RSS2019 ROAD SAFETY & SIMULATION INTERNATIONAL CONFERENCE
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Transformations in Transportation

The University of Iowa
The National Advanced Driving Simulator

Interaction between autonomous vehicles and vulnerable road users

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Presentation outline

1. Automated driving
2. Vulnerable Road Users Road Safety
3. Vehicle automation and the impact on VRUs
4. Conclusions
5. Discussion

Automated Vehicles

When considering vehicle automation, usually **two approaches are distinguished:**
1. smart infrastructure with a non-intelligent vehicle
2. non-smart infrastructure with an intelligent vehicle

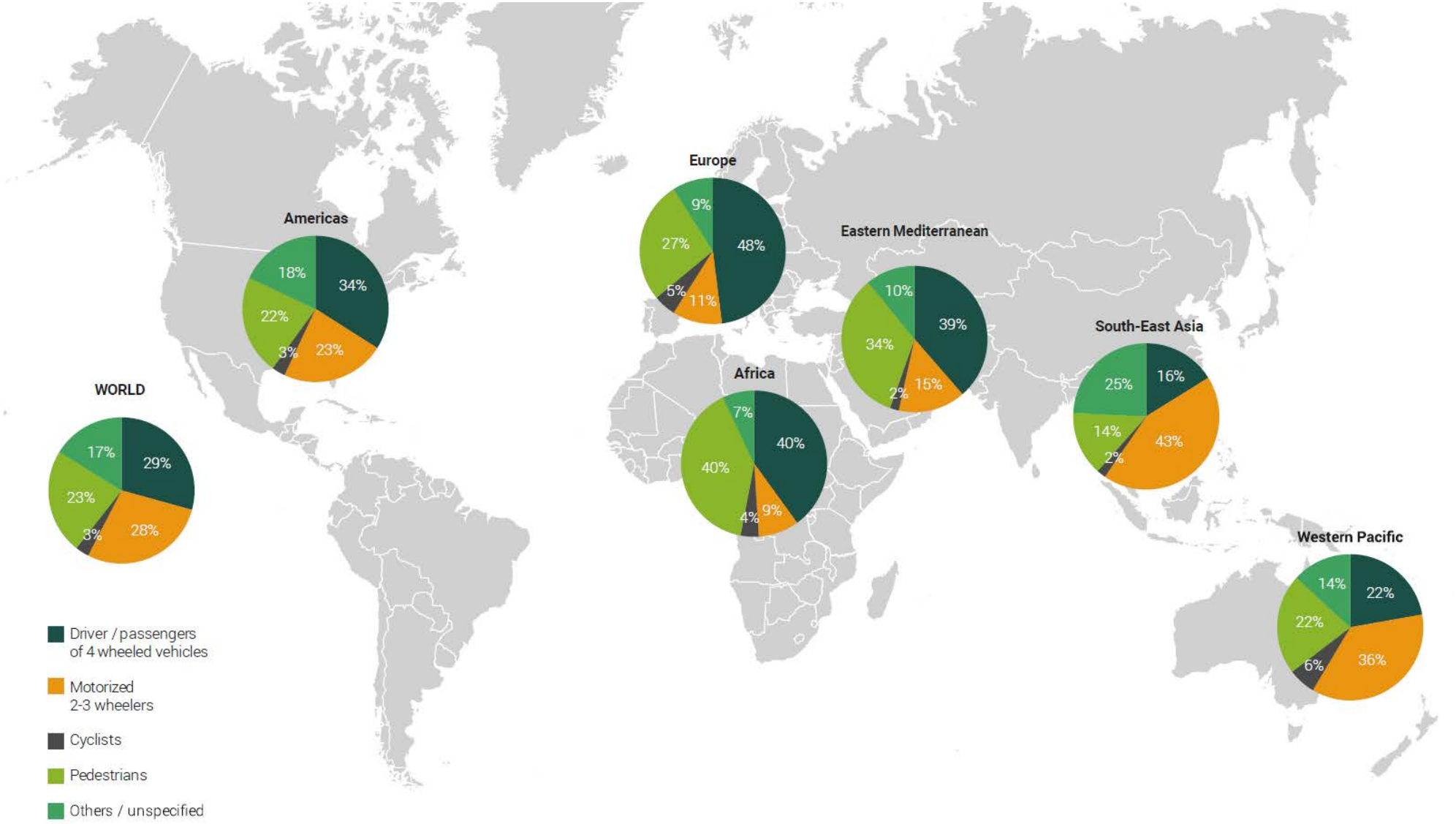
By means of the cooperative driving-approach, developments towards full automation **will be implemented in stages**, with an increasing number of tasks being automated until finally the fully automated traffic system becomes a reality.

Automated Vehicles

- Methods and metrics for human factors research at **higher levels of automation** are missing.
- Highly and fully automated test vehicles are independent and researchers have often **limited access to them**.
- Vehicle automation will require VRUs to **adapt to a changing road traffic system** and a **different type of road user**.
- Major challenge: **Conflict points – Intersection in urban areas**

VRUs Road Safety

Share of road fatalities per transport mode in different world regions (WHO, 2018)



VRUs Road Safety

FACTS

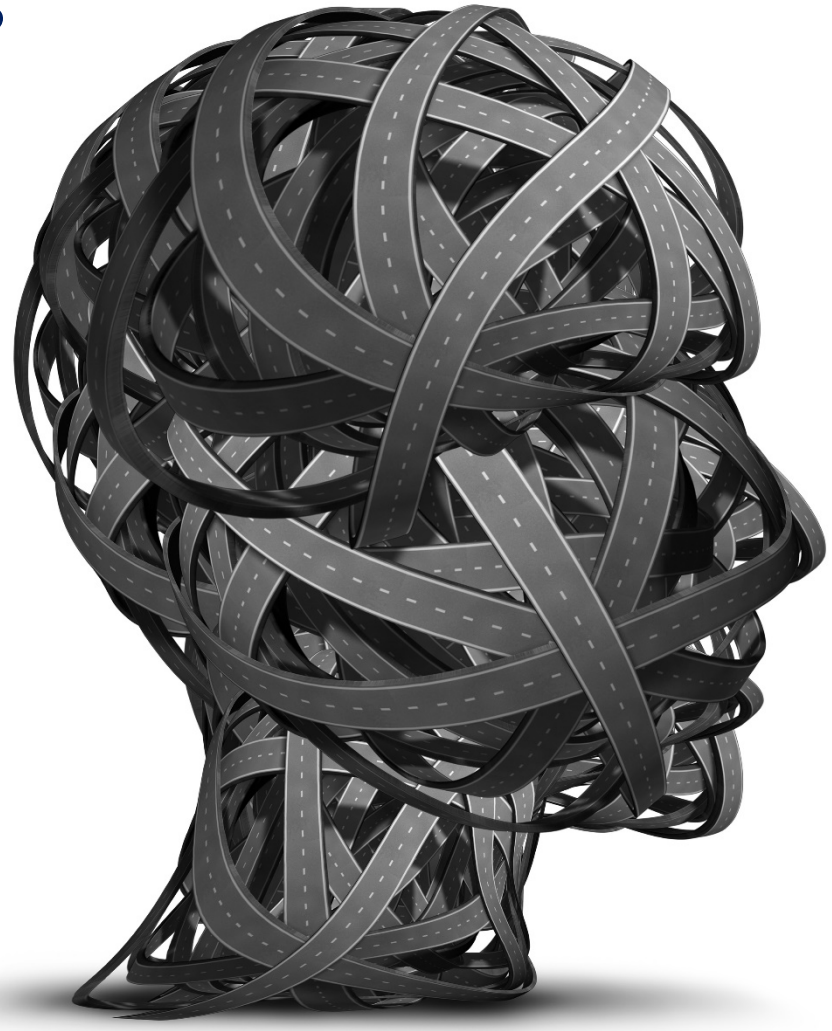
- Many pedestrian and cyclist fatalities on **urban intersections**
- Pedestrians and cyclists fatalities account for more than **32%** of road fatalities in EU
- Most pedestrian and cyclist fatalities in **collisions with vehicles**
- Most pedestrian and cyclist fatalities are **males**
- **Highest fatality risk** for older pedestrians and cyclists

The human factors perspective

What factors currently impact interactions?

- **Visibility**
  - Can pedestrian/cyclist be seen?
- **Choice of Crossing Location**
  - Crosswalk/midblock/other, distraction
- **Choice of When to Cross**
  - Gap judgment, social norms
- **Behavioral Interplay**
  - "Negotiation" between driver & VRU

Understanding **each other's intent is crucial** for safe and pleasant interactions between road users.

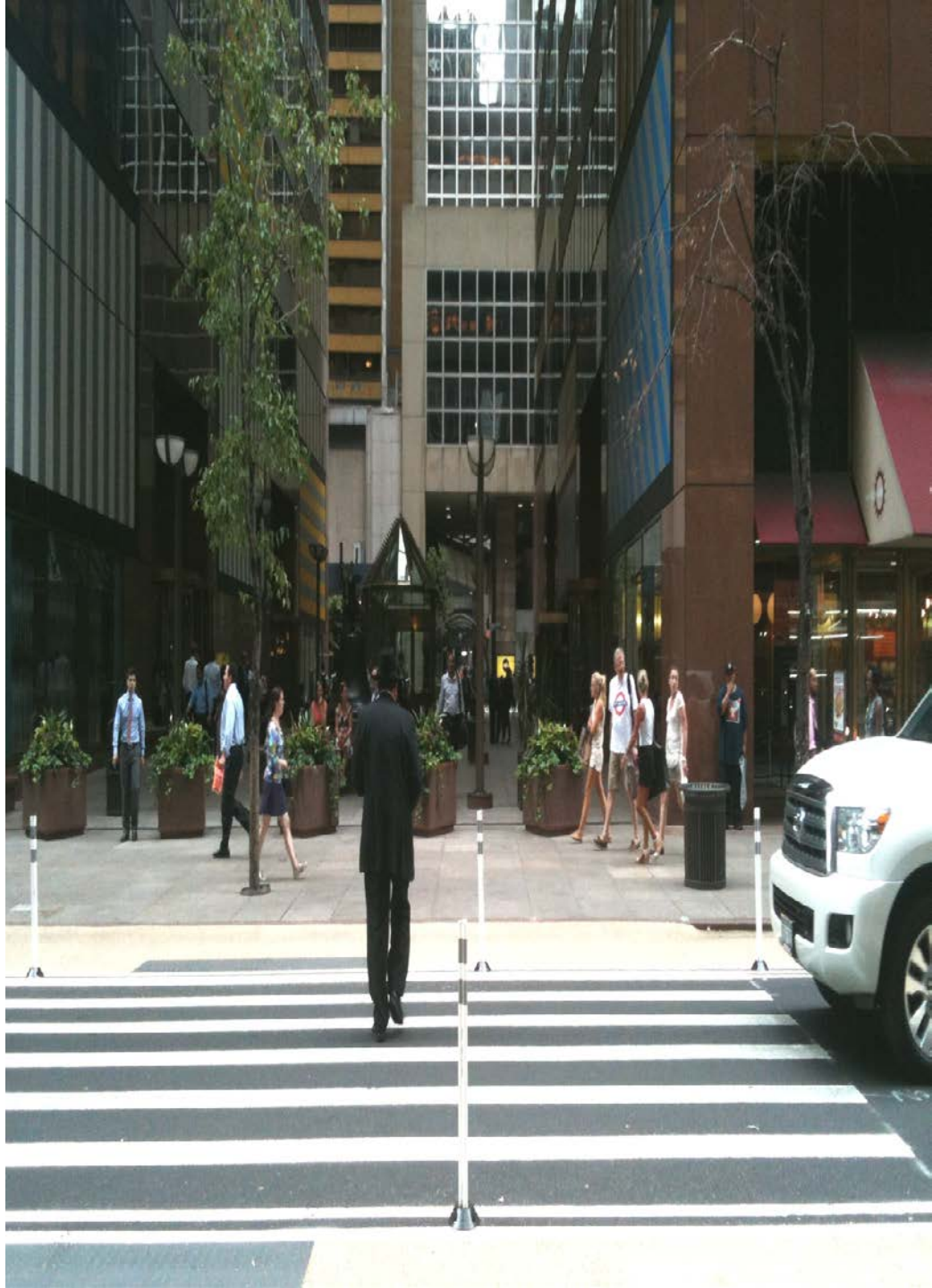


Vehicle automation and effects on VRUs

- **Individual differences**
  - The fact that road users are not at all a homogenous group constitutes a challenge.
- **Expectations**
  - Road users base their expectations of what the others are going to do on a variety of aspects.
- **Behavioural adaptation**
- **Informal rules and non-verbal communication**
  - Sometimes, the formal traffic rules are replaced by informal ones.

A recent study

- Velasco et al., 2019, aimed to investigate how the physical appearance of the AV and a mounted external human-machine interface (eHMI) **affect pedestrians' crossing intention**.
- Fifty-five individuals participated
- The results show that the presence of a zebra crossing and larger gap size between the pedestrian and the AV **increase the pedestrian's intention to cross**.
- In contrast to one's expectations, participants intended to **cross less often when the speed of the vehicle was lower**.
- Participants who recognized the vehicle as an AV had, overall, **lower intentions to cross**.



Conclusions

- Many car manufacturers, supported by scientific research, are developing **safety and communication systems** that aim to avoid collisions with VRUs.
- Nevertheless, **many difficulties are yet to be overcome** (e.g., reliable operation in adverse weather conditions), and it is even more challenging to develop technology that can **reliably predict** intentions and behaviour of pedestrians and cyclists.
- So far, systems have been mainly developed from the perspective of the vehicle and it is not clear to what extent these systems can deal with the **often unsystematic behaviour of VRUs**.
- Moreover, it cannot be excluded that the behaviour of pedestrians and cyclists **changes** if they have to interact with automated vehicles or, in the likely transition period, with a combination of fully automated vehicles, partly automated vehicles and manually-driven vehicles.

Discussion 1/2

Hard bets to be won with one common goal: Safety

- Pedestrians feel **a little uncomfortable** when seeing a driverless vehicle
- To what extent do **personal characteristics** (age, gender, experience, motivation, trust in automation, etc.) affect the behaviour and decisions of pedestrians and cyclists?
- What cues will become important for pedestrians/cyclists when **interacting** with automated vehicles? **Is eye contact as important as is assumed**?
- An **eHMI** helps pedestrians to interpret a driverless vehicle as being no threat

Discussion 2/2

- Do pedestrians and cyclists need to adapt their behaviour to **different levels of automations** and if so, how can vehicles be made distinguishable?
- To what extent need pedestrians and cyclists be trained to deal with automated vehicles and e-HMI, and **what can be trained** and how?
- Research on the detection of mobility-impaired VRUs such as **manual or electric-powered wheelchair** users seems to be lacking.

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