Cross-study research on utility and validity of driving simulator for driver behaviour analysis

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Motivation

Situation

- When facing current challenges and complex environment, researchers need to understand drivers behaviour
- To do surveys or even observe driver's in the real environment is not always applicable
  - Costly
  - Not available for new scenarios
  - May be risky for the drivers…
- Driving simulators have been used for such task

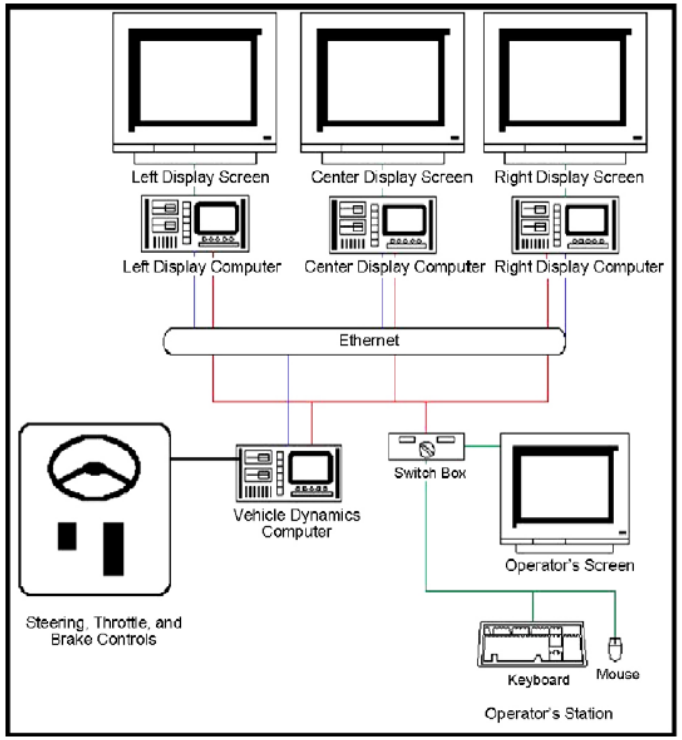
We must always answer the following questions:

- Are simulators able to imitate real driving?
- Are simulators studies results explanatory for real world driving?
- Are simulated experiments sufficient to learn about the driver's real behaviour?

What are actually driving Simulators?

- Simulates vehicle driving experience
- It's purpose is to study individual drivers behaviour
- Complex software and hardware setup aiming on imitating real car
- Very high hardware requirements
- Often real car-like experience for participating driver

Source: Czech Technical University, Faculty of Transportation Sciences



Driving Simulator

Driving simulator is an excellent alternative to performing dangerous and costly experiments on real roads, especial when testing extreme conditions or new applied solutions in car.

http://www.highriskautopros.ca/drowsy-driving-ever-hit-road-tired/

http://songpaz.blogspot.cz/2013/06/music-music-music-music-music-music_73.html

Experiment in Driving Simulator

What does it mean to prepare driving simulator experiment?

Source:
www.emercedesbenz.com (Mercedes-Benz advanced driving simulator)

Experiment setup steps

- Definition of the desired experiment deliverables,
- Defining of the simulated road geometry,
- Defining of the driving conditions (weather, time of the day etc.),
- Defining of the surrounding traffic,
- Defining of the desired data collection,
- Design of additional data collection tools if needed

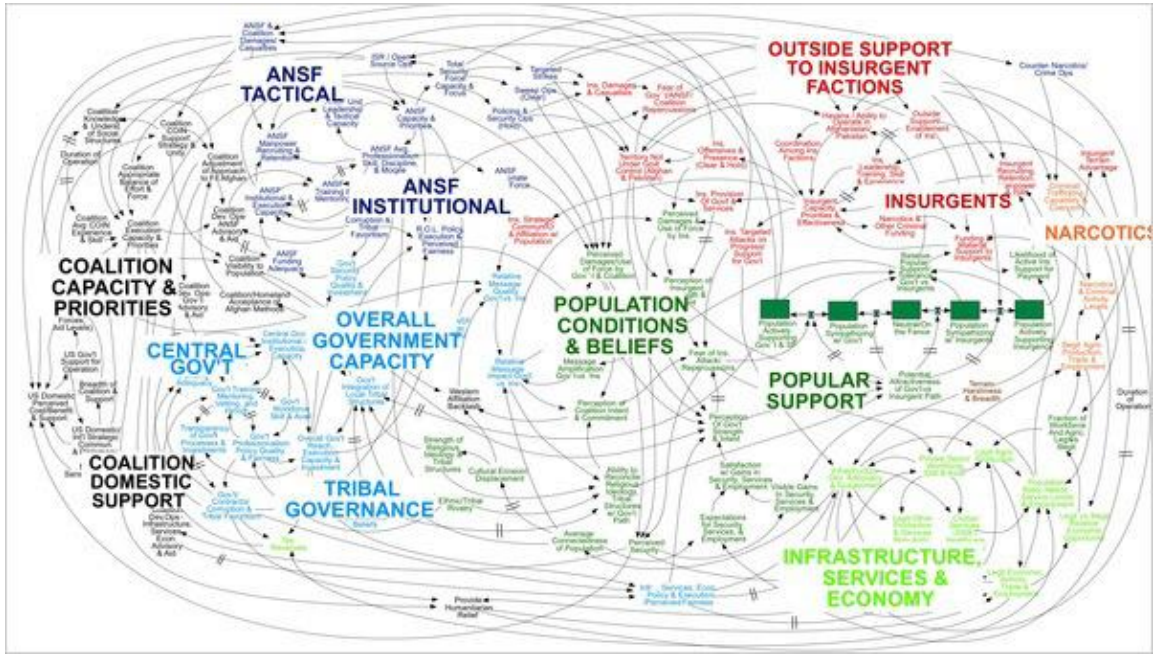
Benefits of Driving Simulator experiments

- Very good repeatability and controllability of the experiment conditions
- No physical risk in case of experiments testing driver distraction, micro-sleeping or other dangerous conditions
- Low cost of research due to no need of insurance for participants and fuel for driven vehicle
- No legislation problems with installing of additional devices in vehicle
- Easy and robust data collection possibilities

De Winter J.C.F., van Leeuwen P.M. and Happe R., *Advantages and Disadvantages of Driving Simulators: A Discussion, (2012)*

Challenges of Driving Simulator experiments

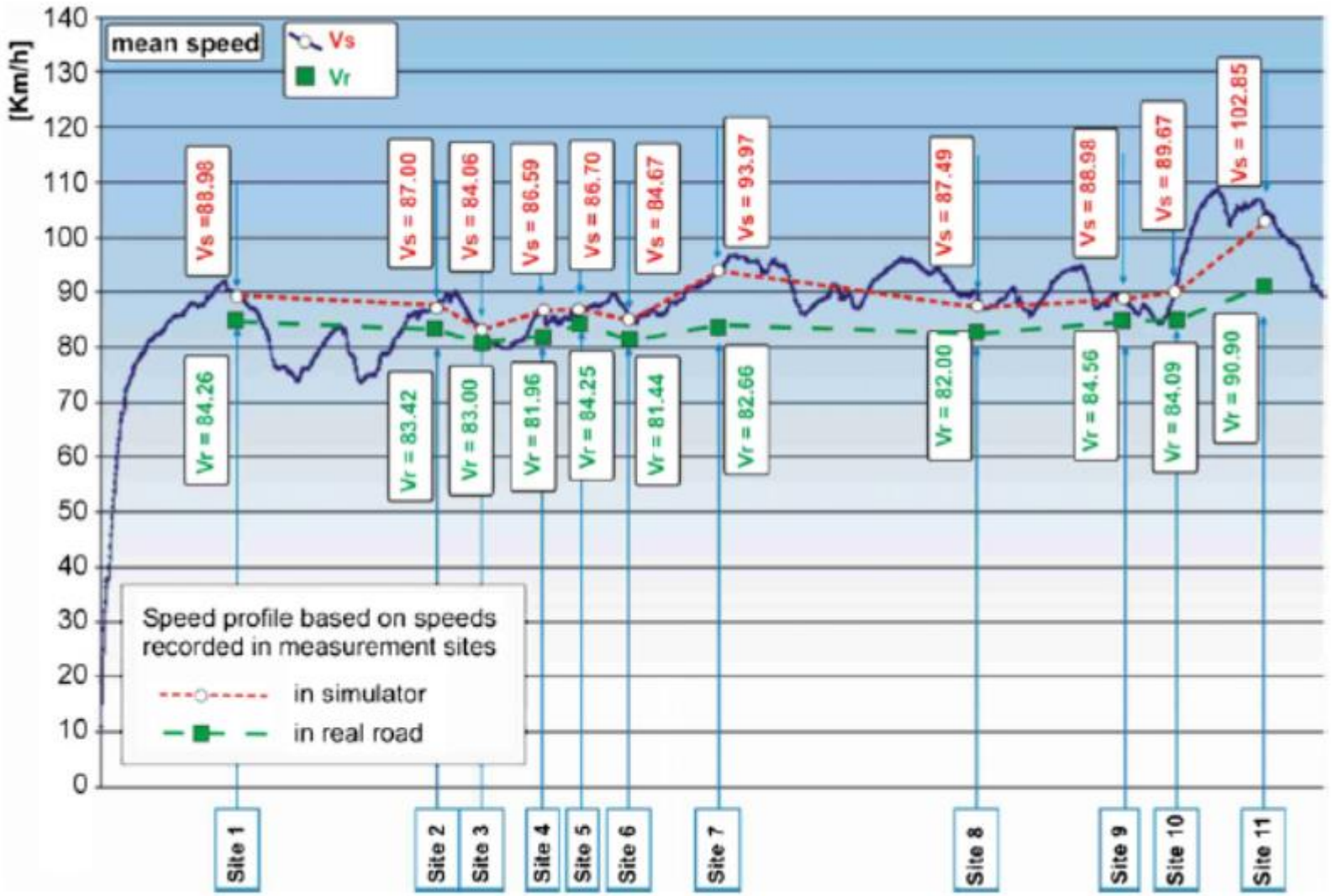
- Questionable validity of the simulators results
- Limited physical, perceptual and behavioural fidelity may cause unrealistic driving behaviour
- Simulator sickness due to the lack of acceleration forces
- Need of detailed and demanding experiment design



Does it work?

- Multiple studies proves validity depending on type of experiment and measured aspects

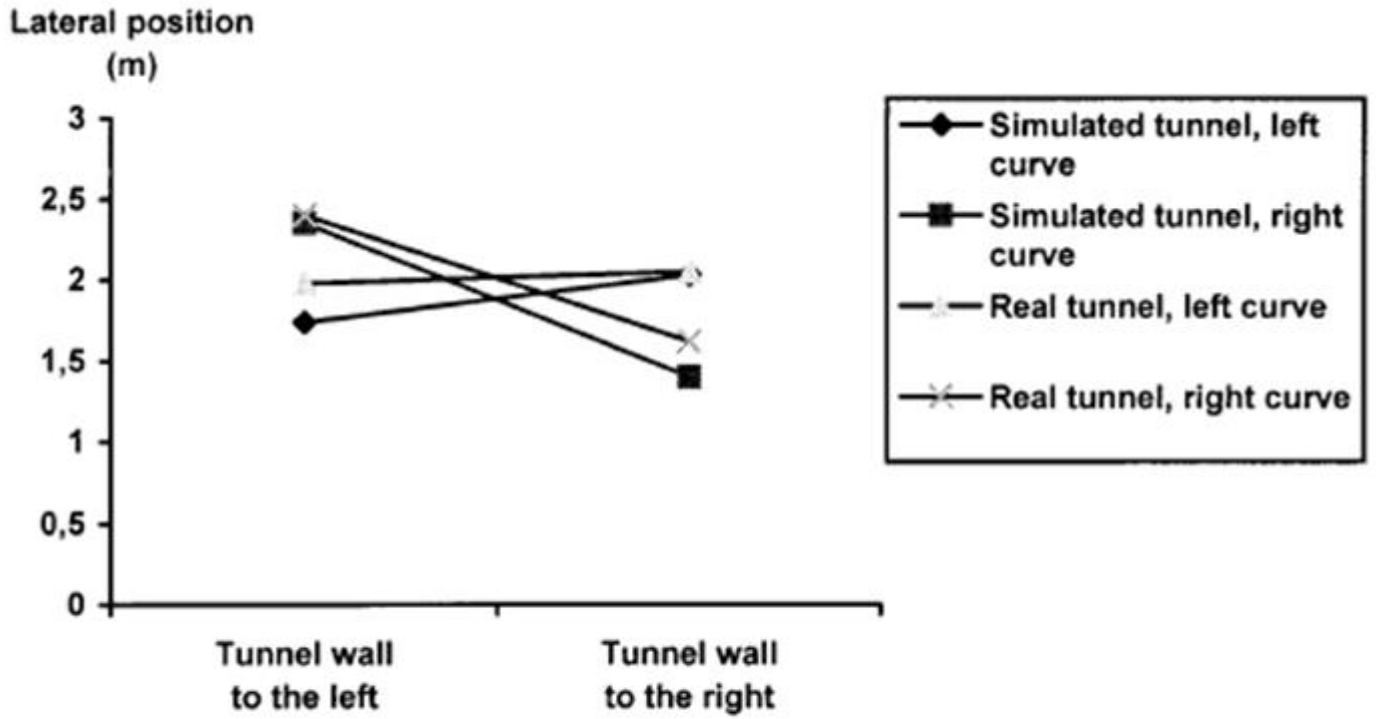
Driving speed



Mean speed from the simulator (V_s) and field (V_r) in the measurement sites.

Bella F., *Driving simulator for speed research on two-lane rural roads, (2007)*

Lateral Position



Average lateral position (m) in the real and simulated tunnels on curved section.

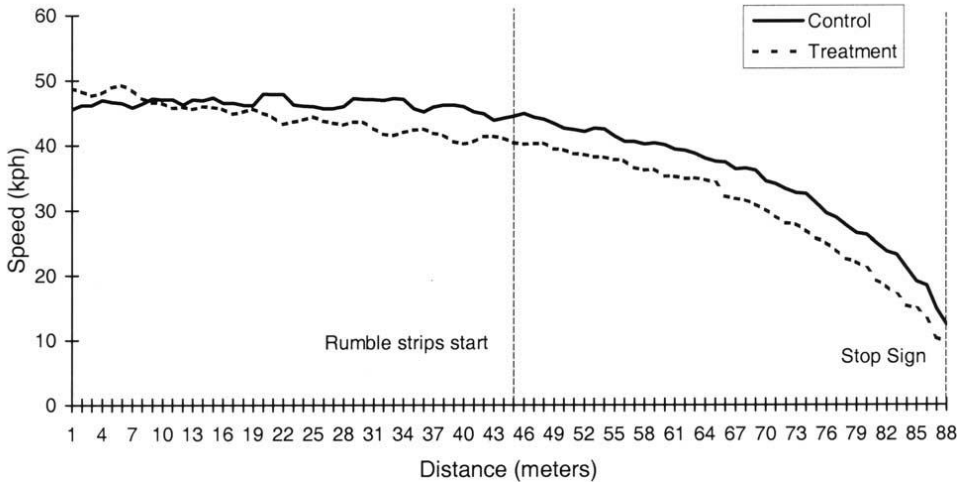
Tornros J., *Driving behaviour in a real and a simulated road tunnel – a validation study, (1997)*

Relative difficulty on the different sub-tasks

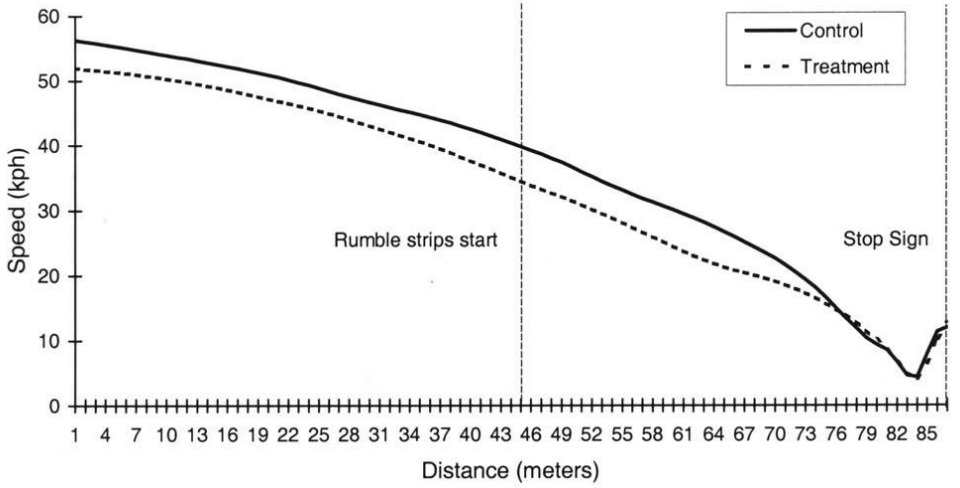
Sub-tasks	Instrumented vehicle on a test tracks	Driving simulator
Steering	Easy	Difficult
Adjusting speed	Easy	Very difficult
Estimating distances	Easy	Rather difficult
Coping with traffic	Difficult	Rather difficult
Bearing accelerations	High lat. And long. Acceleration	No acceleration
Using the visual display	Rather difficult	easy

Blana E., *Driving simulator validation studies: A literature review, (1996)*

Perception and decision of chosen speed



Mean speed at the stop sign approach for instrumented car experiment.



Mean speed at the stop sign approach for simulator experiment.

Godley S.T., Triggs T.J. and Fildes B.N., *Driving simulator validation for speed research, (2001)*

Conclusions and recommendations

- Most of the studies support the use of simulators suggesting relative validity
- Simulator driving performance shows medium to strong correlations with a range of on-road driving performance measures
- Proven validity of simulator results in previous experiments does not guarantee validity of new performer experiment
- Not only simulator itself but also measured results need to be ensured valid
- Where absolute values are required, on-road testing will be generally necessary
- As part of the technology advancement, simulators will play increasingly important role in driving performance measurement

Thank You for your attention