Self-driven MRDH
A Method to Assess the Impact of Automated Vehicles on Urban Liveability in the Rotterdam The Hague Metropolitan Region

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European Post-Master in Urbanism / P5 presentation / 26 June 2017
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Hypothesis

CITY

TECHNOLOGY
Mobility and the city. Automated vehicles, the next disruption?

Sources:
www.tijdreis.nl
Google, Street View
Mobility and the city. Automated vehicles, the next disruption?

Sources:
Policy and society related implications of automated driving: a review of literature and directions for future research, Milakis et al, TU Delft, 2015
Scientific and societal relevance

Development

Emerging Technology Hype Cycle

- Augmented Reality
- Internet of Things
- Smart Cities
- Machine Learning
- Big Data
- Robotics
- 3D Printing
- Cloud Computing
- Virtual Reality
- Advanced Networks
- Mobile Application Development
- Cloud Computing

Sources:
www.gartner.com
Artificial Intelligence and Life in 2030, Report of the 2015 Study Panel, Stanford University

Mobility trends

Societal impact
Problem statement

Despite the potentially important positive and negative effects of automated vehicles on mobility and human life in general, their spatial impacts represent a research gap which must be addressed.
Where does the urbanist stand?

State of research

Technology
Legislation & ethics
Spatial Impact?
Economy & energy

Aim

Urbanism

Method

Sources:
Farah, H (2016) State of Art on Infrastructure for Automated Vehicles
Milakis, D, van Arem, B & van Wee, B (2017) "Policy and society related implications of automated driving: a review of literature and directions for future research"
Aims. Definitions of liveability

**Administrative**
- Amount of housing
- Distance to jobs
- Crime rate
- Air pollution level

**Academic definition**
- Contact with nature
- Social encounter
- Control & safety
- Prosperity

**Urban theory**
- Sidewalk width
- Shading
- Active ground floors

Sources:
- www.leefbaarometer.nl
- M. v. Dorst, Liveability, 2012
- Downtown is for people, J. Jacobs, 1958
- Cities for people, J. Gehl, 2010

**Liveability evaluation criteria**
- Mobility performance & impact
- Built & natural environment
- Society & economy
- Mobility performance & impact
- Built & natural environment
- Society & economy
Aims. Regional criteria of liveability

Mobility system:
Coverage, efficiency and modal choice
Reduced air and noise pollution

Contact with (open) nature

Housing and work premises:
sufficient and diverse (type, location)
Aims. Local criteria of liveability

Accessibility and spatial integration

Contact with nature next to home and work

Spaces for socio-economic encounter

Control and safety
Research questions

**How can we assess the impact of automated vehicles on urban liveability through instruments specific to urbanism?**

What directions of research, design and policy should be followed in the future in order to enhance urban liveability in the context of automated vehicle adoption?

Are the tools specific to urbanism useful to assess the impact of automated vehicles on the urban environment?

How can the urbanist/architect be ahead of the times by imagining the living environments and lifestyles resulting from technological innovation?
Building a method. Foresight and through-sight

Haussmann, Boulevard cross-section in Plan for Paris, 1859.

Sources:
Calabrese, LC (2004), Reweaving UMA
Building a method. Scenario construction

- Recognised method to imagine the future
- In the post-war Dutch planning tradition
- Analytical (Salewski)
- Radical proposal, background for discussion (Vettoretto)

Sources:
VROM Atelier Randstad 2040, One Architecture, Matthijs Bouw, Randstad 2040, 2008: Kuststad / Coast City. idem.
AIR-Alexander; OMA, New Urban Frontiers, 1993: Point City and South City. idem.
Building a method. Transect analysis

- Recognised territorial analysis method
- Geddes: valley section
- Duany: Smart codes

Sources:
Building a method. Visionary urban sections

Sources:
Le Corbusier, VilleRadieuse 1930. From Calabrese, LC (2004). Reweaving UMA.
Building a method. Foresight and through-sight

- Technology Automated vehicles
- Driving forces
- Scenario construction
- Transect analysis
- Sections Evaluation
- Liveability definitions
- Research, design and policy tasks
Automated vehicles. Literature review

- Level 5 automation: technology is in control in all cases
- Foreseen introduction in the Netherlands in 2025, largely available in 2040
- Spatial impacts: road, networks, fields

Sources:
Autonomous driving and urban land use, Heinrichs, 2016
Policy and society related implications of automated driving: a review of literature and directions for future research, Milakis et al, TU Delft, 2015
Farah, H (2016) State of Art on Infrastructure for Automated Vehicles
Automated vehicles. Spatial impacts on roads

- safety and public space quality
- smart sensing
- shared space
- dynamic street management
Automated vehicles. Spatial impacts on roads

road capacity
high intensity traffic in the same road space
Automated vehicles. Spatial impacts on roads

intersection management
smart sensing
Automated vehicles. Spatial impacts on roads

road profiles: provincial road
new design opportunities through narrower lanes
Automated vehicles. Spatial impacts on roads

road profiles: motorway
lower investment
less pollution
sharing
active mobility
landscape integration
Automated vehicles. Spatial impacts on networks

public transport in low density areas
on-demand and economically sustainable coverage of rural areas
Automated vehicles. Spatial impacts on networks

parking racks & service points
self-parking for cars on cheap land
Automated vehicles. Spatial impacts on networks

multimodal hubs
synergy of high and low intensity transport modes
transfer from long distance to local active mobility
Automated vehicles. Spatial impacts on networks

energy
- e-charging points
- charging while parking
- car as battery
- solar roads with wireless charging
Automated vehicles. Spatial impacts on fields

low-density development
Automated vehicles. Spatial impacts on fields

new centralities
Automated vehicles. Spatial impacts on fields

urban infill
less parking requirement enables higher density
Automated vehicles. Spatial impacts on fields

no on-street parking
active streetscape
Automated vehicles. Spatial impacts on fields

residential parking reconversion
new uses in residential areas
Automated vehicles. Spatial impacts on fields

car-related economy
restructuring of car-related economy
new uses in attractive areas
Automated vehicles. Main driving forces

Separation of flows

Concentration

COMPACTNESS

Merged flows

Dispersions

Flows
MRDH. A dynamic region

2,244,159 inhabitants
2,246 people per 1 km²
23 municipalities

121,330 companies
170 GDP bn Euros

1,165 total area km²
166 / 999 water / land km²

144 built km²
117 asphalt cover km²

Data sources: OECD Territorial Reviews, Metropolitan Regions Rotterdam The Hague; CBS, RIVM, en ProRail 2016; Kadaster Landregistratie Toepassingen, Topo102.
Map source: Google Earth Pro satellite imagery.
MRDH. Trends of urbanisation and infrastructure

**Networks**

Data and image sources: www.mrdh.nl, www.rail.de

- Automated vehicles
- Road
- Railway

- AV in Binnenhof, Ripweijk, TU Delft, Rijnmond, Schiedam, Rijswijk
- Road connections: Blankenburg tunnel, A16 Rotterdam, Nieuwe Rotterdamseweg

- RandstadRail extension to Binnenhof, Schwenningen
- 4-line railway corridor Den Haag - Rotterdam
- New bridges in Rotterdam

**Fields**

Urban expansion north of Rotterdam, aerial view, 2017 Photograph by author

Urbanisation after 2005. Data from Corine Land Cover 2012, CBS and eurovista.org
MRDH. Mapping the mobility landscapes
MRDH. Spaces of cars on the move

Figure 86. Surfaces occupied by road type. Measured in GIS based on 'wegens_net' and 'wegens_vlak' layers from nvp10d, CBS 2015.
Figure 5.8. Surfaces occupied by parking types. Measured in GIS based on ‘wagen lijn’, ‘wagen jach’ and ‘parkeren’ (parking zones) – ‘parkdak’ layers from cycat, CBS 2015.
MRDH. Spaces of no car
MRDH. Spaces of car-related economy
MRDH. Mapping the driving forces: density
MRDH. Mapping the driving forces: flows

Legend:
- Green: High regional integration by road
- Blue: High regional integration by public transport
- Red: High local concentration
- Yellow: High local integration
- Light yellow: Low integration
MRDH. Transect choice: density-program matrix

main urban transect
MRDH. Transect analysis and liveability

[Image of a map with various data layers indicating population, jobs, pollution, and green areas, with legend for different categories such as Urban centre, Agricultural green, Urban residential high density, and High local integration (betweenness).]
Scenario construction: hypotheses and driving forces

Agenda 2040

380,000 new housing units

80,000 new workplaces

Fully automated vehicles available from 2025

Source: Milakis et al.

Concentration

S1 Clockwork Utopia

S2 Shared patchwork

Separation of flows

S3 Efficient Garden Region

S4 Infinite Randstad

Merged flows

Dispersion
Scenario construction. Learning from the visionaries

Figure 125. Visionary projects table, organised by scenario and type. Scenarios 1 and 4 link to most project-driven types, whereas scenarios 2 and 3 are connected to mostly demand-driven models or realized projects. Therefore, scenarios 1 and 4 are the most interesting to develop in an explorative direction.
Scenario development. Clockwork Utopia and Infinite Randstad

S1
Clockwork Utopia

S4
Infinite Randstad
Scenario development. Clockwork Utopia and Infinite Randstad

**S1**
Clockwork Utopia

**HUMAN CONTROL**

**S4**
Infinite Randstad

**HUMAN-MACHINE COOPERATION**
Scenario development. Clockwork Utopia and Infinite Randstad

S1
Clockwork Utopia

S4
Infinite Randstad

AUTOMATION EXCEPTION

AUTOMATION COMMON
Scenario development. Clockwork Utopia and Infinite Randstad

**S1**
Clockwork Utopia

**S4**
Infinite Randstad

MOBILITY SYSTEM MULTIMODAL

DOOR TO DOOR ON ONE MODE
Scenario development. Clockwork Utopia and Infinite Randstad

S1
Clockwork Utopia

S4
Infinite Randstad

Shared
Public Time

Individual
Private Time
Scenario development. Clockwork Utopia and Infinite Randstad

S1
Clockwork Utopia

Separation of flows

S4
Infinite Randstad

Shared space
Scenario development. Clockwork Utopia and Infinite Randstad

S1
Clockwork Utopia

Concentration

S4
Infinite Randstad

Dispersion
Scenario development. Clockwork Utopia and Infinite Randstad

S1
Clockwork Utopia

S4
Infinite Randstad
Scenario development. Clockwork Utopia and Infinite Randstad

S1
Clockwork Utopia

S4
Infinite Randstad
Scenario development. Clockwork Utopia and Infinite Randstad
New mixed used buildings

Drop off bays for automated trambus and shared pods

AV fast lanes with solar panels. Only shared pods allowed in the city centre

Intensive densification through building additions and vertical extensions

Living in the city centre

Multi-level urban core

Regional transport is delivered by automated metro trains

Increased leisure time is spent in the city centre: culture, shopping, bars, sport facilities.
Scenario development. Clockwork Utopia and Infinite Randstad
New housing and facilities for the growing population replace the existing fabric or are added on the top level.

Smart road used mostly by shared pods, but individual AVs of residents are accepted.

The hub concentrates neighbourhood services on multiple levels, acting as a downsized version of the city centre.

Scarcity of space encourages multifunctionality and alternate idiorhythm for the new economy.

Living denser is the new normal.

Former parking space becomes building extension, bicycle lane or green area.

Old garages and parkings are refunctionalised in a neighbourhood-wide strategy.
Nature is ‘around the corner’. There is room for large parks and sports amenities in every neighbourhood.

People moved into new developments in the Randstad, so there is more room for public amenities and greenery.

Homes, streets and automated vehicles are part of a single smart energy system, using the resources alternately.

Vibrant community and family-centred life

Shared space is designed for low speed and mixed use

Public and commercial uses occupy the ground floor to create a lively street. AV are welcome as well.

Freed-up parking becomes hobby space, office, student room or simply the family terrace.
Scenario development. Clockwork Utopia and Infinite Randstad
Denser built fabric within the urban limits

City edge HUB connects people to public transport, individual automated vehicles, local transfer pods, bikes and e-bikes. It also acts as a gate to the city and offers multiple facilities.

The urban edge is intensified as the space for innovation and logistics.

Parking and maintenance of urban pod fleet is located outside high-demand urban land, but close to the hub.

Urban residents enjoy ‘open’ nature on the city edge, where they can relax or practice new sports enabled by technology.

The motorway is integrated in the public transport system.

Ecoducts ensure safe crossing of the highway and ecosystem continuity.
High speed lifestyle means many activities are performed in the time and space of mobility.

A13 is the new ‘Zuidrandstad Boulevard’ offering a multi-speed metropolitan promenade from Zuidplein to Scheveningen.

Drones are able to deliver most parcels from the main network into the territory.

A flexible, connected society is multi-tasking and moving in the territory faster and more efficiently. Mundane trips are rendered unnecessary by automation.

New types of vicinity: office in the polder, house on the highway.

New architectural typologies allow real door-to-door experience. Welcome to the drive-in office.

Buildings, roads and cars are part of the smart energy grid.

Same-level access to regional infrastructure.
Reflection

How can we assess the impact of automated vehicles on urban liveability through instruments specific to urbanism?
Reflection

What directions of research, design and policy should be followed in the future in order to enhance urban liveability in the context of automated vehicle adoption?

<table>
<thead>
<tr>
<th>RESEARCH</th>
<th>DESIGN</th>
<th>POLICY</th>
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</thead>
<tbody>
<tr>
<td>Electric vehicles</td>
<td>Design of street profile</td>
<td>Encourage sharing and electric</td>
</tr>
<tr>
<td>Synergies with other mobility trends</td>
<td>Transfer hubs</td>
<td>Limit city centre access</td>
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<td>Pedestrian &amp; cyclist safety</td>
<td>Accessibility</td>
<td>Serve marginal areas</td>
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<tr>
<td>Societal acceptance of AV</td>
<td>Social and economic encounter in shared space</td>
<td>Parking areas</td>
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<tr>
<td>Urban sprawl impact</td>
<td>New programs</td>
<td>Tackle economic disruptions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Encourage active mobility</td>
</tr>
</tbody>
</table>
Reflection. Methods

Are the tools specific to urbanism useful to assess the impact of automated vehicles on the urban environment?
Reflection. Forerunners not followers

How can the urbanist/architect be ahead of the times by imagining the living environments and lifestyles resulting from technological innovation?
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