Impacts of New Technological and Economic Trends in Transportation and Land Use Activity

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The session...

- JHV
  - Freight activity in metropolitan areas
  - Impacts of new technologies and ecommerce on land use patterns
- David Greenfelder
  - The perspective of the retail sector
- Jeffrey Wojtowicz (in lieu of Catherine Lawson)
  - What should land use agencies do?
About the Freight System and Its Activity
When people think of freight, most think about…

Intermodal terminals

In reality:

(1) the amount of freight activity at these facilities is a minuscule portion of the total;

(2) freight activity takes place at all levels: global, national/regional, metropolitan/urban, neighborhood, block, household/establishment
**Economic Classification Systems** (NAICS, SIC, etc.) cluster commercial establishments taking into account the nature of activity.

<table>
<thead>
<tr>
<th>NAICS</th>
<th>Freight-intensive Sectors (FIS)</th>
<th>Service-intensive Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Agriculture, Forestry, Fishing, Hunting</td>
<td>51 Information</td>
</tr>
<tr>
<td>21</td>
<td>Mining, Quarrying, Oil / Gas…</td>
<td>52 Finance and Insurance</td>
</tr>
<tr>
<td>22</td>
<td>Utilities</td>
<td>53 Real Estate and Rental and Leasing</td>
</tr>
<tr>
<td>23</td>
<td>Construction</td>
<td>54 Professional, Scientific, Tech. Services</td>
</tr>
<tr>
<td>31-33</td>
<td>Manufacturing</td>
<td>55 Management of Companies /</td>
</tr>
<tr>
<td>42</td>
<td>Wholesale Trade</td>
<td>56 Administrative, Support, Waste Manag.</td>
</tr>
<tr>
<td>44-45</td>
<td>Retail Trade</td>
<td>61 Educational Services</td>
</tr>
<tr>
<td>48-49</td>
<td>Transportation and Warehousing</td>
<td>62 Health Care and Social Assistance</td>
</tr>
<tr>
<td>72</td>
<td>Accommodation and Food Services</td>
<td>71 Arts, Entertainment, and Recreation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>81 Other Services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>92 Public Administration</td>
</tr>
</tbody>
</table>

45% of establishments and about half the employment are in FIS.
Key Trends and Technologies
Economic System and Emerging Trends

- Economic Trends
- Environmental Trends
- Societal Trends
- Technological Trends
<table>
<thead>
<tr>
<th>Economic Trends</th>
<th>Technological Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Globalization</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>Nationalism</td>
<td>BIG Data Analytics</td>
</tr>
<tr>
<td>Rising income</td>
<td>Internet of Things</td>
</tr>
<tr>
<td><strong>Internet economy</strong></td>
<td><strong>Novel vehicular technologies (e.g., CAVs, Drones)</strong></td>
</tr>
<tr>
<td>Sharing economy</td>
<td><strong>Advanced robotics (e.g., Droids)</strong></td>
</tr>
<tr>
<td>Advanced manufacturing (e.g., 3D printing)</td>
<td><strong>Rising efficiency in energy capture, storage and transmission</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Societal Trends</th>
<th>Environmental Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ageing population</td>
<td>Changing Climate</td>
</tr>
<tr>
<td>Rising geographic mobility</td>
<td>Environmental Awareness</td>
</tr>
<tr>
<td>Rising urbanization</td>
<td></td>
</tr>
</tbody>
</table>
The Impacts of the Internet Economy
Freight Trip Generation Models

- Freight-trip generation models
- Establishment-level
- Economic based
A Long View of Freight Trip Generation

Seoul, South Korea, with a generation of deliveries to HHs of 0.20 Deliveries/p-day in 2017

Chief Implication: All signs indicate that with the on-demand Internet economy, freight traffic will continue to increase.
# Freight and Service Activity for Key Cities

<table>
<thead>
<tr>
<th></th>
<th>Kansas City, KS</th>
<th>Austin, TX</th>
<th>Columbus, OH</th>
<th>San Jose, CA</th>
<th>Seattle, WA</th>
<th>Washington, DC</th>
<th>Boston, MA</th>
<th>New York, NY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (2016)</td>
<td>151,042</td>
<td>916,906</td>
<td>852,144</td>
<td>1,023,031</td>
<td>688,245</td>
<td>672,391</td>
<td>669,158</td>
<td>8,560,072</td>
</tr>
<tr>
<td>Total Area (km²)</td>
<td>323.3</td>
<td>830.8</td>
<td>566.2</td>
<td>459.8</td>
<td>217.1</td>
<td>158.4</td>
<td>125.2</td>
<td>777.9</td>
</tr>
<tr>
<td>Population density</td>
<td>467.23</td>
<td>1103.60</td>
<td>1505.08</td>
<td>2225.14</td>
<td>3169.76</td>
<td>4246.19</td>
<td>5344.31</td>
<td>11003.60</td>
</tr>
<tr>
<td>Establishments (est)</td>
<td>2,965</td>
<td>33,661</td>
<td>20,106</td>
<td>20,508</td>
<td>33,019</td>
<td>21,264</td>
<td>13,071</td>
<td>245,009</td>
</tr>
<tr>
<td>Employment</td>
<td>66,670</td>
<td>629,432</td>
<td>472,088</td>
<td>375,824</td>
<td>595,301</td>
<td>511,541</td>
<td>404,412</td>
<td>3,786,192</td>
</tr>
<tr>
<td>FTG/day</td>
<td>17,277</td>
<td>117,216</td>
<td>87,997</td>
<td>80,165</td>
<td>117,681</td>
<td>56,647</td>
<td>43,929</td>
<td>873,380</td>
</tr>
<tr>
<td>STA/day</td>
<td>1,493</td>
<td>12,222</td>
<td>8,176</td>
<td>7,495</td>
<td>15,082</td>
<td>11,695</td>
<td>6,824</td>
<td>88,640</td>
</tr>
<tr>
<td>FSA trips/p-day</td>
<td>0.12</td>
<td>0.14</td>
<td>0.11</td>
<td>0.09</td>
<td>0.19</td>
<td>0.10</td>
<td>0.08</td>
<td>0.11</td>
</tr>
</tbody>
</table>

## All Sectors

|                      |                 |             |              |              |             |               |             |             |
|----------------------|-----------------|-------------|--------------|--------------|-------------|---------------|-------------|
| Deliveries/day       | 18,125          | 110,029     | 102,257      | 122,764      | 82,589      | 80,687        | 80,299      | 1,027,209   |

## Internet Deliveries to Households

|                      |                 |             |              |              |             |               |             |             |
|----------------------|-----------------|-------------|--------------|--------------|-------------|---------------|-------------|
| Deliveries/day       | 18,125          | 110,029     | 102,257      | 122,764      | 82,589      | 80,687        | 80,299      | 1,027,209   |

## Density Indicators

<table>
<thead>
<tr>
<th></th>
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<th>Washington, DC</th>
<th>Boston, MA</th>
<th>New York, NY</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSA trips/km²</td>
<td>114.13</td>
<td>288.23</td>
<td>350.47</td>
<td>457.68</td>
<td>991.82</td>
<td>941.13</td>
<td>1,046.66</td>
<td>2,557.07</td>
</tr>
<tr>
<td>ZIP Code(s) analyzed</td>
<td>Kansas City, KS</td>
<td>Austin, TX</td>
<td>Columbus, OH</td>
<td>San Jose, CA</td>
<td>Seattle, WA</td>
<td>Washington, DC</td>
<td>Boston, MA</td>
<td>New York, NY</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------</td>
<td>-----------</td>
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<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Population (2016)</td>
<td>9691</td>
<td>7875</td>
<td>14322</td>
<td>62039</td>
<td>12408</td>
<td>5836</td>
<td>23215</td>
<td>23947</td>
</tr>
<tr>
<td>Total road length (km)</td>
<td>583.47</td>
<td>129.28</td>
<td>374.06</td>
<td>384.14</td>
<td>88.44</td>
<td>32.89</td>
<td>81.50</td>
<td>50.92</td>
</tr>
<tr>
<td>% Available for Parking</td>
<td>84.4%</td>
<td>74.3%</td>
<td>79.3%</td>
<td>74.6%</td>
<td>70.5%</td>
<td>78.0%</td>
<td>75.6%</td>
<td>87.2%</td>
</tr>
<tr>
<td>Total linear road cap (km)</td>
<td>492.43</td>
<td>96.04</td>
<td>296.67</td>
<td>286.58</td>
<td>62.31</td>
<td>25.66</td>
<td>61.64</td>
<td>44.42</td>
</tr>
<tr>
<td>Establishments</td>
<td>377</td>
<td>2,996</td>
<td>2,571</td>
<td>2,197</td>
<td>2,956</td>
<td>2,824</td>
<td>2,060</td>
<td>8,221</td>
</tr>
<tr>
<td>Employment</td>
<td>14,534</td>
<td>59,387</td>
<td>67,682</td>
<td>44,735</td>
<td>87,499</td>
<td>65,962</td>
<td>61,340</td>
<td>174,552</td>
</tr>
<tr>
<td>FTG/day</td>
<td>4,157</td>
<td>7,279</td>
<td>6,274</td>
<td>11,071</td>
<td>9,537</td>
<td>4,458</td>
<td>7,372</td>
<td>35,174</td>
</tr>
<tr>
<td>STA/day</td>
<td>335</td>
<td>970</td>
<td>925</td>
<td>747</td>
<td>1,583</td>
<td>1,474</td>
<td>1,180</td>
<td>2,748</td>
</tr>
<tr>
<td>Total Trips(FSA)/day</td>
<td>4,492</td>
<td>8,249</td>
<td>7,199</td>
<td>11,818</td>
<td>11,120</td>
<td>5,932</td>
<td>8,551</td>
<td>37,922</td>
</tr>
<tr>
<td>FTG/km</td>
<td>8.44</td>
<td>75.80</td>
<td>21.15</td>
<td>38.63</td>
<td>153.05</td>
<td>173.76</td>
<td>119.59</td>
<td>791.93</td>
</tr>
<tr>
<td>STA/km</td>
<td>0.68</td>
<td>10.10</td>
<td>3.12</td>
<td>2.61</td>
<td>25.41</td>
<td>57.43</td>
<td>19.14</td>
<td>61.87</td>
</tr>
<tr>
<td>FSA/km</td>
<td>9.12</td>
<td>85.90</td>
<td>24.27</td>
<td>41.24</td>
<td>178.46</td>
<td>231.19</td>
<td>138.72</td>
<td>853.80</td>
</tr>
<tr>
<td>Internet Deliveries to HH</td>
<td>1,163</td>
<td>945</td>
<td>1,719</td>
<td>7,445</td>
<td>1,489</td>
<td>700</td>
<td>2,786</td>
<td>2,874</td>
</tr>
<tr>
<td>ID to HH/km</td>
<td>2.36</td>
<td>9.84</td>
<td>5.79</td>
<td>25.98</td>
<td>23.90</td>
<td>27.29</td>
<td>45.19</td>
<td>64.70</td>
</tr>
</tbody>
</table>
Anticipated B2C Traffic

- NYC, NY (20.2M)
- Los Angeles, CA (13.3M)
- Chicago, IL (9.5M)
- Washington, DC (6.2M)
- Seattle, WA (3.8M)
- Portland, OR (2.4M)
- New Orleans, LA (1.3M)
- Albany, NY (0.88M)
- Toledo, OH (0.6M)
- Houston, TX (6.8M)

The graph shows the relationship between freight deliveries (in thousands) and population at MSA (in thousands). The data points are color-coded as follows:

- **B2B**
- **B2B+B2C(Seoul)**
- **B2B+B2C(Seoul)+On-Demand(0.05)**
Ecommerce Impacts on Land Use

“Amazon can already ship to 72% of US population within a day...” CNBC

https://www.cnbc.com/2019/05/05/amazon-can-already-ship-to-72percent-of-us-population-in-a-day-map-shows.html

Blue: 2014 Coverage
Maroon: 2018 Coverage
Impact of Vehicular Technologies
A Tsunami of New Technologies...

Truck Platooning / Connected and Autonomous Trucks

Amazon Testing Drone Delivery System

Delivery Drones

The drone launches from the top of the truck

Truck / Delivery Drone Systems

Delivery Robots (Bots)
Truck Platooning, Driverless Trucks

1) Major role in interconnecting large traffic generators
2) Major threat to freight rail
3) Could foster logistic sprawl

https://www.eutruckplatooning.com/about/default.aspx
https://www.youtube.com/watch?v=lx9EFJ6qqZc
Truck-drone combinations

- https://www.youtube.com/watch?v=xx9_6OyjJrQ

1) Could help make internet deliveries in suburbs
2) Could reduce VMT
Drones

1) Likely to be used in suburbs, low density cities
2) Large and dense cities not the best targets
Delivery robots

1) Will necessitate major changes in curbside / sidewalks
2) Conflicts with pedestrians

A Toaster on Wheels to Deliver Groceries?
Self-Driving Tech Tests Practical Uses

Postmates has created a robot to start automating its deliveries

It can carry 50 pounds of cargo, and travel 30 miles on a single charge.

By Jon Porter | @JonPorty | Dec 13, 2018, 12:12pm EST

Starting this week, two small self-driving cars made by Nuro, a start-up, will chug along at no faster than 25 miles an hour to deliver groceries in Scottsdale, Ariz. Colin D’Herde for The New York Times
Levels of Impacts

Individual Decisions

Land use choices
- Location of firm / residence
- Distance btw suppliers & customer
- Locate in center or periphery
- Size of establishment

Freight/Transportation choices
- Demand quantity
- Delivery frequency / shipment size
- Mode / transportation technology

System-level Impacts

Direct
Land use
- Density
- Land value
- Land use mix

Transportation
- Travel time
- Truck VMTs
- Truck trips

Externalities
- Congestion
- Pollution (noise, air)
- Pavement damage

Technologies impact these choices
History (and the EOQ model) shows

- **Reductions in generalized transportation costs**
  - Decreases shipment sizes
  - Increases shipment frequencies
  - Increases the separation between economic units

- **Reductions in shipment sizes**
  - Leads to the use of the smaller vehicles and modes
  - Since the amount of cargo per-capita increases or stay the same, the total VMT increases
Concluding Remarks
Mixed Impacts

- **Ecommerce Impacts**
  - Regional Distribution Centers are getting closer to metropolitan areas
  - Expedited deliveries (anything that is faster than “normal”), i.e., next-day, two-days, and On-Demand deliveries are bound to need urban DCs

- **Vehicular Technologies**
  - Will support the ecommerce tsunami
  - In other sectors, may lead to increasing the physical separation between the stages in supply chains

- **Together, Ecommerce and Vehicular Technologies:**
  - Will reduce even further shipment sizes, increasing freight vehicle traffic, and VMT
Implications

- In most cases, new technologies solve some problems ... and create others...
- Comprehensive approaches are needed to:
  - Maximize beneficial impacts
  - Mitigate/Eliminate negative effects
- This may require:
  - Collaborative public-private-research efforts
  - Freight demand management
  - Better allocation of curbside space
  - Innovative logistics
CO$_2$ Emissions: RHD Truck #3 vs. OHD Truck #1

(RHD) Delivery Truck #3

(OHD) Delivery Truck #1