Road safety in an uncertain technological future

Ana Martins – Ph. D. Student
(CERIS, Instituto Superior Técnico, Universidade de Lisboa)
anarmrmartins@tecnico.ulisboa.pt

Filipe Moura (presenting author) – Associate Professor
(CERIS, Instituto Superior Técnico, Universidade de Lisboa)
fmoura@tecnico.ulisboa.pt

Carlos Azevedo – Associate Professor
(Technical University of Denmark)
climaz@dtu.dk

October 25, 2018

Contents

1. AVs and Expectations of positive impacts on road safety

Six Dimensions for AVs and Road Safety

Summary and Conclusions

“who does what, when”

Human driver monitors the driving environment

No automation

Driver assistance

Partial automation

Conditional automation

High assistance

Full automation

Automated driving “system” monitors the driving environment

1. No automation

2. Driver assistance

3. Conditional automation

4. High assistance

5. Full automation

(USDOT/NHTSA, 2016)

Expected advantages...

representative but certainly not comprehensive

• User perspective
  – Greater mobility freedom
  – From disutility to utility of travel time
  – Another mode of shared mobility (more flexibility)
  – Possibly, no or less car ownership costs
  – Fewer traffic collisions (elimination or minimization of human errors)
Expected advantages ...
representative but certainly not comprehensive

• Operation perspective
  – Reduced congestion
  – More effective navigation (less time losses and costs)
  – More effective use of vehicles (Shared AVs)
  – Reduced number of on-road vehicles (Shared AVs)
  – More efficient infrastructure (e.g., platooning)
  – Less infrastructure repair and maintenance costs (incl. those related to accidents)

• Society perspective
  – Better mobility for impaired and senior citizens
  – Reduced externalities (if electric and shared AVs)
  – Reduced accident rates and less societal losses
  – Increasingly feasible transportation services of enhanced safety, reliability, security, and productivity

Problems ...
representative but certainly not comprehensive

• User perspective
  – Costs
  – Privacy loss
  – Computer malfunctioning
  – Hacking of AV
  – Liability in case of accidents

• Operation perspective
  – Upgrade for connected infrastructures and vehicles
  – Different patterns of pavement deformation
  – Hacking of the system
  – Weather (heavy rain)
  – Technology not fully mature
  – Relies heavily on satellite systems
Problems ...
representative but certainly not comprehensive

- Society perspective
  - Loss of jobs
  - Equity
  - Potential pollution increase (if not electric)
- Terrorist attacks
  - If just another technological change, more vkm potentially

The automation of driving task takes the human error out of the safety equation and it promises to reduce the number of accidents and victims. (Fagnant & Kockelman, 2015; Hayes, 2011)
The human error is blamed for 90% of road accidents. (Maddox, 2012)
2. Six Dimensions for AVs and Road Safety

A proposal for a Framework of Reference

- Less control by humans => less human-related mistakes
  - Ethics: non-ethical human behavior towards AV (e.g., imagine an AV in a circle; bullying?)
  - Offsetting behavior: higher perceived safety => more careless behavior (e.g., belts)
  - New realities:
    -automation reduces driving experience => reduce capacity of reaction
    - Transition period when drivers will share the road with driverless cars or with pedestrians and 2-wheelers

- More flexibility & comfort => more VKM?
  - New realities: Travel time becomes a positive utility => More urban sprawling
  - Rebound effect: More flexible and easy-to-use (no parking issues) => More trips
  - New scenarios: Empty trips in passenger transportation; new congestion patterns with fierce taxiing competition and private AV
Proof and validation of new technologies

- New scenarios: AV’s software capabilities might change with new traffic patterns in the future
- Time: New technologies must prove they are reliable, especially in these circumstances where safety is a cornerstone issue
- New development: Technological development is fast and new technological solutions must be tested constantly (new validation methodologies are required)

Better hardware, sensors and software capacity for new problems

- New development: New technological solutions solve problems at a fast pace
- Diffusion: Challenges (such as safety) depend on rapid diffusion of new technologies (bad experiences can slow down the pace of diffusion – Tesla accident)
- Segregation: Diffusion of innovation must not depend on standard technological penetration of the automotive industry, i.e. new technology with new cars (software updating and hardware standardization)

Integration of innovation into society

- Segregation: Vehicles with drivers and driverless vehicle will coexist (at least at intersections). In the beginning, segregate AV. In the future, segregate old (current) technologies
- Points of conflicts: Intersections are always a major problem, also with AV (in potential conflict with all other modes)
- Data: Standard protocols have to be defined in a connected road environment (V2V or V2I) for the consistency of the system

The decision-maker

- Data: Software must be robust to resist hacks; It must be interoperable between makes and across countries
- Liability: Liability in AV is from the car producer; seller; software developer; software distributor? Implication for insurance companies?
- Ethics: Moral decisions can’t be learned. They must be programmed according to idiosyncrasies. These vary from country to country and culture to culture.
Contents

AVs and Expectations of positive impacts on road safety

Six Dimensions for AVs and Road Safety

A proposal for a Framework of Reference

Summary and Conclusions

1. Human behavior
2. Ethics
3. Liability
4. Data
5. Offsetting behavior
6. Time

New development

Points of conflict

Diffusion

Software development

Travel behavior

Technology maturity

Technology deployment

Innovation and development

New calls

New scenarios

Rebound effect

Segregation

Road safety & AV

Policies

Legislation

Regulation

Conclusion

The future is being built now:

• To prepare the society for the diffusion of the AV
• And before that:
• To define regulation for AV

Do not forget that the human being is in the center of development.
### Selected References

**Human behavior**


**Travel behavior**


**Technology maturity**


**Technology deployment**


**Innovation and Development**


**Software Development**