Spatial Impacts of Automated Driving
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Spatial and Transport Impacts of Automated Driving

2016-2020, www.stad.tudelft.nl
Much progress short term and small scale impacts on driver behaviour and traffic flow.

Research on longer term, indirect, wider scale impacts on mobility, logistics, residential patterns and spatial-economic structure in its infancy.

Potential impacts on traffic

- Solve traffic jams by increased outflow
- Prevent traffic jams by better stability
- Increased throughput by smaller headways
- Decreased throughput by larger headways
- Decreased stability by lack of anticipation

Less congestion delay
Increased risk of congestion

Non connected, high penetration rate
General findings on motorway capacity

“CACC can double roadway capacity”
- on motorways without on/off ramps -

Many microsimulations
Different reference cases
ACC and CACC
Hardly any bottlenecks

ACC changes motorway capacity between -5% and +10%
At bottlenecks change is less than +10%
Additional benefits: improving stability (CACC) and reducing capacity drop
CACC increase capacity further at penetration rates beyond 40%

Hoogendoorn et al (2014), Automated driving, traffic flow efficiency and human factors: literature review. Transportation Research Record
Value of travel time in private vehicles

The amount a traveller is willing to pay for 1 minute travel time reduction.

Trip is less useful or comfortable, traveller is willing to spend more for a shorter trip

Trip is useful and comfortable, traveller is willing to spend less for a shorter trip
### Value of time in private vehicles: a stated preference experiment

Assume your next trip is from home to work, which option would you choose?

<table>
<thead>
<tr>
<th>Option</th>
<th>Travel time</th>
<th>Travel costs</th>
<th>Walking time</th>
<th>AV activity</th>
<th>Travel companions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Conventional car</td>
<td>15 Min</td>
<td>€ 4.50</td>
<td>6 Min</td>
<td>driving</td>
<td>friends and/or family</td>
</tr>
<tr>
<td>B. AV – office interior</td>
<td>45 Min</td>
<td>€ 4.50</td>
<td>0 Min</td>
<td>working extra time</td>
<td>friends or family</td>
</tr>
<tr>
<td>C. AV – leisure interior</td>
<td>30 Min</td>
<td>€ 7.50</td>
<td>0 Min</td>
<td>do whatever you want</td>
<td>alone</td>
</tr>
</tbody>
</table>

**Mean value of travel time**

<table>
<thead>
<tr>
<th>Option</th>
<th>Time Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional car</td>
<td>7.91</td>
</tr>
<tr>
<td>AV Office interior</td>
<td>4.97</td>
</tr>
<tr>
<td>AV Leisure interior</td>
<td>10.47</td>
</tr>
</tbody>
</table>

242 respondents; results excluding 96 non traders

Office interior aligns with work activities

Leisure interior does not align with work activities

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De Looff et al (2017), Value of travel time changes as a results of vehicle automation – a case study in the Netherlands, TRB 97th Annual Meeting, paper 18-03109
Automated Vehicles in National Market and Capacity Analysis (NMCA)

NMCA

Updated every 4 year to identify main transport problems

Used to support major transport infrastructure decisions

Typical horizon 20 years

Uses Dutch National Transport Model (LMS)

What if AVs could deliver substantial capacity improvement in 20 years?

## Results* motorways

<table>
<thead>
<tr>
<th></th>
<th>AV Penetration rate cars</th>
<th>AV Penetration rate trucks</th>
<th>PCU car HWN</th>
<th>PCU truck HWN*</th>
<th>ΔVOT car</th>
<th>ΔVOT truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck platooning</td>
<td>0%</td>
<td>40%</td>
<td>1</td>
<td>0.75</td>
<td>0%</td>
<td>-20%</td>
</tr>
<tr>
<td>Autonomous</td>
<td>30%</td>
<td>40%</td>
<td>1.15</td>
<td>0.75</td>
<td>-5%</td>
<td>-20%</td>
</tr>
<tr>
<td>Cooperative</td>
<td>30%</td>
<td>40%</td>
<td>0.7</td>
<td>0.75</td>
<td>-5%</td>
<td>-20%</td>
</tr>
<tr>
<td>Cooperative VOT</td>
<td>30%</td>
<td>40%</td>
<td>0.7</td>
<td>0.75</td>
<td>-20%</td>
<td>-20%</td>
</tr>
</tbody>
</table>

Capacity -4.5%
Capacity + 9%

<table>
<thead>
<tr>
<th>KM driven</th>
<th>Morning peak</th>
<th>Evening peak</th>
<th>Other</th>
<th>Total</th>
<th>Vehicle loss hours</th>
<th>Morning peak</th>
<th>Evening peak</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck platooning</td>
<td>100.9</td>
<td>100.8</td>
<td>100.9</td>
<td>100.8</td>
<td>Truck platooning</td>
<td>97.6</td>
<td>95.9</td>
<td>99.6</td>
<td>97.8</td>
</tr>
<tr>
<td>Autonomous</td>
<td>99.1</td>
<td>100.2</td>
<td>99.0</td>
<td>99.8</td>
<td>Autonomous</td>
<td>103.6</td>
<td>107.9</td>
<td>104.7</td>
<td>105.3</td>
</tr>
<tr>
<td>Cooperative</td>
<td>105.3</td>
<td>103.2</td>
<td>105.4</td>
<td>103.9</td>
<td>Cooperative</td>
<td>91.0</td>
<td>80.0</td>
<td>91.9</td>
<td>87.9</td>
</tr>
<tr>
<td>Cooperative VOT</td>
<td>106.4</td>
<td>105.0</td>
<td>106.7</td>
<td>105.5</td>
<td>Cooperative VOT</td>
<td>94.0</td>
<td>83.9</td>
<td>95.1</td>
<td>91.3</td>
</tr>
</tbody>
</table>

* Results are indications. Functionality to assess impacts of AVs is still experimental.
Toward spatial implications of Automated Driving

Legene et al (in preparation), Transportation and spatial impact of automated driving in urban areas- An application to the Greater Copenhagen Area
System dynamic simulations

Uncertainties
- Penetration rate
- AVs
- Efficiency
- Vehicle operation
- VOTT
- Increased mobility
- Idle time car
- Parking density rate
- Car sharing rate

2015-2070
Time step 1/32 yr

AREA KPI’s
- Attractiveness to live
- Population
- Accessibility to jobs
- Average trip distance
- Incoming trips
- Congestion level
- Road surface
- Parking surface
Main sensitivities
Penetration rate
AVs
Efficiency vehicle operation
VOTT
Increased mobility
Idle time car
Parking density rate
Car sharing rate

System dynamic simulations
2015-2070
Time step 1/32 yr

AREA KPI’s
Attractiveness to live
Population
Accessibility to jobs
Average trip distance
Incoming trips
Congestion level
Road surface
Parking surface
**Undesirable AV futures**

- Very low VOTT
- No sharing

**Desirable AV futures**

- Low VOTT
- High level of sharing

**Much more trips**

- Increased congestion, especially in city centre
- No land use savings

<table>
<thead>
<tr>
<th>Land use saving</th>
<th>City centre</th>
<th>Other urban districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road infrastructure</td>
<td>-</td>
<td>4%</td>
</tr>
<tr>
<td>Parking</td>
<td>8%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Spatial impacts of Automated Driving

System dynamics and basic transport models provide first order impacts

Ranges available for changes roadway capacity and Value of Time

Land use savings require high penetration rate and high level of sharing

Improve models using real-world experience
Extend to land use, urban design, smart grids