De ontwikkeling van zelfrijdend vervoer
Bart van Arem

A first drive with fully automated vehicle...

Dutch minister of Infrastructure & Environment Mrs Melanie Schultz

INTEREST IN AUTOMATED DRIVING

Self driving cars can improve traffic efficiency and safety
Netherlands to facilitate large scale testing of self driving vehicles

DEFINITIONS AND SCENARIOS
Arcadis themasessie Zelfrijdend Vervoer, Amersfoort, 18 februari 2016

**Automated driving**

- **Driver assistance/ Partial automation**
  - Driver needs to be able to intervene at all times
  - Automated parking, autocruise

- **Conditional/ High automation**
  - Vehicle in control in special conditions
  - Taxibots, platooning, automated highways

**Comfort, efficiency, safety, costs**

**Mode choice, location choice, urban and transport planning**

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**Automated Vehicle System, Graham**

**Market Introduction (SAE Levels), Median, IQR**

- **5 FULL AUTOMATION**
  - (Driver not required, e.g., robotic taxi)
  - Freight, recommended for urban environments

- **4 HIGH AUTOMATION**
  - 2018 to 2020

- **3 CONDITIONAL AUTOMATION**

**2015**

- **2020**

- **2025**

- **2030**

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**Knowledge urgently lacking**

- 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.

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**DRIVER BEHAVIOUR**

- Personal Estimates of Market Introductions *(based on technological feasibility)*

- Everywhere
- Some urban streets
- Campus or pedestrian zone
- Limited-access highway
- Fully Segregated guideway

**Color Key:**
- New
- 2020
- 2025
- 2030
- 2050
Fundamental changes in driving behaviour

- Workload, driving performance, attention, situation awareness, risk compensation,
- Driver Vehicle Interface, acceptance, mode transition, purchase and use

The congestion assistant

- Detects downstream congestion
- Visual and auditive warning starting at 5 km before congestion
- Active gas pedal at 1.5 km to smoothly slow down
- Takes over longitudinal driving task during congestion

Impacts on driving behaviour

Motorway scenario with congestion

Effects on mean speed

TRAFFIC AND ROADS
Potential impacts on traffic

- Solve traffic jams by increased outflow
- Prevent traffic jams by better stability
- Better distribution of traffic over network
- Decreased throughput by larger headways
- Decreased stability by lack of anticipation

Less congestion delay

Increased risk of congestion

The congestion assistant

- Detects downstream congestion
- Visual and auditory warning starting at 5 km before congestion
- Active gas pedal at 1.5 km to smoothly slow down
- Takes over longitudinal driving task during congestion

Traffic flow simulation: merging area A12 motorway, Woerden, the Netherlands

Results

General findings on motorway capacity

- Many micro-simulation studies
- Difficult to compare
- Focus on ACC and CACC
- Hardly any bottleneck

A20: bottleneck motorway, no more space to expand

How can AVs relieve congestion here?
Automated roads?
- Implication of changes in traffic load? Platoons, bridges, rutting?
- Automated driving under adverse roadway and weather conditions?
- Implications for traffic management? Opportunity or threat?
- eHorizon: automated driving cloud for real-time positioning, maneuvering and safety?
- Level 4 certified roads?
- Geometric design, transition zones?

Acceptance
- Drivers state that they prefer warnings over control
- Control could be acceptable in special conditions such as congestion driving
- Acceptance of (different levels of) automation increases after (positive) experience
- Scepticism is declining

Car driving more attractive!
- Partial automation
  - Better comfort
  - Less accidents
  - Less congestion
- High automation
  - Travel time can partially be used for other purpose
- Full automation
  - Travel time can fully be used for other purposes

Shared automation
Shared automation—between dream and vision?

Between dream and vision?
Huge implications
Land use
Car ownership
10% of number of cars suffices?

**IMPACTS ON STRATEGIC DECISION MAKING**

**Spatial implications**

- Geometric redesign of roads and junctions
- Increasing sprawl residential and employment locations
- Concentration activities by better accessibility
- Redesign of urban, commercial, touristic areas
- No on street parking
- Combinations with car sharing, electric driving

**Policy relevance**

- Congestion and accessibility
- Safety
- Travel patterns
- Freight transport
- Public transport
- Socio-economic development
- Urban design
- Spatial structure
- Investment policies

Automated cars can improve traffic efficiency and safety
Netherlands to facilitate large scale testing of automated cars

**Exploration using LMS**

<table>
<thead>
<tr>
<th>Automated Autonomous</th>
<th>Automated Cooperative</th>
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<tbody>
<tr>
<td>5% capacity decrease on primary road network</td>
<td>15% capacity increase primary road network</td>
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<tr>
<td>10% capacity increase secondary road network</td>
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<td>10% decrease value of time commuting and business car trips</td>
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<tr>
<th>Mode</th>
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<td>Train</td>
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<tr>
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<td>Car passenger</td>
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**Scientific challenges: understanding the spatial and transport changes**

- Travel and location choice behaviour
- Freight and Logistics applications
- Infrastructure service networks
- Spatial structure and economy
- Accessibility, economy, traffic, safety, urban quality
- Regional spatial and transport system
The road to automated driving...

- Develop efficient and reliable technology
- Collect, analyse and publish large scale real-world experience
- Study spatial, transport and societal impacts
- Regulations, type approval
- Awareness, ambitions, expectations, reality checks