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17.10.2014

Investigating the psychological effect of worksites on road users

Content

- Introduction
- Selected results from the field tests
- Key insights of field tests
- Summary and outlook
Introduction 1/2

Current situation

- Increasing traffic volume
- Aging infrastructure
- ~ 850 long-term worksites
  - average length ~ 3.3 kilometers
  - mean duration ~ 106 days
- ~ 100,000 short term worksites
- Growing vehicle width vs. constant lane width

High demands to maneuver and control level driving task and attention of drivers

Introduction 2/2

The psychological properties of road users need to be considered more intensely

- Drivers and their interaction with the road are the main causes for accidents
- Only poorly consideration of psychological aspects of drivers
- Road users shall be conducted safe and quick through worksite areas
- Mainly guidelines composed of technical aspects (e.g. min. lane width 2.5 m, max. length of worksite 12 km)

Schlag et al. 2002
Project overview

Psychological effect of worksite’s length, arrangement and design on road users

- **Project runtime:** 05/2013 – 04/2015
- **Project partners:**
  - Institute of Highway Engineering Aachen (Isac)
  - Institute of Information Management in Mechanical Engineering (IMA)
  - Prof. Dr. Eva-Maria Skottke
- **Funded by:** German Federal Highway Research Institute (BAST)

Project goal

- Conduct **field and simulator tests** to investigate the influence of different aspects of worksites on the drivers behavior, workload and attitude
- Develop recommendations for the design and build of future worksites

Work plan

1) Analysis of current situation
2) Selection of worksites
3) Research tools
4a) Empirical survey
4b) Empirical field study
5) Simulator study design
6) Simulator study
7) Analysis and evaluation
8) Documentation

Development of hypotheses concerning:
- Length
- Arrangement
- Design
Research design

Psychological effects not directly measurable

- **Objective measurements**
  - Breaking maneuvers
  - Overtaking behavior
  - Longitudinal and lateral positioning
  - Choice of speed
  - Gaze behavior
  - Heart rate

- **Subjective measurements**
  - Attitude
  - Work load

Set up of field tests

- **Participants (N=10/worksite)**
  - Gaze behavior
  - Heart rate
  - Attitude

- **Test vehicle**
  - Velocity
  - Acceleration
  - Steering angle
  - Distance to vehicle ahead

- **Accompanying vehicle**
  - Breaking behavior
  - Choice of lane
  - Lateral positioning
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Investigated worksites

- **A5 north of Frankfurt**
  - 11.5 km (among the 5% longest worksites)
  - Comfortable lane width of minimum 3 m over all lanes
  - Speed limits 80 - 100 km/h

- **A4 west of Cologne**
  - Two worksites 3.1 and 1.6 km
  - Right lane 3.25 m, left lane 2.6 m
  - Speed limits 60 – 80 km/h

- **A8 east of Augsburg**
  - Sequence of three worksites
  - Overall more than 40 km affected length
  - Speed limit 80 km/h (no speed limit in between the worksites)
Selected results - Vehicle speed 1/2

Velocity profiles A5

Velocity profiles A4

Selected results - Vehicle speed 2/2
Selected results - Following distance

### Distances to vehicle ahead

<table>
<thead>
<tr>
<th>Highway</th>
<th>Traffic load</th>
<th>$t &lt; 0,9 \text{s}$</th>
<th>$0,9 \text{s} \leq t &lt; 1,8 \text{s}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 5</td>
<td>Medium</td>
<td>55,9 %</td>
<td>44,1 %</td>
</tr>
<tr>
<td>A 5</td>
<td>High</td>
<td>55,7 %</td>
<td>44,3 %</td>
</tr>
<tr>
<td>A 4</td>
<td>Medium</td>
<td>61,5 %</td>
<td>38,5 %</td>
</tr>
<tr>
<td>A 4</td>
<td>High</td>
<td>50,1 %</td>
<td>49,9 %</td>
</tr>
</tbody>
</table>

Selected results - Eye tracking 1/2

### Gaze behavior during free run

- 80% of all drivers primarily focus their gaze in the middle of their field of view
- In 70% of all cases wide lanes lead to a tendency to let the gaze wander
- Oncoming traffic in worksites attracts the gazes of the drivers (especially heavy vehicles)
- Recordings show almost no fixations on traffic signs
Gaze behavior while overtaking

- While overtaking, 70% of the drivers let their gaze constantly wander from left to right.
- The other 30% focus their gaze straight ahead (tunnel vision).
- The difference in gaze behavior cannot be explained through other collected variables as age, gender or driving experience.
- It also does not correlate with driving behavior like lane positioning or velocity.

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Key insight of field tests 1/3

Road users change their driving behavior when overtaking

- Evidence found in:
  - Gaze behavior
  - Choice of speed and lane
  - Lateral movements
- More affected by large vehicles and narrow lanes

The traffic volume has an effect on the driving behavior

- Evidence found in:
  - Choice of speed
  - Braking performance
  - Drivers adapt their behavior to the situation of traffic volume

Key insight of field tests 2/3

Passing diversions effects the driving behavior of road users

- Evidence found in:
  - Gaze behavior
  - Choice of speed and lane
  - Heart rate
  - Driving within worksite areas with changing tracking leads to a more conscious adaption of the driving actions to the driving situation

The oncoming traffic has an impact on the road users

- Evidence found in:
  - Gaze behavior
  - Heart rate
Key insight of field tests 3/3

Road users are affected in his driving behavior by the width of the auxiliary lane

- Evidence found in:
  - Choice of speed
  - Lateral position
  - Narrow lanes lead to a longer distance to the vehicle ahead

No Evidence that the length of worksites effects the driving behavior

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Summary

Field tests
- The field tests showed that the design of worksites effect the driving behavior
- Triangulation of the multiple data collected allowed stronger evidence on these effects

Limitations
- Collection and analysis of multiple data streams very challenging
- Only effects on the maneuver and control level have been investigated
- Eye tracking data very difficult to analyze and not as meaningful as expected

Outlook

Driving simulator study
- Developed hypotheses will be tested in a controlled environment during driving simulator study
- N=60 participants
- Data collection similar to field test
- Variation of worksite length and worksite furnishing
Thank you for your kind attention!

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