UNIVERSIDADE LUSÓFONA

DREAMS
CENTRO INTERDISCIPLINAR DE DESENVOLVIMENTO E INVESTIGAÇÃO EM AMBIENTE, GESTÃO APLICADA E ESPAÇO

FCT
Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA

Older Drivers and Driving Automation

HUMANIST Summer School

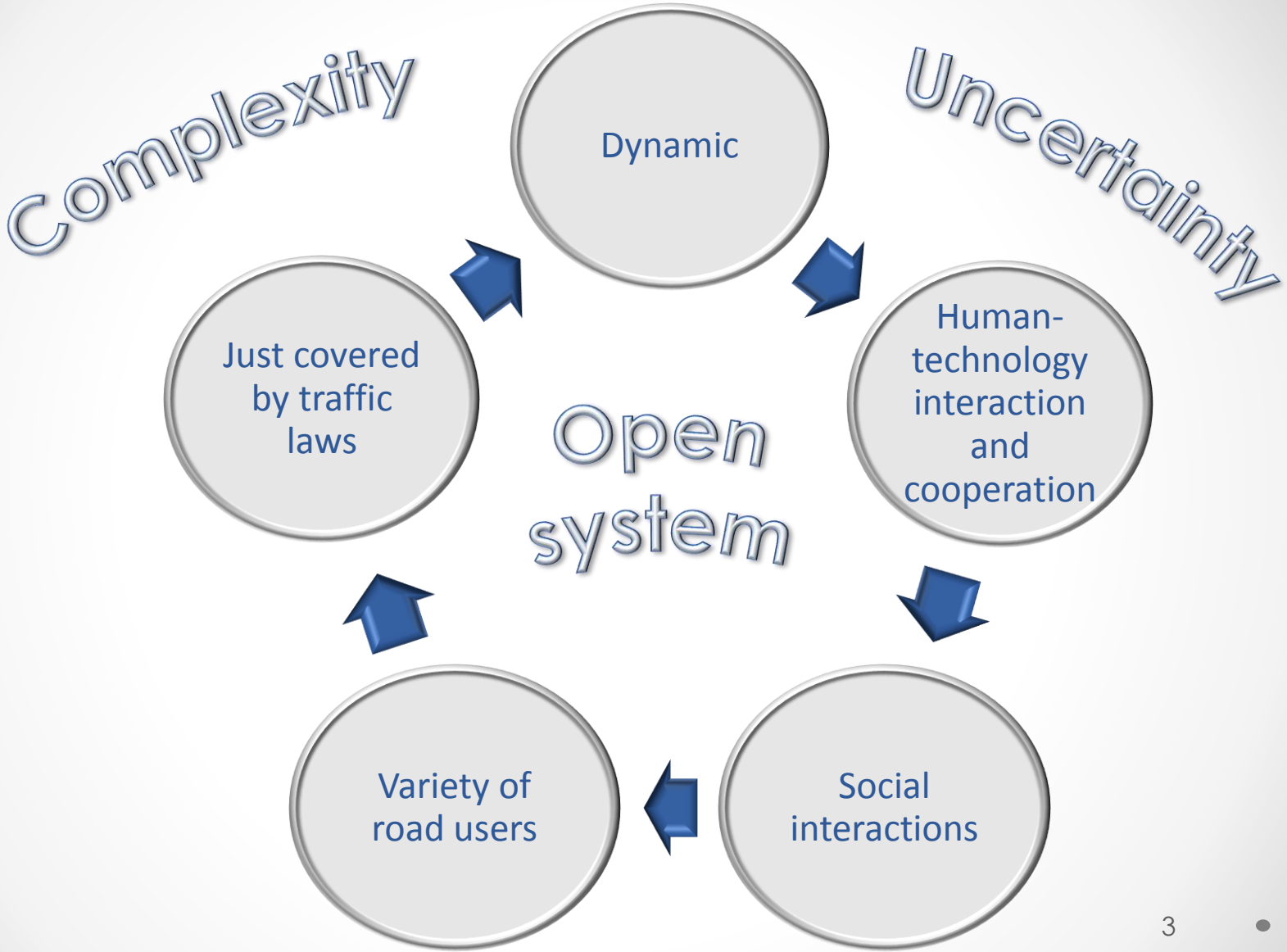
CTAG, 13-15/09/2017

Anabela Simoes

Introduction

- Driving automation represents a major technological advancement influencing and shaping the future of mobility.
- So far, few is known about safety and security issues, as well as the impacts of human-automation interaction in driving.
- It is expected that self-driving vehicles will share the road with conventional ones, which are driven by human drivers.
- This requires:
  - continuous research on human factors issues towards a perfect human-system integration,
  - specific actions towards public awareness on new risks introduced by self-driving vehicles on the shared road,
  - Training and education towards the appropriate use of automation, the prevention of risky behaviors and avoidance of misuse and disuse.

The road transport system



Road users

- Drivers
  - Common drivers
    - Private cars
    - PTW

    } Age, Experience
  - Professional drivers
    - Light vehicles
    - Heavy vehicles
- Vulnerable road users
  - Pedestrians
    - Age
    - Reduced mobility
  - Riders

Factors influencing the driver's activity

Mental workload

- Driver's functional state
  - Fatigue
  - Consumptions
- Task demands
  - Traffic conditions
  - Frequency of manoeuvres
  - Additional tasks to driving
  - Driver's variables:
    - Age
    - Experience

Factors influencing the driver's behaviour

- Cultural factors
  - Traffic law
  - Social environment
  - Behaviour norms

- Psychological factors
  - Attitudes
  - Personality

- Driving experience
  - Risk perception

Developing maturity, experience and anticipation ability

Older drivers and the RTS

- Older drivers are generally cautious drivers.
- They self-regulate their driving behaviour to minimize the risk of crashing.
- Despite individual diversity, older people develop the same self-regulatory behaviours for the same task performance to compensate their functional declines.
- Self-regulation behaviours include the insight to one's own limitations and related compensatory behaviours, which reduce:
  - the stress and anxiety felt by older drivers in some driving situations,
  - the risk related to driving in such situations.
- Avoidance behaviour is a self-regulatory behaviour that depends on high-level strategic choices requiring efficient metacognitive abilities.

Age-related limitations	Driving-related problem	Technology
Increased reaction time, inability to divide attention	Difficulty driving in unfamiliar/congested areas	Navigation; traffic information; VMS
Deteriorating vision, particularly at night	Difficulty detecting pedestrians at night and reading signs	Night vision enhancement systems; in-vehicle signing
Difficulty in judging speed and distance	Failure to perceive oncoming vehicles	Collision warning, automated lane changing and merging
Difficulty in perceiving and analyzing situations	Failure to comply with yield signs and traffic signals	In-vehicle signing and warnings; intelligent cruise control
Difficulty turning head, reduced visual field	Failure to notice obstacles; difficulties in merging/lane changing	Blind spot; automated lane changing and merging
More prone to fatigue	Getting tired on long journeys	Intelligent cruise control; automated lane following
General effects of aging	Worries about driving to unfamiliar places, driving at night, and driving in heavy traffic	Emergency systems; route guidance; traffic info via on-board display, and use of VMS
Impairments varying in severity	Concern over fitness to drive	Driver condition monitoring

The RTS and older drivers

Pre-conditions for an effective self-regulatory behaviour	The use of experience, a more stable and user-friendly road environment.
The diversity of in-vehicle technologies	Increase the task complexity, reducing the possibility of using previous experience.
To improve or maintain older drivers' safe mobility	Specific training programs to contain age-related declines technology-based support to the driver.

The RTS as a safety-critical system

The technological development impose fast, efficient and precise actions to human beings

The success of actions, resulting from a good cooperation between humans and technologies, require the identification of the different factors leading to the variability of performance

These factors, resulting from the human diversity and short-term and life span variability, contradict the assumption of the stability of human activity over time that presides to the design and management of numerous systems

Human variability, resulting from diversity or the instability of human activity, is an uncomfortable reality that systems designers and managers have to face and proceed accordingly

Complex and safety-critical systems

The more developed and technology-based working systems are	the more safety critical they become	imposing high performance levels towards safety and efficiency
As much as a system is complex and safety critical	the more human's skills and abilities are important	human variability and instability, as well as human behaviour
the more skilled and competent the operators are	the better they can compensate for their functional declines	the less their performance is influenced by transient factors

Transient factors increase variability and lead to uncertainty
Aging
Adequately managed in each organisation

The human side of technology

Human actors in every system represent the most flexible, adaptable and valuable elements of any system

- They learn with experience as responsible, collaborative, tool creating/wielding agents towards success.
- Even under resource and performance pressure, they learn and adapt to different situations and multiple task goals.

They are also the most vulnerable elements of a system, as a result of human variability and instability, as well as human behaviour

Human variability

The great variability among human beings is a source of uncertainty

- **To older people, driving a private car represents more autonomy and promotes their self-esteem being also a symbol of freedom, independence and self-reliance.**
- **The private car is also perceived by them as the safest and most comfortable and reliant transport mode.**
- **The RTS must be managed as an open system accommodating a huge diversity of users who evolve for different purposes in different routes interacting on the road environment.**

Transient factors of variability creating uncertainty

- Fatigue, mood, distraction, sleep deprivation
- Ageing and the related effects on functional abilities

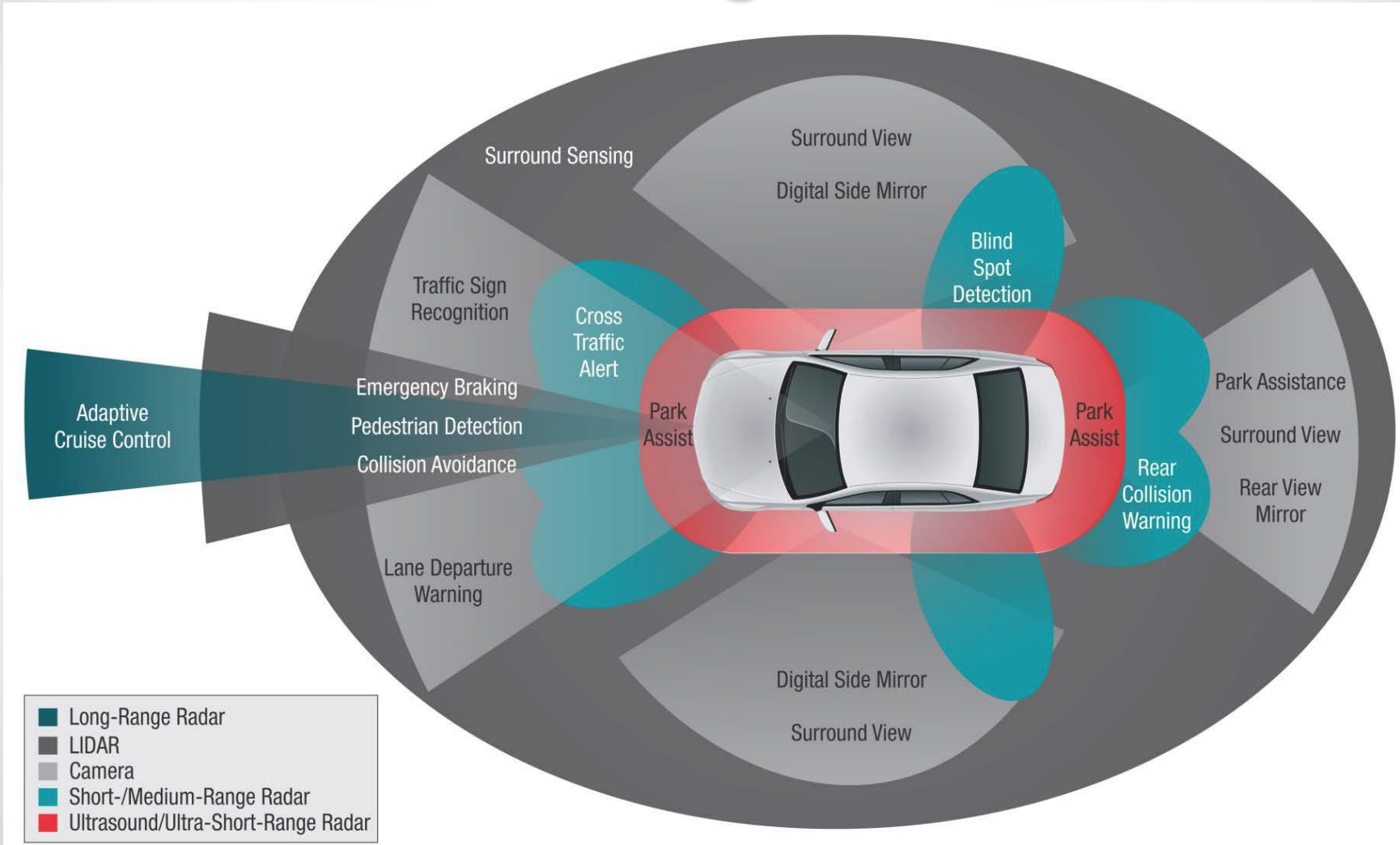
Such variability is also related to the ability of humans to permanently adjust their performance, in order to maintain a certain degree of stability

- Sustained adaptability
- Self-regulation

Innovative technology in the RTS

- The purposes behind the introduction of new technologies on the road transport system:
  - improving safety, mobility, system efficiency and environment protection,
- This requires:
  - a good acceptance of the innovation and related trust, which depends on:
    - the system design with people in mind, accommodating the needs and expectations of all potential users;
    - the respect for users' rights (privacy and security);
    - the provision of adequate training.
- These are key issues that will favour the person's trust on the technology and its appropriate and safe use.
- The same principles are required for any technological innovation in the road transport system, such as, **automation**, which is coming faster than expected but most road users have an unrealistic representation of self-driving vehicles.

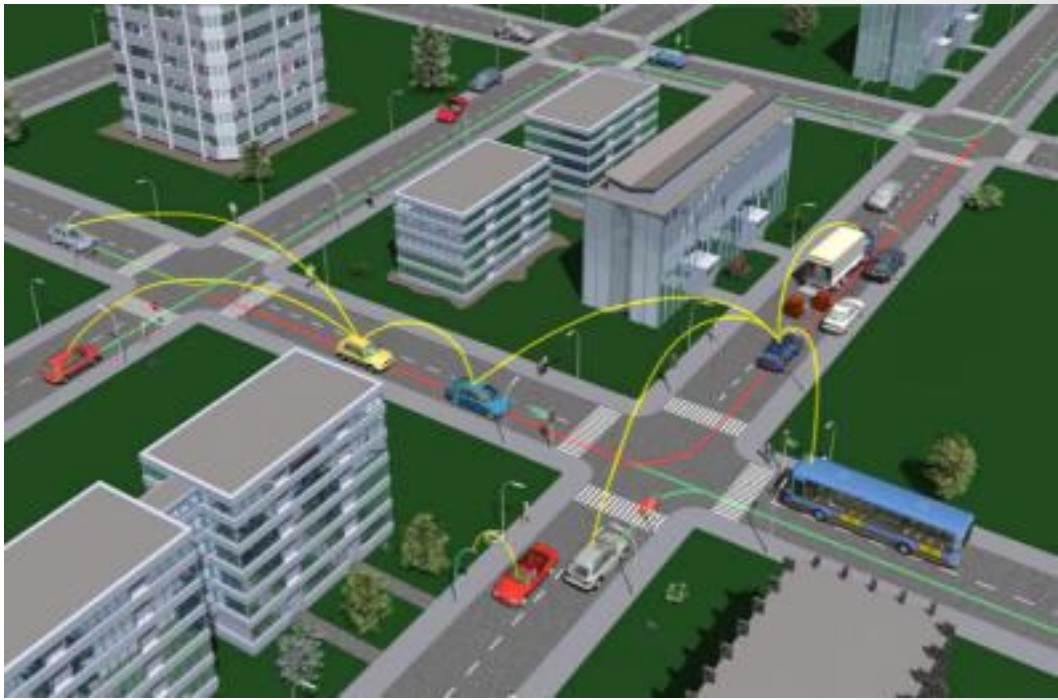
In-vehicle technologies



Cooperative systems

Communication based on the interaction between vehicles and the infrastructure:

- Vehicle to infrastructure
- Vehicle to vehicle
- Vehicle to others
  - traffic control, emergency services, police, etc.



An automated road transport system

- The evolution towards a fully connected and automated RTS is being fast but it will be much slower in terms of adaptation of all users to a fully regulated, connected and automated system.
- Similarly to aviation, a well-trained, competent, skilled and in good fitness driver is required behind the wheel as, at any moment, he/she could be called to intervene.
- A fully connected and automated road transport system doesn't seem compatible with the complexity of the nowadays shared space on the road environment.

Autonomous vehicles

The long run towards driving automation

Human-centred automation as a transfer of cognitive functions to the technology defining the attributes of automation and following guidelines supported by a set of design criteria.

This transfer should be supported by a task and activity analysis.

- The available simulation capabilities allow for testing the system and carrying out such analysis since very early design phases.

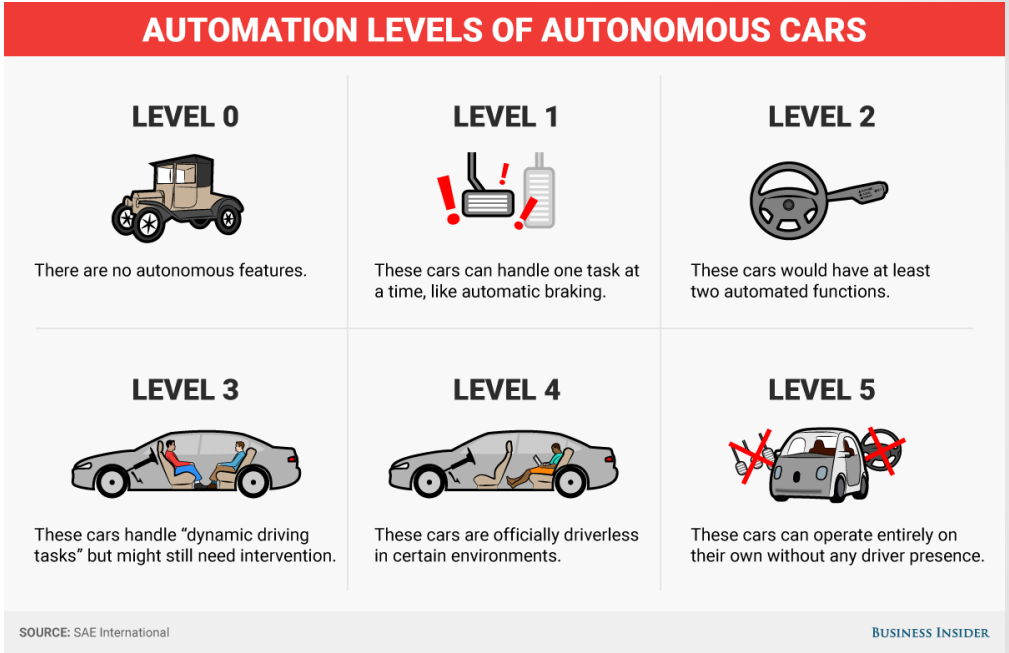
In the evolution towards automation, there is a progressive isolation of the human operator from the mechanical system requiring a reciprocal adaptation between the human and the technology.

The human operator is not replaced by the machine but instead he/she is cooperating with the technology,

- This requires higher levels of knowledge and understanding than before, as well as the system acceptance and trust.

Levels of automation (SAE)

- 0. No automation
- 1. Driver assistance
- 2. Partial automation
- 3. Conditional automation
- 4. High automation
- 5. Full automation



Automation level	Dynamic driving sub-tasks		Functional capability	
	Sustained execution of lateral and/or longitudinal control	Object and event detection and response (OEDR)	Fallback Performance of Dynamic Driving Task (DDT)	Driving Mode Circumstance, Location Capabilities
The human driver monitors the driving environment				
0 No automation	Driver	Driver	Driver	None of the DDT is automated
1 Driver Assistance	Driver and system	Driver	Driver	Some driving modes
2 Partial Automation	System	Driver	Driver	Some driving modes
The automated driving system monitors the driving environment and performs the entire DDT while engaged				
3 Conditional automation	System	System	Driver	Some driving modes
4 High automation	System	System	System	Some driving modes
5 Full automation	System	System	System	All driving modes

Levels of automation

- Since the last decades several studies proposed different levels of automation resulting from theoretical classifications of the different functions to be allocated to the technology.
- A new taxonomy has been proposed in the context of automation in air traffic management (ATM):
  - The LOAT (Level of Automation Taxonomy).
  - The taxonomy is organized according to the generic functions to be allocated to the system (defined by Parasuraman, Sheridan & Wickens, 2000 and Endsley & Kaber, 1999) :
    - information acquisition,
    - information analysis,
    - decision and action selection,
    - action implementation.

Driving automation and Self-driving Vehicles

Automation requires a human-centred design approach in order to avoid bad and poor outcomes from well-intentioned but poorly designed and tested technology.

From a human-centred design approach, the role of the human in driving automation and his/her interaction with such technology should lead research and development in this field.

The extent of automation should be decided based on the identification of the cognitive functions to be transferred from the human to the technology.

It should be highlighted that the same approach that has worked for automation in industry might not work for a dynamic system like any transport mode.

Drivers' preferences for driving automation

A survey aiming at identifying the drivers' preferences among three levels of automation, including preferences for interacting with and overall concern about riding in self-driving vehicles (Schoettle & Sivak, 2016)

- No self-driving, partially self-driving completely self-driving

From a total of 618 licensed drivers in US (23,6% being 60 years old and over), the most frequent preference for vehicle automation

- for no self-driving (45,8%)
- partially self-driving (38,7%)
- completely self-driving as the last preference with 15,5%

It was also noted that the preferences for self-driving generally decreased with increasing age (60 and over)

- 56,2% for no self-driving
- 34,2% for partially self-driving
- 9,6% for completed self-driving

Drivers' preferences for driving automation

Regarding gender differences, similar percentages were found with females and males preferring no self-driving most frequently

- 48.4% for females
- 43.1% for males

This is expected once common citizens are not so much aware of innovation in the car industry and see those times very far from nowadays

- It will take much time until having a fully connected and automated road environment

It will take time as it will be necessary that users

- Appropriate the current innovations in this field,
- Develop trust on their use and the required willing to use & pay for it

Concerns about drivers and self-driving vehicles

- Due to both safety and security issues featuring the RTS, the new reality involving autonomous vehicles and automated driving requires:
  - the acceptance of the automated technology by users together with the formation of the required trust on technology.
- For all road users, the public awareness and understanding of the actual changes are also necessary, together w/ new regulations.
- The new reality will generate behavioral adaptations, which should be facilitated by
  - the road environment design, new traffic laws and the provision of appropriate and in due time information and training.
- There is still a long way towards a fully connected and automated road transport system.
- If the technological development is fast, the use of the related innovation by users (common people) takes time.

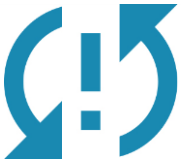
Concerns about older drivers and self-driving vehicles

- Due to their resistance to changes, older drivers will require some specific actions:
  - Training, which should target
    - The understanding of the innovation and its benefits in terms of fitting their mobility needs in safety and security conditions
    - The learning of the technology functioning and its limits
    - The trust on the technology, which will depend on successful experience and the maturity of the technology
    - The users' willing to use the technology
  - Public awareness addressing changes and their benefits
- The increasing variety of vehicles in the road environment during the next decades will increase older drivers' difficulties in adherence to automation.

Some of the main human factors challenges

- Although the importance of user acceptance, there is much more:
  - Designing with the user in mind (and preferably engaged in the process)
    - Mode confusion
    - Reduced situation awareness
    - Long-term effects (skills loss)
    - Age, ability and cultural differences
    - Trust versus complacency
    - The adequate time to resume control

What do we need to know?



Older drivers

Automated cars in connected environment

Your suggested research questions

Research questions

Many questions without answers are arising and answers are urging.

The following research questions are based on the general assumption that "**the better the automation is, the less attention drivers will pay to traffic and the technology and the less able they will be to resume control**":

- Which are the drivers' preferences for the automation levels across gender, age, education level, user group, etc.?
- Which are the limits of the technology?
- Which changes in traffic laws, as well as drivers' licensing and training are required?
- Will the driver become just a passenger?
- Are remote drivers/controllers previewed?
- Will the driver be functionally ready to resume the control of the vehicle following a period of automated driving?
- Are there unsafe behaviours when switching control modes of the vehicle?
- Which behaviours in automatic driving will be considered misuse?
- Automated driving as a good mobility solution for older drivers?
- Older drivers' concerns about safety?
- Security issues?

Thank you for your attention

anabela.simoes@ulusofona.pt