Effective Decision-Making Methods for Freight-Efficient Land Use

José Holguín-Veras,
William H. Hart Professor
Director of the VREF Center of Excellence
for Sustainable Urban Freight Systems
jhv@rpi.edu
Acknowledgements

- **Principal Investigators**
  - José Holguín-Veras, Ph.D., P.E. (PI) – jhv@rpi.edu (RPI)
  - Cara Wang, Ph.D., P.E. (Co-PI) – wangx18@rpi.edu (RPI)
  - Catherine Lawson, University at Albany
  - Dan Haake, SRF
  - Dan Murray, ATRI

- **Other Team Members:** J. Wojtowicz, X. Qin, G. Feller, J. Ng, D. Ramirez-Rios, C. Rivera-Gonzalez, W. Yushimito, S. Pérez, J. Schmid, C. Gonzalez

- **Funded by the National Cooperative Highway Research Program**
Outline

- Background
- Metropolitan Economies
- Freight and Service Activity for Selected MSAs
- NCHRP 08-111 Approach
- Tools of the Trade
- Next Steps
Background
Research Goal and Objectives

**Goal:** To develop effective decision-making methods to advance freight efficient land-uses (FELU)

**Objectives:**
- Quantify and evaluate the impact of land-use practices and policies to support efficient movement of all modes of freight.
- Develop quantitative and qualitative land-use assessment tools (e.g., models, guide) to assist local, regional, and state land-use and transportation decision makers to support efficient movement of freight.
When people think of freight, most think about…

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.
Metropolitan Economies
Freight and the metropolitan economies...

- 60% of Global GDP → Produced in top 600 cities
- In the US, metro/micropolitan areas represent:
  - 83% of establishments, 78% of employment, and 76% of the value of manufactures
  - 80% of US cargo transported (top 100 metro areas)
- Statistics about freight transported:
  - USA (entire country) → USA: 114 kg/person-day
  - New York City, USA → 45 kg/person-day
  - Beijing, China → 35 kg/person-day
  - Medellin, Colombia → 25 kg/person-day
  - Port-au-Prince, Haiti → 8 kg/person-day
- Amount of cargo transported increases with income... with rising incomes → Things will get worse
## Employment and Industry Sectors

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

<table>
<thead>
<tr>
<th>NAICS</th>
<th>Description</th>
<th>Establishments</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>11</td>
<td>Agriculture, Forestry, Fishing ...</td>
<td>15,614</td>
<td>0.22%</td>
</tr>
<tr>
<td>21</td>
<td>Mining, Quarrying, Oil and Gas</td>
<td>21,929</td>
<td>0.31%</td>
</tr>
<tr>
<td>22</td>
<td>Utilities</td>
<td>14,643</td>
<td>0.21%</td>
</tr>
<tr>
<td>23</td>
<td>Construction</td>
<td>613,873</td>
<td>8.72%</td>
</tr>
<tr>
<td>31-33</td>
<td>Manufacturing</td>
<td>271,633</td>
<td>3.86%</td>
</tr>
<tr>
<td>42</td>
<td>Wholesale Trade</td>
<td>397,026</td>
<td>5.64%</td>
</tr>
<tr>
<td>44-45</td>
<td>Retail Trade</td>
<td>990,533</td>
<td>14.07%</td>
</tr>
<tr>
<td>48-49</td>
<td>Transport and Warehousing</td>
<td>195,853</td>
<td>2.78%</td>
</tr>
<tr>
<td>72</td>
<td>Accommodation / Food Services</td>
<td>633,191</td>
<td>9.00%</td>
</tr>
<tr>
<td></td>
<td>Sub-Total</td>
<td>3,154,295</td>
<td>44.81%</td>
</tr>
</tbody>
</table>
Employment Patterns in Selected MSAs
### Establishments in Freight Intensive Sectors (FIS)

<table>
<thead>
<tr>
<th>NAICS</th>
<th>Description</th>
<th>New York, NY</th>
<th>Chicago, IL</th>
<th>Houston, TX</th>
<th>Washington, DC</th>
<th>Seattle, WA</th>
<th>San Diego, CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Mining, Quarrying, Oil / Gas…</td>
<td>0.0%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>23</td>
<td>Construction</td>
<td>17.4%</td>
<td>17.5%</td>
<td>13.3%</td>
<td>22.4%</td>
<td>22.2%</td>
<td>17.4%</td>
</tr>
<tr>
<td>31-33</td>
<td>Manufacturing</td>
<td>9.6%</td>
<td>15.5%</td>
<td>15.2%</td>
<td>6.7%</td>
<td>12.9%</td>
<td>14.1%</td>
</tr>
<tr>
<td>42</td>
<td>Wholesale Trade</td>
<td>13.4%</td>
<td>12.0%</td>
<td>14.3%</td>
<td>7.2%</td>
<td>11.1%</td>
<td>11.5%</td>
</tr>
<tr>
<td>44-45</td>
<td>Retail Trade</td>
<td>35.0%</td>
<td>27.7%</td>
<td>31.1%</td>
<td>35.8%</td>
<td>29.0%</td>
<td>32.3%</td>
</tr>
<tr>
<td>48-49</td>
<td>Transportation and Warehousing</td>
<td>6.3%</td>
<td>11.1%</td>
<td>6.9%</td>
<td>5.3%</td>
<td>6.0%</td>
<td>5.1%</td>
</tr>
<tr>
<td>72</td>
<td>Accommodation and Food</td>
<td>18.4%</td>
<td>16.3%</td>
<td>17.0%</td>
<td>22.5%</td>
<td>18.8%</td>
<td>19.4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% of Establishments (FIS)</th>
<th>Number of establishments (FIS)</th>
<th>Number of establishments (Total)</th>
<th>% FIS Establishments of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>269,208</td>
<td>582,761</td>
<td>46%</td>
</tr>
<tr>
<td></td>
<td>114,423</td>
<td>241,246</td>
<td>47%</td>
</tr>
<tr>
<td></td>
<td>62,017</td>
<td>129,122</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>59,180</td>
<td>160,686</td>
<td>37%</td>
</tr>
<tr>
<td></td>
<td>49,205</td>
<td>106,612</td>
<td>46%</td>
</tr>
<tr>
<td></td>
<td>37,419</td>
<td>85,777</td>
<td>44%</td>
</tr>
</tbody>
</table>
### Establishments in Service Intensive Sectors (SIS)

<table>
<thead>
<tr>
<th>NAICS</th>
<th>Description</th>
<th>New York, NY</th>
<th>Chicago, IL</th>
<th>Houston, TX</th>
<th>Washington, DC</th>
<th>Seattle, WA</th>
<th>San Diego, CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>Information</td>
<td>3.6%</td>
<td>3.1%</td>
<td>2.4%</td>
<td>3.6%</td>
<td>3.7%</td>
<td>3.0%</td>
</tr>
<tr>
<td>52</td>
<td>Finance and Insurance</td>
<td>8.7%</td>
<td>11.7%</td>
<td>12.2%</td>
<td>7.3%</td>
<td>9.2%</td>
<td>10.1%</td>
</tr>
<tr>
<td>53</td>
<td>Real Estate</td>
<td>10.8%</td>
<td>7.6%</td>
<td>9.5%</td>
<td>7.4%</td>
<td>10.7%</td>
<td>12.0%</td>
</tr>
<tr>
<td>54</td>
<td>Professional and Technical Services</td>
<td>22.2%</td>
<td>25.4%</td>
<td>25.3%</td>
<td>32.8%</td>
<td>23.6%</td>
<td>27.8%</td>
</tr>
<tr>
<td>55</td>
<td>Management of Companies</td>
<td>1.0%</td>
<td>1.5%</td>
<td>1.9%</td>
<td>1.3%</td>
<td>1.3%</td>
<td>0.9%</td>
</tr>
<tr>
<td>56</td>
<td>Educational Services</td>
<td>9.2%</td>
<td>10.1%</td>
<td>9.6%</td>
<td>9.0%</td>
<td>9.5%</td>
<td>8.6%</td>
</tr>
<tr>
<td>61</td>
<td>Education Services</td>
<td>2.9%</td>
<td>2.8%</td>
<td>2.3%</td>
<td>3.0%</td>
<td>3.2%</td>
<td>2.9%</td>
</tr>
<tr>
<td>62</td>
<td>Health Care and Social Assistance</td>
<td>19.2%</td>
<td>19.2%</td>
<td>20.6%</td>
<td>16.2%</td>
<td>19.8%</td>
<td>18.8%</td>
</tr>
<tr>
<td>71</td>
<td>Entertainment</td>
<td>3.7%</td>
<td>2.6%</td>
<td>1.9%</td>
<td>2.2%</td>
<td>2.8%</td>
<td>2.5%</td>
</tr>
<tr>
<td>81</td>
<td>Other Services (except Public)</td>
<td>18.6%</td>
<td>16.2%</td>
<td>14.3%</td>
<td>17.1%</td>
<td>16.2%</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% of Establishments (SIS)</th>
<th>313,553</th>
<th>126,823</th>
<th>67,105</th>
<th>101,506</th>
<th>57,407</th>
<th>48,358</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of establishments (SIS)</td>
<td>313,553</td>
<td>126,823</td>
<td>67,105</td>
<td>101,506</td>
<td>57,407</td>
<td>48,358</td>
</tr>
<tr>
<td>Number of establishments (Total)</td>
<td>582,761</td>
<td>241,246</td>
<td>129,122</td>
<td>160,686</td>
<td>106,612</td>
<td>85,777</td>
</tr>
<tr>
<td>% FIS Establishments of Total</td>
<td>54%</td>
<td>53%</td>
<td>52%</td>
<td>63%</td>
<td>54%</td>
<td>56%</td>
</tr>
</tbody>
</table>
Freight and Service Activity for Selected MSAs
Generation of Freight, Freight Trips, and Service Trips

- Models estimated using:
  - Establishment-level surveys
  - CFS microdata
- Estimated freight, freight-trip, service-trip models
  - Establishment-level
  - Economic based
- Validated them
Freight and Service Activity Generation (FSAG) Software

https://coe-sufs.org/wordpress/software/

**Steps to Access Software:**

1. Request account by email
2. Administrator provides user account & password
3. Access webpage & try out the software!

- Produces freight and service activity estimates at state, city, county, ZIP Code and establishment level for the entire United States.


- Estimates at a 2-digit level NAICS:
  - Daily freight deliveries and shipments,
  - Service trips attracted, and
  - Freight attracted and produced

- Estimates at a 2- and 3-digit NAICS:
  - Freight produced at a ZIP code level

- Types of account:
  - **FREE version** enables the user to run 100 models and access estimates for 2-digit level NAICS.
  - **FULL version** includes unlimited runs and all available models for 2- and 3-digit level NAICS, and access to a growing number of international models.

- Visit [https://coe-sufs.org/wordpress/software](https://coe-sufs.org/wordpress/software) to learn more.
Key concepts

- **Generation of demand/cargo (FG):**
  - A manifestation of the production/consumption processes
  - Implication: FG will increase with (economic) inputs

- **Generation of traffic (FTG):**
  - Result of logistical decisions
  - Implication: FTG do not necessarily increase with (economic) inputs (shippers can increase shipment size instead...)

- **Service Trip Generation (STG):**
  - A manifestation of the amount of services received or produced by an establishment
### Freight and Service Activity

**Description**

<table>
<thead>
<tr>
<th>City</th>
<th>Freight Shipments</th>
<th>Freight Deliveries</th>
<th>FTG (all sectors)</th>
<th>STA (all sectors)</th>
<th>FTG per establishment</th>
<th>STA per establishment</th>
<th>FTG per resident</th>
<th>STA per resident</th>
<th>Internet deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York, NY</td>
<td>1,242,327</td>
<td>1,089,374</td>
<td>2,331,700</td>
<td>274,636</td>
<td>3.5-4.3</td>
<td>0.471</td>
<td>0.116</td>
<td>0.014</td>
<td>&gt; 0.10 deliveries/person-day</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>605,990</td>
<td>573,218</td>
<td>1,179,208</td>
<td>83,363</td>
<td>0.35 – 0.47</td>
<td>0.346</td>
<td>0.124</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>Houston, TX</td>
<td>323,149</td>
<td>320,656</td>
<td>643,805</td>
<td>46,322</td>
<td>0.12 – 0.27</td>
<td>0.359</td>
<td>0.097</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>Washington, DC</td>
<td>295,071</td>
<td>274,547</td>
<td>569,618</td>
<td>55,799</td>
<td>0.09 – 0.12</td>
<td>0.347</td>
<td>0.094</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>233,442</td>
<td>218,919</td>
<td>452,361</td>
<td>36,864</td>
<td>0.09 – 0.12</td>
<td>0.346</td>
<td>0.121</td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>183,254</td>
<td>179,718</td>
<td>362,972</td>
<td>29,472</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The generation per capita are:

- **Per establishment**: 3.5-4.3 freight trips/day, 0.35 – 0.47 service trips/day
- **Per employee**: 0.12 – 0.27 freight trips/day, 0.01 – 0.03 service trips/day
- **Per resident**: 0.09 – 0.12 freight trips/day, 0.01 – 0.02 service trips/day
- **Internet deliveries**: > 0.10 deliveries/person-day
32% to 47% of FTG from establishments with less than 5 employees
Breakdown of STA by Establishment Size

51% to 55% of STA from establishments with less than 5 employees
## Breakdown of FSA for Freight Intensive Sectors

### Freight Trip Generation

<table>
<thead>
<tr>
<th>Description</th>
<th>New York, NY</th>
<th>Chicago, IL</th>
<th>Houston, TX</th>
<th>Washington, DC</th>
<th>Seattle, WA</th>
<th>San Diego, CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight Intensive Sectors (FIS)</td>
<td>2,174,924</td>
<td>1,115,796</td>
<td>610,253</td>
<td>518,865</td>
<td>423,657</td>
<td>338,793</td>
</tr>
<tr>
<td>Service Intensive Sectors (SIS)</td>
<td>156,777</td>
<td>63,412</td>
<td>33,553</td>
<td>50,753</td>
<td>28,704</td>
<td>24,179</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,331,700</strong></td>
<td><strong>1,179,208</strong></td>
<td><strong>643,805</strong></td>
<td><strong>569,618</strong></td>
<td><strong>452,361</strong></td>
<td><strong>362,972</strong></td>
</tr>
<tr>
<td>% Freight Intensive Sectors</td>
<td>93.28%</td>
<td>94.62%</td>
<td>94.79%</td>
<td>91.09%</td>
<td>93.65%</td>
<td>93.34%</td>
</tr>
<tr>
<td>% Service Intensive Sectors</td>
<td>6.72%</td>
<td>5.38%</td>
<td>5.21%</td>
<td>8.91%</td>
<td>6.35%</td>
<td>6.66%</td>
</tr>
</tbody>
</table>

### Service Trip Attraction

<table>
<thead>
<tr>
<th>Description</th>
<th>New York, NY</th>
<th>Chicago, IL</th>
<th>Houston, TX</th>
<th>Washington, DC</th>
<th>Seattle, WA</th>
<th>San Diego, CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight Intensive Sectors (FIS)</td>
<td>115,948</td>
<td>25,032</td>
<td>15,802</td>
<td>14,092</td>
<td>10,581</td>
<td>9,083</td>
</tr>
<tr>
<td>Service Intensive Sectors (SIS)</td>
<td>158,688</td>
<td>58,331</td>
<td>30,520</td>
<td>41,707</td>
<td>26,282</td>
<td>20,390</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>274,636</strong></td>
<td><strong>83,363</strong></td>
<td><strong>46,322</strong></td>
<td><strong>55,799</strong></td>
<td><strong>36,864</strong></td>
<td><strong>29,472</strong></td>
</tr>
<tr>
<td>% Freight Intensive Sectors</td>
<td>42.22%</td>
<td>30.03%</td>
<td>34.11%</td>
<td>25.26%</td>
<td>28.70%</td>
<td>30.82%</td>
</tr>
<tr>
<td>% Service Intensive Sectors</td>
<td>57.78%</td>
<td>69.97%</td>
<td>65.89%</td>
<td>74.75%</td>
<td>71.30%</td>
<td>69.18%</td>
</tr>
</tbody>
</table>
NCHRP 08-111 Overall Philosophy
Fundamental Tenets

- Freight activity takes place at all levels (global, national/regional, metropolitan/urban, neighborhood, block, household/establishment)
- Emergent market and technological trends could disrupt economies, supply chains and spatial distribution of economic activities
- Complex multi-stakeholder decision-making environments surround land-use policy decisions
- Great diversity of land-use conditions
The goal is to define procedures that lead to freight land use patterns that account for both impacts on freight, and the surrounding communities.

Accounting for:

- Impacts on supply chains
  - Network effects must be considered
- Impacts on communities (externalities)
  - External effects during the journey
  - External effects at nodes

Land Use should account for Social Benefits / Costs
- Benefits and Costs to freight and communities
- Simplified to only consider

Social Costs = Private Freight Costs + Externalities
Understanding Freight/City Dynamics

- Develop schematic networks for supply chains
- Assuming a generic metropolitan area:

Metropolitan System

City Center
The Concept of Social Costs

- Assume we need to locate a DC for e-deliveries along a corridor.

Regional DC → Local DC → Urban Core

Challenge: Multiple land use jurisdictions

Cost vs. Location

The social optimal location?

Social optimal location

Private optimal location
Why does it matter? The Case of the Port of NY

https://www.panynj.gov/port/history.html

Early 1900s

Early 1920s
Port Newark and beyond...
What’s the issue?

The chief insight: The impacts across entire supply chains must be considered.

Transporting the cargo across the Hudson River has cost NYC about 1 trillion dollars in congestion.
Components of the work

- Characterization of supply chains
- Identification of “ideal” location patterns
- Identification of externalities
- Identification of ways to redress externalities
- Tools to quantify the impacts of LU decisions
  - Freight and Service Activity Generator
  - Behavioral Micro-Simulation
- Procedures to induce Freight Efficient Land Uses
Characterization of Supply Chains: Typologies
Generic Configuration

- **Global**
  - International Supplier
  - International Gateways
  - International DC
  - International Supplier
  - Rail Station/Port/Airport

- **National/Regional**
  - Regional Supplier
  - Regional DC
  - National/Regional DC
  - Rail Station/Port/Airport

- **Metropolitan**
  - Urban Area
  - Metropolitan Area
  - Local DC
  - Supplier

- **Local**
Internet Deliveries to Households

Metropolitan System

Supplier

Regional DC

International DC

International Supplier

Airport

Supplier

Retail

Consumers

City Center

Pickup point

Consumer

Pickup point

Retail

Retail
Food Services

International gateways

Metropolitan Area

Regional DC

Broadline Warehouse

Satellite yard

Restaurants

Institutions

City Center

Domestic producers

Vendor plants & DC

Specialized warehouse
Ideal Locations vs. Externalities
Criteria to Locate Nodes

- Distance to the City Center
  - Surrounding attractiveness
  - Competition
  - Investment cost
  - Safety and security

Metropolitan System

- Power Plant
- Regional Distribution Center
- Warehouses
- City Center
- Restaurants
Criteria to Analyze Links between Nodes

- Frequency of Deliveries
  - Low
  - Medium
  - High

- Accessibility (distance and traffic impact)
  - Not Important
  - Important
  - Very Important

- Externalities Produced (congestion, emission, noise)
  - Low
  - Medium
  - High
Identification of ways to redress externalities
Improving Freight System Performance in Metropolitan Areas: Planning Guide

Freight flows are physical manifestations of the manufacturing and consumer economies that are foundations of modern life. Transportation policy seeks to ensure that freight is moved as efficiently as possible, as hampering the flow of cargo is bound to have a negative effect on the...
### Initiative 26: Restricted Multi-Use Lanes

**Description:** These initiatives promote the use of available road capacity by allocating restricted lane right-of-way to trucks, buses, and occasionally high-occupancy vehicles. The lane usage can be allocated to different users using time windows, shared among designated users all day, or restricted to special use for certain users. Restrictions can be by vehicle type, or they can allow mixed traffic during the restriction interval.

**Targeted mode:** All traffic/large trucks  
**Geographic scope:** Area  
**Type of initiative:** Traffic management: lane management  
**Primary objective:** Optimize road capacity

**Expected costs and level of effort to implement:** Lane management strategies and restrictions to multi-use lanes require thorough planning to consider the characteristics of the network and the needs of different users. Planning should involve extensive stakeholder engagement, and weigh both the positive and negative impacts to all agents that are part of the system. The costs are mainly associated with the installation of variable message signs or changeable message signs, and enforcement resources.

**Advantages:**  
- Reduce congestion  
- Enhance safety  
- Increase efficiency  
- Enhance livability  
- Can be used as incentive to foster other strategies  

**Disadvantages:**  
- May confuse drivers  
- May conflict with other traffic users  
- May not be adequate for sensitive locations  
- Hard to enforce  
- Lane geometry may not be adequate for large trucks

**Examples:**  
- Multifunctional lanes in its commercial center: Barcelona, Spain (City Ports 2005)  
- Clean vehicles are allowed to use public transport lanes: Göteborg, Sweden (START 2009)  
- Consolidation vehicles are allowed to use bus lanes: Bristol, England (START 2009)  
- Truck lane restricted to right lane: New York City, New York, United States (The City of New York 2012), North Carolina, United States (Federal Highway Administration 2011; North Carolina Department of Transportation 2013)  
- Ban on through-trucks on Interstate inside the perimeter freeway: Georgia, United States (Georgia Dept. of Public Safety 2010)

**Sources:**  
- Federal Highway Administration 2011


**References:** Ogden 1992, City Ports 2005; BESTUFS 2007; START 2009; Georgia Department of Public Safety 2010; Federal Highway Administration 2011; SUGAR 2011; The City of New York 2012; North Carolina Department of Transportation 2013
Tools to quantify impacts of land use decisions
Freight and Service Activity Generation (FSAG) Software

https://coe-sufs.org/wordpress/software/

**CONTACT:**
Jeffrey Wojtowicz
Rensselaer Polytechnic Institute
wojtoj@rpi.edu

**STEPS TO ACCESS SOFTWARE:**
1. Request account by email
2. Administrator provides user account & password
3. Access webpage & try out the software!

- Produces freight and service activity estimates at state, city, county, ZIP Code and establishment level for the entire United States
- Estimates at a 2-digit level NAICS:
  - Daily freight deliveries and shipments,
  - Service trips attracted, and
  - Freight attracted and produced
- Estimates at a 2- and 3-digit NAICS:
  - Freight produced at a ZIP code level
- Types of account:
  - **FREE version** enables the user to run 100 models and access estimates for 2-digit level NAICS.
  - **FULL version** includes unlimited runs and all available models for 2- and 3-digit level NAICS, and access to a growing number of international models.

Visit https://coe-sufs.org/wordpress/software to learn more.
Behavioral Micro-Simulation

- Originally developed for the study of policies to foster Off-Hour Deliveries in NYC
- It uses the estimates from the FSAG as an input
  - Freight and Service Trip Generation
  - Data about delivery stops/tour by industry sector
- Estimates freight activity patterns
Different industry sectors have different tour lengths

NYC and NJ (Holguin-Veras et al. 2012):
- Average: 8.0 stops/tour; 12.6% do 1 stop/tour; 54.9% do < 6 stops/tour; 8.7% do > 20 stops

Synthetic population match observed traffic and FTG
Tour simulations

- Select a truck in an industry sector
  - Number of stops is randomly assigned
  - Select receivers at random from the group of receivers in that sector
  - Compute optimal tour and store it
- Repeat until delivery tours satisfy the FTG for the entire area

Diagram:
- 1) Origin of a delivery truck that carries food products to five restaurants
- 2) Five random receivers
Next Steps
Next Steps

- Develop practice-ready tools to:
  - Estimate freight and service activity as a function of land use and economic data (DONE)
  - Estimate the performance of supply chains as a function of land use patterns (IN PROGRESS)
- Develop policy procedures to foster freight efficient land uses
- Conduct case studies (let us know if you want to get involved...)
- Stay tuned...
Thanks!