IMOB Driving simulator team
Outline

- Introduction
- Driving simulation
- The SignSIM simulator
- Example projects
1. INTRODUCTION
Fact

- In depth evaluation and user testing has become everyday practice in most industrial sectors
  - Food industry
  - Pharmaceutical industry
  - Car manufacturing industry
  - …

- And what about the design and construction of roads?
  - At best we have guidelines (but which often differ from region to region)
  - In most cases we test for conformity to the guidelines ≠ user testing
An old English proverb

The proof of the pudding is in the eating
Need for evaluation and road user testing

- Why to involve the road user in the evaluation? Because:
  - *Road user perception*: does the road user understand what we want to build?
  - *Road user behavior*: does the road user behave as we had in mind when designing the infrastructure?
  - Design errors may lead to serious collisions
  - Correcting for errors after construction of the infrastructure is expensive and causes additional disturbance
How to involve the road user in the design process?

- As early as possible during the design process
- In a naturalistic setting, as representative as possible to the real world understood by the road user
- In an evidence-based way by means of scientific and verifiable parameters
- In a cost-efficient way

-> Solution: Driving Simulation
2. DRIVING SIMULATION
Driving simulation
Advantages of Simulation

- Virtual representation of real road and traffic conditions
Advantages of Simulation

- Different road environments & profiles

Rural

Urban

Motorway
Advantages of Simulation

- Detailed analysis of driving behaviour

- Speed
- Acceleration / Deceleration
- Lateral position on the road
- Steering wheel use (frequency, force, reaction time)

- Brake use (frequency, force, reaction time)
- Changing gear
- Headway
- Offences (red light, lane violations, speeding, …)
Advantages of Simulation

- Detailed analysis of road user observations

---

**Head movements**
Number of times | Direction | Reaction time | ...

**Eye movements**
Where (and how often)? | Blinking, how often, how long | Reaction time | ...

**Facial expressions**
Fear | Excitement | Drowsiness
Advantages of Simulation

- Physiological monitoring of the driver

Elektro-EncefaloGram (EEG)  Elektro-CardioGram (ECG)  Galvanic Skin Response (GSR)

Stress | Concentration (loss) | Distraction | Attention | Fatigue
Road infrastructure evaluation

- Road marking (dangerous curves)

  - Both markings lower the mean speed
  - **TRS:** Delay from 166 m before the curve
  - **HB:** Delay from the beginning of the curve
Road infrastructure evaluation

- design of transition zones (gate constructions)

Gate construction provides a local speed reduction (100m before the gate up to 100m after)

*Gate construction recommended in areas with vulnerable road users (hospitals, schools)*
Driving behavior at intersections equipped with red light cameras

- Relative risk of rear-end collisions increases when RLC installed
- Risk decreases when RLCWS is placed upstream

**RLC are very useful to prevent red light running**
3. THE SIGNSIM SIMULATOR
Why simulate traffic signs?

- Increasing intensity of traffic flows
- Increasing complexity of traffic network
- Increasing participation by foreign drivers
- Increasing use of dynamic signposting
- Changing road situations: major road works
Why simulate traffic signs?

- Improper signing creates uncertain, nervous driving behavior (e.g. last minute reactions)
  - Effects on safety
    > not only for the road user, also for road workers!
  - Effects on congestion
  - Effects on emissions
Objectives of SignSIM simulator

- Integration of virtual signing and marking in real world video footage of an existing road
- To carry out a scientifically validated evaluation of virtual signing with the use of a panel of test drivers in an environment that resembles as closely as possible the real road environment
- In order to identify potential problems and make suggestions for improvement in the proposed sign plan
- Before actual implementation on the real road
Principles

- "prevention is better than cure"
  - pre-testing of signing concepts
  - testing by normal road user
  - testing in realistic scenarios
Who?

simulator environment, testing and analysis of driving data

production of video material and integration of virtual signing

stakeholder participation and communication, recruitment of test drivers
**Approach**

1. Analyse proposed signing plan and signing concept
2. Produce simulation material
3. Develop test scenario
4. Select test panel, perform tests
5. Analyse, report results
Typical road works signage map
Challenge 1

- Recording of video footage of existing road in high quality
Challenge 2

Integration of virtual signing and markings

> By adapting camera-tracking/matching techniques
Challenge 2

Result
Production of visual material
Challenge 3: Integration into the IMOB driving simulator
Challenge 4

- Integration with an eye tracking system to monitor gaze behavior
The Traffic Sign Simulator

- Purpose of eye tracking is to:
  - Observe the visual search behavior of the driver
  - Evaluate the position of road signs
  - Evaluate interactions between signing, markings, other traffic and the road environment in general
  - Evaluate the complexity of road signs: number of fixations, gaze duration, …
  - Evaluate ordering of information on the road sign
The Traffic Sign Simulator

- Press launch of the SignSIM with Minister of Transport & Public Works
4. EXAMPLE PROJECTS
Case: Vilvoorde flyover
Case: Vilvoorde flyover
Case: Vilvoorde flyover
Case: Vilvoorde flyover
Case: Vilvoorde flyover
Case: Vilvoornde flyover
Case: Vilvoorde flyover
Analysis and recommendations report
Case: Vilvoorde flyover

Analysis and recommendations report

As a result of the project, we have determined that a certain level of improvement is needed to ensure the safety of the area.

In order to achieve this, we have implemented a series of measures to improve traffic flow and safety for pedestrians and cyclists. These measures include:

1. Improved pedestrian crossings
2. Increased visibility of traffic signals
3. Enhanced traffic signage
4. Additional pedestrian walkways

These improvements have significantly reduced the number of accidents and improved the overall safety of the area. We are continuing to monitor the situation and will make further adjustments as necessary.
Case: Vilvoorde flyover

- More than 20 recommendations related to
  - Location of traffic signs
    - Optimal spread of information over distance and time
    - Optimizing flow of traffic (e.g. in case of lane changes)
  - Visibility and readability of traffic signs
  - Repetition of certain traffic signs
  - Additional road markings
Case: Vilvoorde flyover

- Deliverables:
  - Optimised and tested signing concept
  - Optimised and tested signing plans
  - Analysis and recommendations report
  - Videos for use on website
Case: Vilvoorde flyover
Case: Vilvoorde flyover
Case: Calamity routes Lummen interchange

- Incoming traffic from out of 4 directions:
  - Liege, Antwerp, Brussels, Aachen

- 3 possible destinations per direction:
  - Antwerp -> Liege
  - Antwerp -> Brussels
  - Antwerp -> Aachen

- More than 100,000 vehicles/day
Message strategy proposed

- Sequenced messaging:
  - STEP 1: Digital Variable Message Sign (on motorway):
    • Message unit 1: what has happened?
    • Message unit 2: which exit to be taken by whom?
  - STEP 2: Static (metal) sign (at exit entry):
    • Message unit 3: which deviation to be followed by whom?
      -> letter coding!
  - STEP 3: Static (metal) sign (at exit end):
    • Message unit 4: which direction to be taken by whom?
Message strategy illustrated
Fragment 1: Cantilever
Fragment 2: Gantry
Conclusions

GROUP 1
- Type 1: on time fixation, correct understanding, correct choice (138)

GROUP 2
- Type 2: fixation TOO LATE, INCOMPLETE understanding, wrong choice (2)
  • “I was driving on automatic pilot, not paying attention”; “I was still occupied with another sign”
- Type 3: fixation on time, INATTENTIVE reading, wrong choice (5)
  • “most of the time, the message appearing doesn’t apply to me”; “I thought it had something to do with construction works”
- Type 4: fixation on time, correct understanding, MISTAKE (2)
  • “I wasn’t really sure whether this was the right exit”
- Type 5: NO fixation (2)

GROUP 3
- Type 6: on time fixation, correct understanding, consciously ignored (1)
  • “I would still try to pass by the accident”
Case: Redesigning of the N80 due to new IKEA site in Hasselt

• N80 highly congested
• New IKEA site -> extra traffic
Redesigning N80

Alt 1: regular signs

Alt 2: gantries
Redesigning N80
Redesigning N80
Redesigning N80
Redesigning N80
Traffic Sign Simulator – Lessons learned

- Feasibility to obtain a scientifically based insight and advice in traffic sign concepts
- Instrument for participation by road users and stakeholders in signing projects
- Communication of planned signing projects:
  - new urban traffic routing plans
  - major, temporary road diversions
  - temporary signing for major events
  - ...
  - “Minder Hinder” > Less Disturbance
Contact details

Prof. dr. Tom Brijs
Transportation Research Institute (IMOB)
Hasselt University
Science Park – Building 5
B-3590 Diepenbeek, BELGIUM
Email: tom.brijs@uhasselt.be