

PROJECT OVERVIEW



- Enhance driver behavior and acceptance of connected, cooperative and automated transport

- 13 partners
- 7 countries
- 34 deliverables

- **Start date** 06.01.2019
- **Duration** 36 + 6 months
- **Budget** € 3.974.041,25

SURVEYS

SIMULATORS

TRAININGS

5 PILOT STUDIES

- High-capacity autonomous bus
- Autonomous driving training
- Autonomous bus shuttle line
- Shared connected transport
- Vulnerable travellers

Guide2Autonomy

PasCAL project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815098

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How do people react on board of an autonomous vehicle? Which are the most likely issues on board? How do passengers /drivers respond then?

BEFORE/AFTER TESTING

- Evolution over time : Most people seem to be nervous and/or skeptical before boarding but usually gain **great confidence** after trying the vehicles

LEVEL 3

Issues : User Interface (switch on/off autonomous mode should be preferably integrated on the steering wheel) rather than on the central panel

LEVEL 4

Issues : Lack of human support must be compensated by ICT solution on board and crucial information about the vehicle environment and status is of essence

LEVEL 5

Issues : Lack of human support must be compensated by ICT solution on board and crucial information about the vehicle environment and status is of essence

Which factors influence their response? - e.g. education/training, automation level, traffic scenario, …?

- Information received before boarding and tech-savvyness are very important factors

- Most importantly is previous experience with CAV technology
- Traffic scenario is also changing their attitudes (presence or not of pedestrian crossing, level of autonomy, traffic density urban - highway)

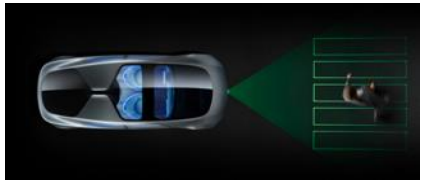
What about other persons? – e.g. other drivers, passengers, pedestrians, …

PASSENGERS IN AUTONOMOUS BUS

LEVEL 5

PEDESTRIANS

About User Interface



About the context/scenario

VULNERABLE PEOPLE

LEVEL 5

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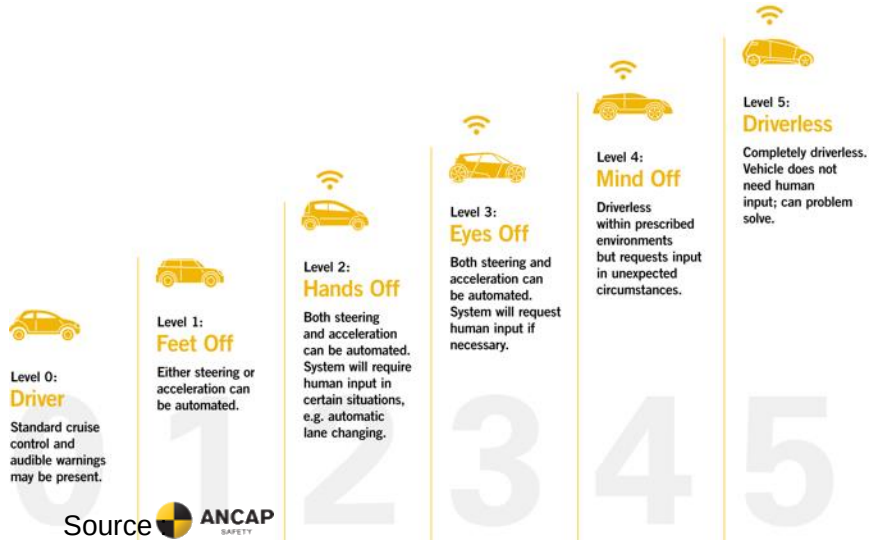
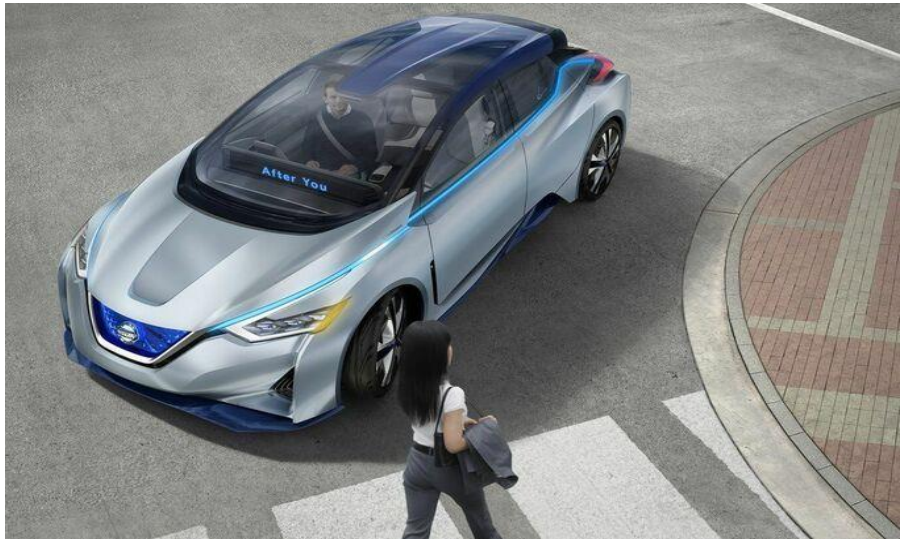
What did not work during the tests?

CAV Terminology?

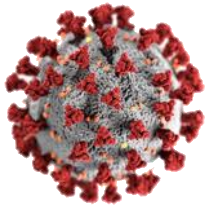


Source ANCAP

User Interface understanding?



Difficulties to enroll during COVID



Any lesson learnt?

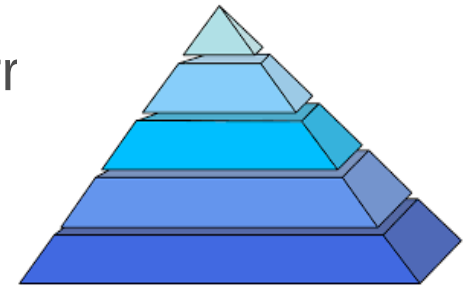
- Need for **standardisation** (for cav communication and behavior) and need for training (sessions in schools and in driving schools)

Standadisation

- Information campaigns are not sufficient. Need **to test and to experiment** by themselves to increase the acceptance

Information vs Experimentation

- CAV are only of interest if the base of transport infrastructure of the surr and works well. Without this base, CAV do not improve the experience.



Thanks for your attention

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PasCAL project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815098

SUpporting acceptance of automated VEhicle

Nicolás Palomares

Instituto de Biomecánica de Valencia (IBV)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814999

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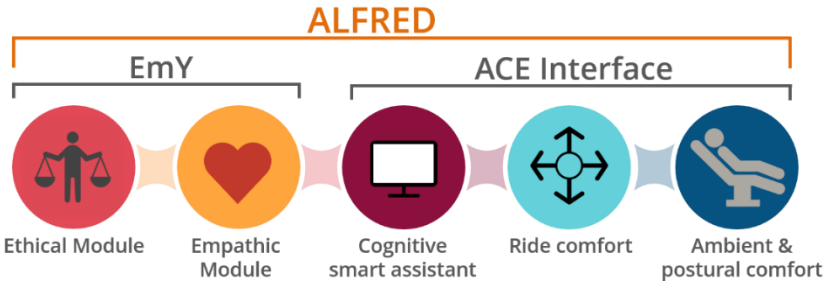
The SUaaVE approach

- Enhance **public acceptance** of **highly automated CAVs (L4+)** by increasing **trustworthiness**.

1
Social-psychological research on CAV acceptability

2
Cross-cultural framework for ethical and legal issues

3
ALFRED:
Humanise the vehicle actions



4
Immersive Virtual Human Centred Design (V-HCD) platform

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814999

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How do people react on board an autonomous vehicle?

- **Reaction** is directly linked with the **emotion felt on board**.

MAIN **POSITIVE** EMOTIONS

SATISFACTION

JOY - EXCITEMENT

MAIN **NEGATIVE** EMOTIONS

FEAR

Which are the most likely issues on board?

- Sense **loss of control.**
- **Lack of understanding** on current driving situations.
- **Feeling** neglected and treated like **a cargo** to be delivered.

How do passengers/drivers respond then?

- The **response** (and behaviour) is the **expression of the emotion**.
- **Negative emotional reactions** might **interfere** with **acceptance and use**.

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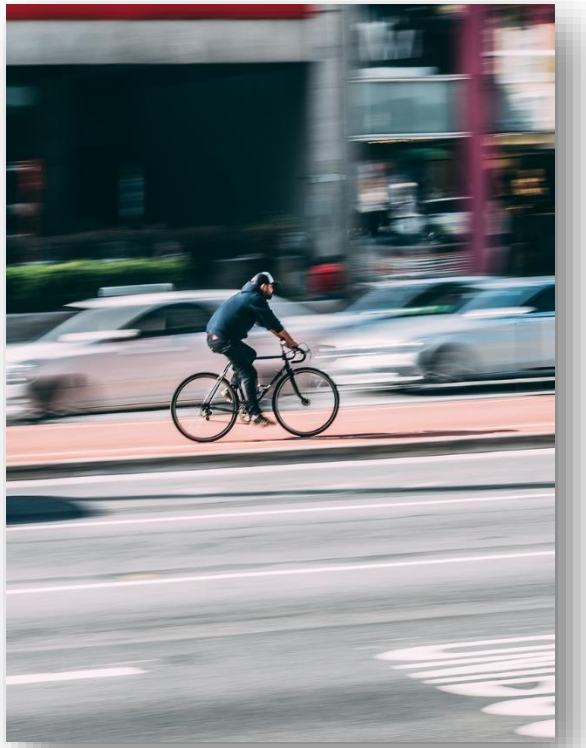
What about other persons?



- Acceptability of **cyclists** is **slightly lower** than of **drivers**.

- High **acceptability of road users with disabilities** because of **perceived convenience** (CAV could enhance their mobility).

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Which factors influence their response?

- People with **higher education rated self-driving cars** as **safer** than people with lower education.

- Automated vehicles are **more acceptable for people with a high interest in technology**.

- Greater **perceived environmental sustainability** is related to greater acceptability.

- **Greater driving frequency is related to lower perceived safety** of automated vehicles.

- **Women care especially more about control and environmental sustainability**. Women **scored significantly lower on acceptability**.

Deliverable 1.2. Model and guidelines depicting key psychological factors that explain and promote public acceptability of CAV among different user groups. RuG

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814999

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What surprised you from the tests results?

- **After experiencing CAV**, **perceived safety** and **trust** in CAV technology **increase**.
- **Ethics policies** protecting **the most vulnerable road user** are perceived acceptable, trustworthy, respecting human life, and fair both by passengers and pedestrians.
- The **emotional state of the participants** from different situations can be **estimated by their physiological signals**.
- **Minimize secondary information** from the HMI and **inform passenger about the vehicle action** only when necessary.

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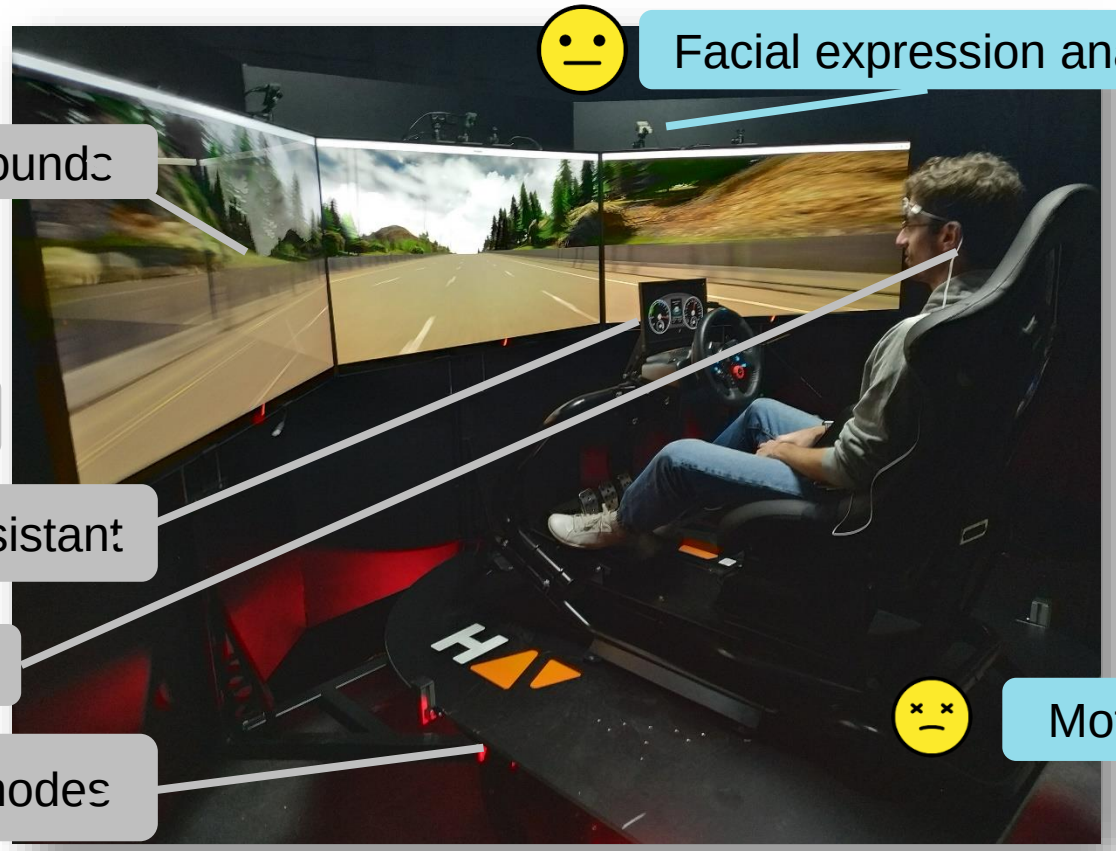
What did not work during the tests? Any lesson learnt?

Pilot test

Test

Engagement of participants



Facial expression analysis

Realistic scenarios & sounds

Context

Duration scenarios

Smart HMI with voice assistant

Physiological signals

Simulation dynamic modes

Motion sickness

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Conclusions

- **Acceptance** has a **high emotional component**.

- **EMPATHIC VEHICLES. <u>Understand how we feel</u>**, adapting the vehicle behavior.

- **User-friendly interface.**

- **High immersivity for testing**.

Thank you

For your attention

SUaaVE

Project Title: SUpporting acceptance of automated VEhicle

Consortium:

IBV Instituto de Biomecánica de Valencia · CRF Centro Ricerche Fiat · nextium by idneo · Bordeaux INP Aquitaine · esi get it right · rijksuniversiteit groningen · Applus IDIADA · IFSTTAR · Technical University of Munich · Institut VEDECOM

http://www.suaave.eu

@SUaaVE_project

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814999

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TRUSTONOMY

Building Acceptance and Trust in Autonomous Mobility

Do we trust self-driving cars?

Social acceptance of autonomous mobility

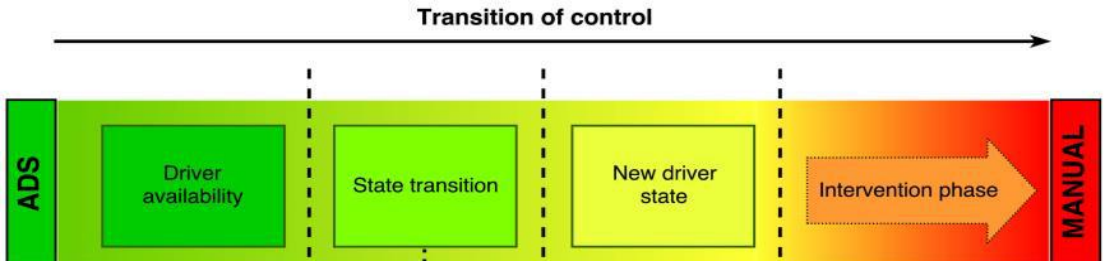
Stefano Bianchi

R&I Manager & Trustonomy Coordinator

algoWATT GREEN TECH SOLUTIONS

Trustonomy has received funding by the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 815003

Multidisciplinary approach



AUTOMATION LEVELS

L5	Full automated driving
L3 – L4	ADS performs the *dynamic driving task*
L0 – L2	Human driver in charge, ADS incremental support

Request to Intervene (RtI)
Transition of control

TRUSTONOMY

ASSESSMENT OF DRIVER STATE MONITORING (DSM) systems

Methodological Framework for the operational ASSESSMENT OF HMI DESIGNS

AUTOMOTIVE TECHNOLOGY ASSESSMENT

Novel DRIVER TRAINING tools and curricula for human drivers of ADS

MEASURE PERFORMANCE, TRUST AND ACCEPTANCE of human drivers of ADS

HUMAN FACTORS

AUTOMATED-DECISION-SUPPORT FRAMEWORK, covering liability concerns and risk assessment

Define a DRIVER INTERVENTION PERFORMANCE ASSESSMENT (DIPA) framework

AUTOMATED VEHICLE RESEARCH

Trustonomy has received funding by the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 815003

How do people react on board an autonomous vehicle*?

- Drivers usually are quite confident to pass control to the AV, *with glance switching to ensure safe passage*
- Generally understanding their role in the driver-AV partnership *with smooth "baton passing" in RtI scenarios*
- Reaction depends on: automation level, knowledge, familiarity (with modern technologies) and personal circumstances

Young people show greater self-confidence and trust in ADS
Less likely to question the correct operation of ADS
More likely to relinquish control of the vehicle

*AV simulators used in 1st iteration of trials

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Which factors influence their response?

- Actions required following the RtI seem to have effects on trust

  Simple monitoring action = vs Brake rapidly or change lanes ▼

- Reaction is influenced by: knowledge of the system, knowledge of UI and communication and (mostly) awareness of limitations

  - Familiarity with the system ⟶ know when to keep ready to intervene when near to system limits
  - Operational awareness ⟶ more confidence in ADS, more decisive and effective reactions

- Tendency to engage in Non-Driving Related Tasks (NDRT) significantly varies

  - NRDT cause distraction ⟶ Reaction time▲
  - Higher education ⟶ NDRT attention▼
  - NDRT engagement: generally > in men than women
  - Age ▲ ⟶ NDRT attention ▲

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What surprised you from the survey results?

- Drivers tend to overestimate their skills behind the wheel (“above-average”)

  but ~20% of respondants caused an accident or a collision → actual abilities?

- Despite awareness of positive impact of driving automation systems on safety, many people still do not know use them properly

  - Only 6% of participants received training on the use of driver support systems (i.e., know how to use them safely and consciously)

    - drivers’ ignorance about ADS could paradoxically lead to more accidents

  - Learning by driving / Learning by mistakes instead of proper training

    - additional stress and mental workload,

    - negative impact on: perception of traffic situations, attention, awareness and ability to intervene in dangerous situations

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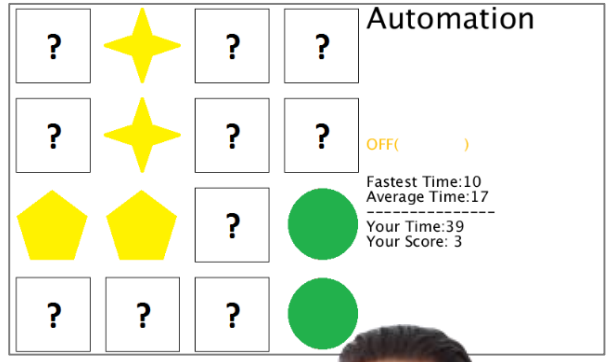
What surprised you from the tests results?

- Drivers became rather addicted to playing the distracting game provided
  - When full AD is operational, some drivers barely look up to the road
- Most drivers are sensitive to changes in criticality and urgency of the RtI scenarios
- If trust is reduced, it is quite quickly regained
- Disengagement: people less likely to take their eyes off the road, compared to either remove hands or feet
- Preferred HMI signals for RtI:
  - intense colour (**orange** / **red**) hands-on-wheel icon displayed on HUD + **seat vibration**
- 15 minutes of training effectively reduce the “fear” of using AV
- ~70% of respondents stated:

  “AV-related driver training should be mandatory”

  (both practical training and e-learning)



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Shortcomings, lessons learnt & take-aways

- COVID-19 PANDEMIC EFFECTS
  - Temporary denied/limited access to labs and facilities, also for researchers
  - Limited possibility to involve external trainees/participants – restrictions/safety rules
  - Additional expenses & longer timing – sanification of facilities/assets/vehicles/simulators

- Trust influences how AV technology is used and accepted
- Trust is affected by type of RtI events and by the RtI interface
- Insufficient knowledge may lead to distrust or overconfidence on ADS
- Current driver training-related regulations do not provide necessary practical skills and knowledg the recently introduced systems – driver curricula to be developed
- Future ADS drivers need preparation to safely perform the driving task, cooperate with the vehicle, understand its limitations and normal behaviour

2nd ITERATION OF TRIALS ON-GOING

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Thank you!

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Discussion / Q&A

European Commission

Discussion / Q&A

- **Future expectations/solutions to increase CCAM social acceptance and enhance driver behaviour.**
  - Awareness on opportunities and challenges of automated mobility
  - Ethics aspects
  - International aspects (CCAM beyond Europe)
  - Social acceptance and driver behaviour in automated mobility

Closing remarks

European Commission

Thank you for your attention - CINEA

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