Impacts of automation on urban areas: some results of TU Delft research

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University of Oregon
URBANISM NEXT

TU Delft
### Shanghai Ranking’s Global Ranking of Academic Subjects 2018 - Transportation Science & Technology

<table>
<thead>
<tr>
<th>World Rank</th>
<th>Institution</th>
<th>Country/Region</th>
<th>Total Score</th>
<th>Score on PUB</th>
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<tbody>
<tr>
<td>1</td>
<td>Beijing Jiaotong University</td>
<td>China</td>
<td>284.1</td>
<td>88.9</td>
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<td>5</td>
<td>University of California, Berkeley</td>
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<td>243.0</td>
<td>81.5</td>
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<td>University of British Columbia</td>
<td>Canada</td>
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<td>66.3</td>
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<td>10</td>
<td>Massachusetts Institute of Technology (MIT)</td>
<td>United States</td>
<td>230.6</td>
<td>71.3</td>
</tr>
</tbody>
</table>
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Modeling

- Observing and analyzing the reality
- Better transport and spatial planning
- Modeling the reality
Automated Driving

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Lots of impacts!

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Urbanism Next framework

One of the key challenges to addressing the multi-level impacts of emerging technologies—such as autonomous vehicles, e-commerce, and the sharing economy—on cities is understanding the range of areas affected and how these areas are related. The Urbanism Next Framework organizes impacts based on four key areas—land use, urban design, transportation, and real estate—and relates those to the implications they have on equity, health, the environment, the economy, and governance.

**LAND USE**
- Retail/commercial/office/industrial (employment uses)
  - How will the changing nature of travel, employment and shopping impact retail, commercial, and industrial districts?
- Housing
  - What are the opportunities to increase housing through infill? Will people choose to locate in cities? Or move farther out in the suburbs?

**URBAN DESIGN**
- Metropolitan footprint
  - When proximity to workplaces and goods/services no longer holds people in cities, what will happen to their already sprawling footprints?
- Street design
  - As cities make plans for future expansions, changes to their street network, the inclusion of various modes/complete streets, and overall street design—what should they be considering?
- Centers and corridors
  - How do rapid change and competing demands for street space affect land use and neighborhood vitality?

**TRANSPORTATION**
- Walking
  - How will we regulate the interactions between pedestrians and vehicles? What happens when pedestrians can stop AVs by simply stepping into the street?
- Biking
  - Will the mixing of modes be frowned upon because it is such a limitation to AV efficiency? What happens when areas ban bikes? How will bikes work around curbside deliveries and dropoff?
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AV and spatial transformation potential

Martijn Hollestelle (master thesis) AUTOMATED DRIVING: DRIVING URBAN DEVELOPMENT? AN INTEGRATED MODELLING AND RESEARCH-BY-DESIGN APPROACH ON THE SPATIAL IMPACTS OF AUTOMATED DRIVING
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Case-study: Utrecht
## Scenarios

<table>
<thead>
<tr>
<th>Scenario 1: <strong>Transformation</strong> of the mobility system</th>
<th>Scenario 2: <strong>Growth</strong> on private AVs with great experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only shared automated vehicles (taxi-bots) on the roads (Level 5). High capacity gains in regional and urban road networks. It’s so convenient that all conventional PT disappears. Good travel comfort and experience. Value of Travel Rime (VOTT) decreasing.</td>
<td>Automated driving develops to full automation everywhere but only as a private mode of transport (Level 5). Technology allows vehicles to drive empty to park at specific outside parking areas. Traveling in a private AV is a great experience. Public transport is the same as today’s. VOTT in cars decreases</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario 3: <strong>Constrained</strong> usage of private AVs</th>
<th>Scenario 4: <strong>Decline</strong> of the mobility system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated driving is level 4 so only full automation in regional networks (no city centers). Capacity only increases on that part of the network. It does not deliver the comfort that was expected at the outset. Parking is the same as today. VOTT decreases but not as much.</td>
<td>Automated driving becomes Level 5 but it does not lead to capacity increases. No real effect on the comfort. No public transport any more. Everyone using private AVs. VOTT the same as today.</td>
</tr>
</tbody>
</table>
## Parameters for the scenarios

<table>
<thead>
<tr>
<th>Category</th>
<th>Scenario</th>
<th>Transformation</th>
<th>Growth</th>
<th>Constraint</th>
<th>Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induced travel</td>
<td>For road travel by new user groups</td>
<td>All public transport transferred to cars on the road network</td>
<td>+10%</td>
<td>N/A</td>
<td>All public transport transferred to cars on the road network</td>
</tr>
<tr>
<td></td>
<td>By empty ride allocation to pick-up other passengers</td>
<td>+20%</td>
<td>+10%</td>
<td>No possibility to pick up other people since it’s level 4</td>
<td>+10%</td>
</tr>
<tr>
<td></td>
<td>By empty ride allocation to designated parking zones</td>
<td>N/A</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Traffic efficiency</td>
<td>Outer-urban roads</td>
<td>+ 100%</td>
<td>+40%</td>
<td>+40%</td>
<td>-20%</td>
</tr>
<tr>
<td></td>
<td>Inner-urban roads</td>
<td>+ 50%</td>
<td>+20%</td>
<td>+0%</td>
<td>+0%</td>
</tr>
<tr>
<td></td>
<td>Intersection delay factor</td>
<td>All 0.1</td>
<td>All 0.25</td>
<td>+0%</td>
<td>+0%</td>
</tr>
<tr>
<td>Travel cost factors</td>
<td>Value of time (all purposes)</td>
<td>-35%</td>
<td>-50%</td>
<td>-15%</td>
<td>+0%</td>
</tr>
</tbody>
</table>
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So what kind of model to estimate the impacts of these scenarios?
What’s modelled there

Induced travel
Induced travel

New user groups
Empty rides allocation
Parking concepts

Infrastructure capacity and flow
Infrastructure capacity and flow

Road capacity
Intersection delays

Travel impedance
Travel impedance

Value of time
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Accessibility to jobs by car

\[ A_i = \sum_{j=1}^{n} D_j \times F_{ijm}(Z_{ijm}) \]

Legend

- **Accessibility to jobs**
  - 510952 - 550000
  - 650000 - 700000
  - 800000 - 850000
  - 900000 - 950000
  - 1000000 - 1050000
  - 1050000 - 1051942
Spatial classification in neighborhood types

Based on the neighborhood typologies by ABF Research (2003)
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Detailed design transformation potential
Spatial quality premium house price, based on research by design at (residential) street (0,2) and (arterial) road level (0,8); +5% if street can be made greener, -5% if demand increases too much;
House choice model: agent-based model

Based on the TIGRIS model

- start
- move-or-stay
- calculate vacant dwellings
- target location choice
- iteration done?
- supply and demand
- final location choice
- end
Model is run for 10 years: do-nothing scenario

Trend of losing population in the main city center as the population searches for more space and lower prices.
Results: mapping density changes

transformation

growth

constraint

decline

Legend
change in household density compared to base scenario at t=10
-200 - 150
-150 - 100
-100 - 50
-50 - 0
0 - 50
50 - 100
100 - 150
150 - 200
>200
Results: Running the scenarios

 transformation

 constraint

 growth

 decline
Summarizing

• **Scenario 1 transformation:** spatial quality effects are balanced over all neighborhood typologies. Average travel times increase but not dramatically. Main urban center of Utrecht does not gain but it does not lose population in relation to the base year. Improvement of city center quality seems to be keeping people in the main center.

• **Scenario 2 Growth:** most spatial quality benefits are found in the larger urban centres such as Utrech. This scenario also shows an increase in population in these areas, who seem to be drawn by the improved quality and by the fact that travel time has increased significantly with the private AVs usage which does not make it easy to commute.

• **Scenario 3 Constraint:** Spatial quality has been maintained in most of the areas. Travel times are similar to today’s. Though it seems that population loss from the city center of Utrecht has been achieved.

• **Scenario 4 Decline:** The spatial quality effects of automated driving do not occur in this scenario and accessibility decreases in most areas. With the increase of travel time the exodus of the city center is not as expressive as in the do-nothing scenario since commuting is not as easy.
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Disclaimer: things missing ...
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More research topics …

AVs routing
- Private AVs can satisfy more trips of your household
- Public shared AVs can be smartly routed to minimize impacts

First/last mile
- How many vehicles?
- How do they charge if they are electric?
- What is their potential?
- Who will use them?
- What costs?

Value of Travel Time
- What if you can work and have leisure in a car?
- What is the experience and comfort?
A lot of contributors for AVs research at TU Delft
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