Autonomous Vehicles - Beyond the Hype?

Transport Studies Unit Seminar
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Mission...

“Furthering understanding and influence on the interactions between mobility, lifestyles & society in a context of technological change.”

Aims

– improving our understanding of travel behaviour
– promoting greater equity in mobility/ accessibility
– developing innovative transport research methodologies
CTS Research Themes

- technologies and travel
- experience of the travel environment
- car dependence
- promoting inclusive, low carbon, active travel
- mobility and the ageing population
- supporting and evaluating sustainable mobility strategies
- understanding and influencing attitudes and behaviours
Venturer Research on the social context of automation

• Understanding, expectance, acceptance by:
  – range of citizens
  – experts & policymakers

• Research methods
  – quantitative survey
  – focus groups
  – Interviews
  – scenario presentation & analysis
Venturer social research on Materials and Competences

• The role of the ‘safety driver’ in an AV
  – Simulator/vehicle trials to investigate handover to/from human/autonomous modes
  – In-vehicle activities a ‘driver’ can undertake whilst legally responsible for the vehicle

• Sharing streets with AVs
  – Social research/experiments to examine how communication between AVs and human road users could occur
  – And how safety parameters will be defined
Narrative of presentation

• AVs are now approaching becoming a consumer technology
• Government and industry identify clear benefits
• AVs are potentially a ‘disruptive’ technology
• Disruption could bring large social and environmental benefits
• But will be associated with major socioeconomic change
• We need to clarify which trajectory for AV adoption we are on, and which one we should be on
Phases of AV development

• 1980-2003 Foundational Research
  – Focused on universities

• 2003-2007 ‘Grand Challenges’
  – Defense Advanced Research Projects Agency

• Commercial development
  – major corporations (Google, motor manufacturers) in competition

Anderson et al. (2013)
## Some Developments in EU and US

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1980s</td>
<td>Munich Federal Defence Force University develops Mercedes van with automatic throttle, brake and steering control on traffic-free streets</td>
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<td>1994-5</td>
<td>PROMETHEUS Mercedes car piloted automatically in traffic for majority of 1,600 km between Munich and Odense</td>
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<td>Carnegie Mellon team crosses US with self-steering Pontiac</td>
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<td>2001</td>
<td>University of Parma Lancia able to follow white lines and regulate speed over 2,000 km extra-urban rural road tour</td>
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<td>2007</td>
<td>third ‘Grand Challenge’: 96km urban course on disused airbase: vehicles required to comply with traffic laws and to negotiate other traffic and obstacles</td>
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<tr>
<td>2009-12</td>
<td>Google Toyota and Lexus vehicles complete 500,000 km of trials</td>
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<tr>
<td>2014</td>
<td>Google bespoke AV with no steering wheel or pedals exhibited</td>
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Commercialisation Roadmap (KPMG 2015):

Autonomy Level: L0 - L5

Timeline:
- 2010: Blind Spot Monitoring
- 2015: Lane Departure Warning, Lane Keep Assist (LKA)
- 2020: Autonomous Emergency Braking, Emergency Driver Assistant, 3D Cloud Based Navigation
- 2025: Vehicle to Vehicle, Vehicle to Device and Vehicle to Infrastructure Communication
- 2030: Certain driving situations e.g. remote parking and urban automated driving
- 2030+: Full end-to-end journey
Usefulness: benefits claimed for AVs

The Pathway to Driverless Cars: A detailed review of regulations for automated vehicle technologies

- Improving the efficiency with which we use our road network
- Fewer deaths and injuries
  - Impaired by alcohol/drugs
  - Inappropriate speed
  - Disobeyed signals/markings
  - Driver distraction including mobile/texting
  - Following too close
  - Failed to look properly
- 94% of road deaths and injuries involve human error
- Opens up access to cars for everyone increasing social inclusion
  - 31% women do not hold a full driving licence
  - 14% men do not hold a full driving licence
  - 46% 17-30 year olds do not hold a full driving licence

The average driver in England can save up to 6 working weeks a year driving time

Money saving through reduced insurance costs

Department for Transport

Reduce pollution
Industry Motive for Automation

- Little/no profit in ‘low end’ car sales
- KPMG identifies £51 b. p.a. UK market ‘prize’ – 320k new jobs
- ‘Added value’ of automation significant
Govt and Expert Perspectives Emphasise

- Inevitability of transition
- Economic growth opportunity
- Technical barriers to be overcome
- Regulatory conditions to be created
- Need for UK to move first/fast
Technology Acceptance Model

- Perceived Usefulness (U)
- Perceived Ease of Use (E)
- Attitude Toward Using (A)
- Behavioral Intention to Use (BI)
- Actual System Use

Perceived Affective Qualities (Q)
In theoretical terms, discourse and actions are:

- Opening up market niches
- Beginning to shape new social practices
  - Although with limited strategic management
- Potentially influencing public opinion towards acceptance
But is there a disconnect?

- the significant benefits claimed mainly arise at Level 5

- AVs have limited relevance for wider society until the technology moves beyond L3/L4
  - at least 2030 according to KPMG
Multi Level Perspective on Technological Transitions

Fig. 3. Multiple levels as a nested hierarchy.
Insights for AV adoption

• landscape level changes
  – migration to cities, impact of mobile ICTs on lifestyles, peak car (?)
  – strengthening agendas around climate change, energy-power systems

• problems with automobility regime
  – Inefficiency, high external costs, particularly in urban areas

• emergence in applied market niches
  – airport parking, local urban taxis
  – Functions of driving process e.g. parking, cruising
Possible Early Adoption Niches

• In segregated environments already (Heathrow, Docklands Light Railway)

• L3 private vehicles with greater AV technology for specific driving tasks (e.g. valet parking, adaptive cruise control)

• Mass transport on dedicated routes/lanes to reduce labour costs (platooning, bus rapid transit)

• Flexible route taxi or bus systems increasingly trialled in less controlled but still defined urban environments
Social Practice Theory: will change to enable AV adoption occur?

- **Materials** – changes to design of vehicles and roads
- **Competence** – changes in road-user skills, employment
- **Meaning** – new aspirations and understandings of being mobile
Changing practices?

• Level 3
  – New expectations about maintenance

• Level 4
  – the ‘sleeper car’

• Level 5
  – AV-chauffeuring?
Highway code to become an operating manual?

Fout

Goed

Rule 163: Give vulnerable road users at least as much space as you would a car
Encounter with the Google car today...

a Google self-driving Lexus has been in my neighborhood for the last couple of weeks doing some road testing.

near the end of my ride today, we both stopped at an intersection with 4-way stop signs.

the car got to the stop line a fraction of a second before I did, so it had the ROW. I did a track-stand and waited for it to continue on through.

it apparently detected my presence (it's covered in Go-Pros) and stayed stationary for several seconds. it finally began to proceed, but as it did, I rolled forward an inch while still standing. the car immediately stopped...

I continued to stand, it continued to stay stopped. then as it began to move again, I had to rock the bike to maintain balance. it stopped abruptly.

we repeated this little dance for about 2 full minutes and the car never made it past the middle of the intersection. the two guys inside were laughing and punching stuff into a laptop, I guess trying to modify some code to 'teach' the car something about how to deal with the situation.

the odd thing is that even tho it was a bit of a CF, I felt safer dealing with a self-driving car than a human-operated one.
What do we know about Citizen Acceptance to date?

- Awareness high
  - Schoettle and Sivak (2014) 2/3rds in US/UK/AU

- Opinion survey findings inconsistent and variable
  - Vary by country, driver status, gender, personality
  - Influenced by question framing
  - ‘Driver experience’, control, security strongest negatives
  - Safety and full automation strongest positives
Citizen Expectations

- Howard & Dai (2014) ‘multi-tasking’ and not having to park as positives
- Schoettle & Sivak (2014) 41% expected to ‘watch the road’ (8.3% would read)
- Casley (2013) fuel efficiency, shorter journey times, environmental credentials more important than productive use of travel time
- Wide range of estimates of willingness to pay
  - One outlier study indicated a $30k premium, but several others only around $1-3k more
## Citizen views from a science festival

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<thead>
<tr>
<th>Positive</th>
<th>Conditional</th>
<th>Negative</th>
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<tbody>
<tr>
<td>Safer</td>
<td>Environmental credentials depend on manufacturers!</td>
<td>Loss of control</td>
</tr>
<tr>
<td>Independent travel by young/old/disabled/disqualified</td>
<td>Clean fuels?</td>
<td>Pleasure of driving</td>
</tr>
<tr>
<td>Can drink alcohol and ‘drive’</td>
<td>Cybercrime?</td>
<td>Loss of driving jobs</td>
</tr>
<tr>
<td>Can relax in journey</td>
<td>Trustworthy?</td>
<td>Reduced practice by human drivers (loss of skill)</td>
</tr>
<tr>
<td>Collective form of transport</td>
<td>Legal responsibility?</td>
<td>Loss of choice e.g. route</td>
</tr>
<tr>
<td>Can use journey time productively</td>
<td>Support if public (collective) transport</td>
<td>Poor interaction with other road users</td>
</tr>
<tr>
<td>More comfortable ride</td>
<td></td>
<td>Loss of identity, personality</td>
</tr>
<tr>
<td>Create inclusive society</td>
<td></td>
<td>Low trust in technology</td>
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<tr>
<td>Reduced congestion</td>
<td></td>
<td></td>
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### Additional citizen views from a technology fair

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<tr>
<th>Positive</th>
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<th>Negative</th>
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</thead>
<tbody>
<tr>
<td>Guaranteed journey times</td>
<td>Affordable by all?</td>
<td>Lack of ‘sex appeal’</td>
</tr>
<tr>
<td>Managed system</td>
<td>Need to understand technology</td>
<td>Power consumption of autonomous system</td>
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<tr>
<td>Standard vehicle type: no social ‘display’</td>
<td>Prefer as second car</td>
<td>Enjoy ‘sporting-style’ driving</td>
</tr>
<tr>
<td>Benefits particularly for those travelling for work</td>
<td>If can switch between human / auto. Control</td>
<td>Won’t solve transport problems</td>
</tr>
<tr>
<td>Smoother traffic flow</td>
<td>Ability to cope with unexpected incidents</td>
<td></td>
</tr>
<tr>
<td>No requirement to park vehicles</td>
<td>Technical problems won’t be solved</td>
<td></td>
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<tr>
<td>Maintenance and cleaning by public operator</td>
<td></td>
<td></td>
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<tr>
<td>More fuel efficient</td>
<td></td>
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Association of AV concept with:

- collective ownership
- standardised vehicles
- Immediate achievement of ‘Level 4’ automation
- Socially positive goals
- Logical, efficient transport system
- Better quality of journey (as passenger)
- Electric/clean power
Low awareness of:

- significant outstanding technological challenges
- transition from current technology to full automation
- financing/funding model
- non-transport sector implications
  - E.g. land value changes if car parks redundant
  - Public health if walking/cycling discouraged
Regime Scenario 1: “business as usual or incremental substitution”

- Gradual development and exploitation of technology
- Replacement of private cars
  - current ownership and use model
- Significant investment in infrastructure
  - Public funds and toll revenue
- Pressure for regulation of other road users
- Increased mobility for those with restrictions on driving capabilities (if able to afford an AV)
Possible outcomes for Scenario 1

- L3 constraints on using (high-specification, expensive) cars reduced
  - (L4 AV empty running, constraints further reduced)
- car ownership and traffic increase
- public transport use, car occupancy fall
- Social exclusion of those without car access
- Worse urban living conditions
  - More vehicles parked
  - Limited decongestion/emissions benefits of AVs offset
- Public health threat of reduced active travel
Regime Scenario 2: “collective efficiency”

- Higher L3 capital cost favours collective ownership of vehicles
- L4 link vehicles further favour collectivity
  - ‘driver experience’ no longer a factor in ownership
  - Immediate availability achieved through summoning rather than own car on drive
  - Removal of owner-driver vs guest-passenger distinction encourages collective use
- Fleets (commercial, public, third-sector) offer a range of automated mobility services
  - Differentiated by price and service attributes
Possible outcomes for Scenario 2

- Efficient ridership + collective ownership minimise vkm
  - Absolute fall in traffic possible
  - Emissions benefits maximised by smoother, lighter traffic

- Parking at origins/destinations largely eliminated
  - Accessibility of city centres favoured
  - Residential streets decluttered

- Social inclusion enhanced by more flexible ‘public’ transport e.g. in low density areas
  - Accessibility and perhaps mobility increased

- Concerns about levels of active travel remain
  - But walking and cycling for part of journeys more possible with collective ownership
Conclusions

• Government / industry emphasise AV benefits
  – Promoting ‘regime’ change

• Citizens more ambivalent, particularly if accept current role of car in society
  – Some reject the new practices expected to emerge around AV automobility

• Current AV transition focused on adapting current practices to minimise ‘disruptiveness’
  – Societal benefits only emerge if AVs are part of a universal shared, electrified, optimised system combining features of private and public modes
Questions?