Automated Driving and Societal Impacts: What about ethics?

Bart van Arem
A first drive with fully automated vehicle...
<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering and Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Fallback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Human driver</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>Human driver and system</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>System</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>All driving modes</td>
</tr>
</tbody>
</table>

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Automated driving

Driver assistance/
Partial automation

Driver needs to be able
to intervene at all times

Automated parking,
aucruise

Conditional/ High
automation

Vehicle in control in
special conditions

Taxibots, platooning,
avtomated highways

Comfort, efficiency, safety,
costs

Mode choice, location choice,
urban and transport planning
Personal Estimates of Market Introductions *(based on technological feasibility)*

<table>
<thead>
<tr>
<th>Everywhere</th>
<th>Some urban streets</th>
<th>Campus or pedestrian zone</th>
<th>Limited-access highway</th>
<th>Fully Segregated Guideway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 (ACC)</td>
<td>Level 2 (ACC+LKA)</td>
<td>Level 3 Conditional Automation</td>
<td>Level 4 High Automation</td>
<td>Level 5 Full Automation</td>
</tr>
</tbody>
</table>

Color Key: Now | ~2020s | ~2025s | ~2030s | ~2075
Fundamental changes in driving behaviour

Driver in control $\Rightarrow$ Vehicle in control

Driver supervision

Workload, driving performance, attention, situation awareness, risk compensation, Driver Vehicle Interface, acceptance, mode transition, purchase and use
Potential impacts on traffic

- Solve traffic jams by increased outflow
- Prevent traffic jams by better stability
- Better distribution of traffic over network

Less congestion
- Decreased throughput by larger headways
- Decreased stability by lack of anticipation

Increased risk of congestion

Non connected
Large penetration
Car driving more attractive!

Partial automation

High automation

Full automation

Better comfort, Less accidents Less congestion

Travel time can partially be used for other purpose

Travel time can fully be used for other purposes
Spatial implications

Functional
- Geometric redesign of roads and junctions
- Increasing sprawl residential and employment locations
- Concentration activities by better accessibility

Spatial
- Redesign of urban, commercial, touristic areas
- No on street parking
- Combinations with car sharing, electric driving
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.
Scientific challenges: understanding the spatial and transport changes

- Automated Driving
- Infrastructure service networks
- Travel and location choice behaviour
- Freight and Logistics applications
- Spatial structure and economy
- Urban design and traffic safety
- Regional spatial and transport system

Accessibility
Economy
Traffic Safety
Urban quality
STAD: Spatial and Transport Impacts of Automated Driving
So what about ethics?

... so much more than robot-dilemmas

- Responsibility
- Values
- Triple helix
- Equity, fairness
- Collaborative design
- Privacy
- Security
- Testing
- Sustainability
- Mixed traffic
- Authority transitions
- Laws and regulations
- Laws and regulations
- ....
4 views on ethics and automated vehicles

- Impacts on the Netherlands
  Tom Alkim

2 views on ethics and automated vehicles

- Naughty software
  Herman Wagter

- Responsible driving automation
  Filippo Santoni di Sio