Safer Level Crossings by improved Road-Rail Infrastructure Design

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Background and Objectives

• **Improve safety and minimize risks at and around level crossings (LCs)**
  … by developing innovative solutions and tools to prevent incidents at level crossings

• **Focus both on technical solutions and on human processes**
  … to adapt infrastructure design to end-users
  … to enhance coordination and cooperation between stakeholders from different transportation modes.

• **Develop a toolbox integrating the project results and solutions**
  … to help rail and road managers to improve safety at level crossings.
Approach

- Analyze LC safety systems
- Define needs and requirements of rail and road users for safer level crossings
- Develop innovative measures
  - Human-centered low-cost measures
  - Technical solutions
- Test and evaluate the measures
- Compile recommendations and guidelines
- Collect all results in a toolbox

Time: May 2017 – April 2020
Challenges in road-user behavior

**Active LCs with full barriers**
- Circumventing closed barriers (climbing over / below)
- Passing LC after pre-signaling has begun / while barriers are closing
  - Getting caught between the barriers
  - Getting stuck on the rails

**Active LCs with half-barriers / light protection**
- Circumventing closed half-barriers (swerving around, climbing over / below)
- Passing in spite of active light signals (e.g. flashing red light)
- Passing after pre-signaling has begun / while barriers are closing
- Getting stuck on the rails

**Passive LCs**
- Insufficient visual scanning of tracks for train
- Insufficient adaption of approach speed to scanning needs
Peripheral blinking lights near the tracks
Safety effects on driver behavior

- peripheral blinking lights near the tracks
  - induced large increases in visual search for a train both to the left and the right side of the tracks
  - induced significant speed reduction on approach to the LC
  - gained high participant ratings on usefulness and moderate to high ratings on ease-of-use dimensions

<table>
<thead>
<tr>
<th>LC safety layout</th>
<th>% participants fixating visual ROI</th>
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<tbody>
<tr>
<td></td>
<td>Left Periphery</td>
</tr>
<tr>
<td>Standard passive LC</td>
<td>64,6</td>
</tr>
<tr>
<td>Periperal blinking lights</td>
<td>83,7</td>
</tr>
<tr>
<td>Rumble Strips</td>
<td>66,7</td>
</tr>
<tr>
<td>Sign ← Is a train coming? →</td>
<td>80,0</td>
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</table>

Test: driving simulator study (Silla et al., in prep.)
Auxiliary strobe light system for trains
Safety effects on driver behavior

- Trains equipped with auxiliary strobe lights
  - … were detected earlier and more reliably than standard trains
  - … were associated with earlier and stronger speed reduction on approach
  - … gained high participant ratings on usefulness and ease-of-use dimensions

- Test: driving simulator study
  (Silla et al. 2019)
## All pilot tests - overview

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<th>Testsites</th>
<th>Measures tested</th>
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<td><strong>Traffic data simulation (VTT)</strong></td>
<td>V2X messaging system between automated vehicles and passive level crossings</td>
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<td><strong>Road Driving Simulators (DLR, SNCF)</strong></td>
<td>Rumble strips, RU-activated peripheral blinking lights, Sign ← Is a train coming? →, Blinking lights on train; Coloured road markings on LC approach, Funnel effect sticks, Rings upstream of LC, Traffic light, Speed bump and flashing sticks, Proximity message via in-car device</td>
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<td><strong>Test track with mock-up LC and rail vehicle (RWTH, CEREMA, UTBM, COMMSIGNIA, IFSTTAR, Geolog, neoGLS)</strong></td>
<td>Smart Detection system, Smart Communication system, Early detection and hazard information by cooperative perception messaging and driver’s warning</td>
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<td><strong>Test site for LC monitoring and remote maintenance (CEREMA)</strong></td>
<td>Monitoring and remote maintenance</td>
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<td><strong>Real-world rail environment at Rukkamaki, Finland (VTT)</strong></td>
<td>Additional warning light system at locomotive front</td>
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<td><strong>Real-world LC at Braunschweig, Germany (Traffic data acquisition, DLR)</strong></td>
<td>VRU-activated blinking amber light with train symbol, warning message written on road</td>
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<td><strong>29 real-world LCs at Thessaloniki, Greece (CERTH, TRAINOSE, DLR)</strong></td>
<td>In-vehicle train and LC proximity warning</td>
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Outlook

• Aggregation of all results in web-based SAFER-LC toolbox, to be used by road and rail infrastructure managers, train operators, engineers, designers, scientists, policy makers and standardization bodies.

• Content:
  • All collected safety measures
  • Empirical findings on effectiveness
  • Consideration of potential negative effects and restrictions
  • Recommendations for application

• Browsable according to specific problems and application contexts

• Consideration of the human factors that lead to errors and violations in road-user behavior is essential in finding solutions that are both effective and low-cost.
Thank you for your attention!

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http://safer-lc.eu/
References
