How Might Automated Driving Impact US Land Use?

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Prediction is very hard, especially about the future.

- Yogi Berra
Era of abundant fuel has ended for good

Romance with car ending

Middle-class returns to city, avoids cars

Public Transportation Revival

One occupant-per-car must end
Predictions: 1973

The Painful Change to Thinking Small, *Time Magazine*, Dec 31, 1973

- There have been multiplying signs that the long American romance with the big car may finally be ending.
- More likely, the heavy car will linger as a limited-purpose, special-use auto, but not again become the basic American vehicle.
- Economists generally are agreed that the era of readily abundant fuel has ended for good.
- Public transportation will experience a revival.
- Car pooling will have to increase...the one-occupant-per-car habit is simply too expensive to be continued.
- Socially, there could be a movement of middle-class whites back to the city, where they can get away from auto dependence.
Summarizing AVS14: AD Level 2+3 and Highways

• Level 2+3 currently easiest on highways, likely first locations of AD.

• Predicted Impacts on highways:
  – Fewer accidents
  – Less traffic congestion
  – Lower environmental impact per mile
  – Faster average speeds
My Own Predictions

• Without policy changes, in the US, Level 2+3 Automated Driving will likely:
  − Increase highway speeds (mostly via reduced congestion and accidents)
  − Increase automobile VMT
  − Increase commute distances (with roughly same commute time as today)
  − Accelerate ongoing trend towards suburbanization of homes and jobs
Across cultures and decades, people travel approx. 1.2 hrs/day

For over 100 years, each new US commuting mode, offering higher speed, has increased commute distances.
Suburbs are growing in every US Region

US Suburbs share of population grows the last 20 yrs, in every region. [Source: W. Frey, Brookings Inst., 2012]
Growth by Metro Size

Majority of jobs will soon be > 10 mi from Central Business District (CBD)
Outer suburbs only region growing in share of jobs.

In Atlanta, trend is even stronger
# US Suburbanization-by the numbers

<table>
<thead>
<tr>
<th></th>
<th>Chicago</th>
<th>Atlanta</th>
<th>Denver</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population</strong> 2010</td>
<td>9,461,105</td>
<td>5,268,860</td>
<td>2,543,482</td>
</tr>
<tr>
<td>City Population 2010</td>
<td>2,695,598</td>
<td>420,003</td>
<td>600,158</td>
</tr>
<tr>
<td>% Growth Metro Area, 2000-2010</td>
<td>4.0%</td>
<td>24%</td>
<td>17%</td>
</tr>
<tr>
<td>% Growth City, 2000-2010</td>
<td>-6.9%</td>
<td>1.0%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Urbanized Land Area sq. mi., 2010</td>
<td>2,443</td>
<td>2,645</td>
<td>668</td>
</tr>
<tr>
<td>New Urbanized Area (Areas &gt; 1,000 pers/sq. mi 2040, 2030, 2035)</td>
<td>189</td>
<td>275</td>
<td>190</td>
</tr>
<tr>
<td>% Commuting by Transit ACS, 2008/2009</td>
<td>11.5%</td>
<td>3.7%</td>
<td>4.6%</td>
</tr>
<tr>
<td>% VMT - Highway 2010</td>
<td>42%</td>
<td>43%</td>
<td>44%</td>
</tr>
<tr>
<td>% VMT - Arterials/Streets 2010</td>
<td>58%</td>
<td>57%</td>
<td>56%</td>
</tr>
<tr>
<td>% Jobs w/in 3 mi. of CBD 2010</td>
<td>20%</td>
<td>10%</td>
<td>22%</td>
</tr>
<tr>
<td>% Jobs 10-35 mi. of CBD 2010</td>
<td>67%</td>
<td>65%</td>
<td>37%</td>
</tr>
<tr>
<td>% Jobs Accessible by Transit &lt; 90 min.</td>
<td>24%</td>
<td>22%</td>
<td>47%</td>
</tr>
<tr>
<td>Projected Jobs Added CBD</td>
<td>143,000</td>
<td>39,800</td>
<td>164,000</td>
</tr>
<tr>
<td>Projected Jobs Added Suburban Areas</td>
<td>1,190,000</td>
<td>788,000</td>
<td>728,000</td>
</tr>
</tbody>
</table>

*Derived
Visualizing Why

• Most models of residential location choice are hard for non-specialists to use, due to complexity and/or impractical assumptions.

• I have concluded that three very important factors for housing location are
  – housing price,
  – school quality, and
  – commute time

• Mapped these for Metropolitan Statistical Area of Chicago
Commute Time

The average one-way commute time for Metro Chicago is 30 minutes. This graph shows the fraction of commuters in each zip code that have a shorter-than-average (<30 min) commute. (American Community Survey, 5-yr Avg., 2007-2001)
Do Suburbs require longer commutes?

Percentage of Low Commutes (<30 min. one-way). The average percentage of low commutes (48%) represents a strong clustering value for Chicago metro area. Percentages rarely go outside of 25-75% low commutes.
<table>
<thead>
<tr>
<th></th>
<th>CBD</th>
<th>City of Chicago</th>
<th>Inner Suburbs</th>
<th>Outer Suburbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>209,430</td>
<td>2,714,711</td>
<td>3,100,224</td>
<td>2,716,532</td>
</tr>
<tr>
<td>Avg. Density (Zip Code)</td>
<td>16,300</td>
<td>14,800</td>
<td>4,320</td>
<td>1,460</td>
</tr>
<tr>
<td>% Low Commutes</td>
<td>65%</td>
<td>44%</td>
<td>50%</td>
<td>48%</td>
</tr>
<tr>
<td>Avg. School Rating</td>
<td>6.3</td>
<td>3.8</td>
<td>6.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Med. Price per Sq. ft ($)</td>
<td>$273</td>
<td>$197</td>
<td>$183</td>
<td>$128</td>
</tr>
</tbody>
</table>

CHICAGO MSA - Urban Area Stats
Conclusions

• Automated Driving Level 2+3 (NHTSA) predicted to increase travel comfort and speed, esp. on highway

• Long history of Americans turning higher speed travel into more VMT, keeping total travel time same. Why would AD be different?

• Increased speed offers house buyer larger area to trade-off price vs. location amenities (e.g. public school quality)
Final thought

It ain’t over ‘til it’s over.

- Yogi Berra
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Backup
School Quality

School Quality is measured from a state-wide standardized test, with scores scaled from 0-10 (10=highest test score). Each dot indicates an elementary, middle, or high school. The larger the dot, the higher the test score for the school. The pink shading is an average of school test scores in the zip code. (Great Schools Rating, 2013)
Housing Price

Shading for each zip code represents the average price of a square-foot of residential space. (Zillow Price Data, 10-yr. Median, 2003-2013)
Commutes, Schools, Cost

\[
Z\text{-score} = \frac{(\text{Value}) - (\text{Average Value})}{(\text{Standard Dev. of Values})}
\]

\[
\text{Z-score}_{\text{Comm}} = 5.0
\]
\[
\text{Z-score}_{\text{School}} = 1.7
\]
\[
\text{Z-score}_{\text{Hsg.$}} = 4.5
\]

\[
+ \quad + \quad x \ (-1) = \text{Total Z-score}
\]

ACS 5-YR Estimates, 2007-2011
Great Schools, 2012 (Non-profit, ind. evaluation)
Zillow Sales Data, 2003-2013

CHICAGO MSA - Z-scoring
Three Determinant Overlay

Darker means more attractive to shoppers.
Can we make Suburbs more sustainable?

Should we?
Example: Pecan Street (Austin, TX)
Example: West Village (Davis, CA)
Example: Low-carbon Society Project (Toyota City, JP)

All 67 homes have:
• PV Solar Panels
• Plug-in Vehicle
• Home Energy Management
• House battery

Soon
• Carsharing
• Multi-modal navigation

Show Video
GenY drives much less

Will GenY culture change car-dependent environment in US?
Gen Y: Life-cycle effect is delayed

A new care-free 20s demographic creating noticeable consumer shifts, exaggerated due to economic crisis
Gen Y: Still want a Family

Gen Y: marriage and family is important, plan to get married and have children.

Will Gen Y resist economic incentives to suburbs when they start families?

Note: Based on ages 18-29, unmarried and without children, n=305.
PEW RESEARCH CENTER
Gen Y: Still want Homes

Share Who Intend to Own a Home, 2012

- TD Bank: 84% (18-34 yr olds)
- Wood. Wilson Center: 75% (non-homeowners)
- Nat. Assoc. of Home Builders: 68% (non-homeowners)

Home ownership level, U.S.
Cost drives adoption rates

• Which would you buy (in 2004)?
  – 2004 Corolla $13.5k 34 MPG
  – 2004 Prius $20.5k 46 MPG

• At time, criticism from both sides, i.e. industry observers (bad value trade-off) and environmentalists (not green enough).

• But, over 2M Prii sold, saved millions of tons CO₂

Prices are minimum MSRP, MPG is EPA Combined. 2004 Prius had 3.4 cu-ft more cargo room than 2004 Corolla
Batteries Have a Long Way to Go

Compared to the same range of gas, the battery is

75 times heavier
1000 times more expensive

Assumes prices of $3.50/gal of gas and at least $250/kWh for the battery
CMAP POPULATION
Percentage Change, 2010-2040

- CITY of CHICAGO
  2010 Urbanized Area
- Interstate

Population Growth
(Mean pop. change by 2040 = 265%)

243 - 436%
436% +