Supply-Chain Mapping to Understand Washington State Freight System Resilience

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Freight Transportation System Disruptions

- Disrupt the normal flow of goods on the transportation infrastructure
  - Vary in length and impact
  - Are caused by a variety of phenomenon

- Estimate consequences disruption
  - Transportation network model
  - Supply chain specific operations
  - Much previous work

- Understand infrastructure utilization by industry
  - Identify benefit of infrastructure changes
  - Identify links and nodes most important to specific industries

Photo courtesy of WSDOT
Priority is to understand economic value of shipments

- Corridor level understanding of consequences to specific industries
- Need commodity data
  - Value of time
  - Product loss
  - Weight/volume constraints
- Need operations data
  - Facilities visited between production and consumption
  - Product type
  - Schedule characteristics

Photo courtesy of WSDOT
Trips take longer through increase travel time
Cost incurred directly and indirectly

- Insufficient remaining capacity/redundancy
- Late deliveries
- Missed connections
- Spoiled product
- Increased travel cost
- Additional driver costs
- Reduced equipment utilization
- Missed business opportunities

Photo courtesy of WSDOT
Developed two case studies

- Potato supply chain in WA
  - Understand pattern of infrastructure utilization
  - Estimate truck trips per day required to move potatoes within Washington
  - Production, distribution, processing
  - Consider a disruption to the transportation network, and identify the impact on truck trips

- Diesel distribution in WA
  - Understand pattern of infrastructure utilization
  - Refinery production, distribution
  - Pipeline, barge, and truck transport
  - Consider a disruption to the transportation network, and identify the impact on truck trips

- Identify the level of effort and the data collection challenges of this approach to understanding the impacts from disruptions
## Potato Data Elements

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Source</th>
<th>Time Period</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato prices at field, retailer purchase price, and retail price</td>
<td>AC Neilson</td>
<td>Monthly</td>
<td>Market forecasting (for profit)</td>
</tr>
<tr>
<td>Potato production</td>
<td>United States Department of Agriculture</td>
<td>Monthly</td>
<td>Market forecasting, industry service</td>
</tr>
<tr>
<td>Relative product production by production area</td>
<td>Washington State Potato Commission</td>
<td></td>
<td>Expert estimate time independent</td>
</tr>
<tr>
<td>Destinations for all potato products</td>
<td>Washington State Potato Commission</td>
<td>Survey in 2006</td>
<td></td>
</tr>
<tr>
<td>Quantity of potato loss</td>
<td>Washington State Potato Commission</td>
<td></td>
<td>Expert estimate time independent</td>
</tr>
<tr>
<td>Ratios of fresh potatoes to potato products volume</td>
<td>Washington State Potato Commission</td>
<td></td>
<td>Expert estimate time independent</td>
</tr>
<tr>
<td>Percentage of potatoes processed into each product in each growing region</td>
<td>State of Washington Potato Committee (SWPC): Disposition</td>
<td>Annual</td>
<td>Industry tracking (interest group)</td>
</tr>
<tr>
<td>Volume of potatoes held in a truckload for each product</td>
<td>Washington State Potato Commission</td>
<td></td>
<td>Expert estimate time independent</td>
</tr>
<tr>
<td>Location and type of potato processors</td>
<td>Washington State Potato Commission</td>
<td>Current</td>
<td>Expert estimate time independent</td>
</tr>
<tr>
<td>Mode choice</td>
<td>Discussions with ConAgra Foods/Lamb Weston</td>
<td></td>
<td>Expert estimate time independent</td>
</tr>
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</table>
# Diesel Data Elements

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<tr>
<td>Underground Storage Tanks (USTs)</td>
<td>Washington State Department of Ecology</td>
<td>2005</td>
<td>Environmental Regulations</td>
</tr>
<tr>
<td>Aboveground Storage Tanks (ASTs)</td>
<td>Environmental Protection Agency (EPA)</td>
<td>2008</td>
<td>Environmental Regulations</td>
</tr>
<tr>
<td>Terminal Locations</td>
<td>Washington State Department of Revenue</td>
<td>Current</td>
<td>Fuel Tax Revenue</td>
</tr>
<tr>
<td>Cardlock Locations</td>
<td>CFN and Pacific Price</td>
<td>Current</td>
<td>Company websites</td>
</tr>
<tr>
<td>Refining Capacity</td>
<td>Energy Information Administration (EIA)</td>
<td>2008</td>
<td>Energy Production</td>
</tr>
<tr>
<td>Waterway Flow</td>
<td>Washington State Department of Ecology</td>
<td>2008</td>
<td>Environmental Regulations</td>
</tr>
<tr>
<td>Tanker Truck Flow</td>
<td>Washington Oil Marketers Association &amp; various marketers</td>
<td>Current</td>
<td>Industry Knowledge</td>
</tr>
</tbody>
</table>
Data concerns

- Integrating data of varied quality
  - Time period
  - Unit of analysis
  - Level of accuracy
  - Bias

- Each case study uses different sources
  - Industry groups
  - Environmental regulation
  - Financial regulation
  - Industry sophistication
Washington Potato Production, 2006
Hundredweight by Township and Range
Washington Potato Processors

Map showing the locations of potato processors in Washington, including Tim's, WA Potato, ConAgra, McCain, Simplot, and others. The map indicates the distribution of frozen, dehydrated, and some dehydrated products, as well as chips.
Shipment Destinations for Lower Basin Potato Production

- Canada 9%
- Western Washington 14%
- Eastern Washington 12%
- Oregon (2%) and California (15%)
- States West of Mississippi 22%
- States East of Mississippi 24%

Road Classification

- State Highways
- Local Roads
- Interstate

Potato Production (cwt.)
- 3,300 - 25,251
- 28,202 - 64,449
- 64,450 - 112,558
- 112,559 - 203,331
- 203,332 - 816,049

Lower Basin
Shipment Destinations for Skagit Valley Potato Production

- Canada 7%
- Skagit Valley
- Western Washington 7%
- States East of Mississippi 24%
- Oregon (4%) and California (41%)
- States West of the Mississippi (13%) and Mexico (2%)
- Eastern Washington 2%
Shipment Destinations for Upper Basin Potato Production

- Eastern Washington 6%
- Idaho 36%
- States East of Mississippi 13%
- States West of Mississippi 8%
- Upper Basin
- California (12%) and Oregon (1%)
- Western Washington 7%
- Other International 13%
- Canada 3%
Washington Potato Movements
Number of Trucks per Day that Traverse WA’s Mountain Passes

Disruption Normal
0.13 - 1.00
1.01 - 5.00
5.01 - 15.00
15.01 - 25.00
25.01 - 32.37
32.38 - 50.36

X = Avalanche Closure of Hwy 2 (Stevens Pass), I-90 (Snoqualmie Pass), and Hwy 12 (White’s Pass)
Columbia River Locks

*MSL = Elevation in meters and feet above mean sea level
Infrastructure Utilization

- Potato distribution
  - Exporting from the state
  - Truck within Washington
  - Significant cross-Cascades travel

- Diesel distribution
  - Moving into the state
  - Uses barge and pipeline as much as possible
  - Very little cross-Cascades travel
Sensitivity to disruption

- **Potatoes**
  - Little profit on potato shipments
    - Not likely to take significant detours which incur cost
  - Not time sensitive
  - Likely to wait rather than reroute

- **Diesel**
  - Very large volumes moved
  - Hazardous material
  - Significant flexibility built into current operations to take advantage of price savings
  - Difficult to “disrupt”

Photo courtesy of Shell
Lessons learned

- This method of building supply chains is time consuming
  - small number of very good data sources
  - highly regulated product

- Consider cost/benefit of the data collection effort
  - What questions do we need to answer?
  - What level of data quality/detail do they require?

- Data can be difficult to synthesize and some liberties will need to be taken with data integration

- Infrastructure and fixed facilities are much easier to identify than flow
  - they are more difficult to change
  - For trips, intermediate handling facilities have significant impact
Recommendations

- Significant benefit from identifying intermediate facilities and typical operations
- Supply chains do use the infrastructure very differently
- Industry detail is required to model responses/costs of delay
  - Potato product/value
  - Diesel acquisition

- Worth doing for important industries or key areas of interest, but in many cases more aggregate approach is justified.
  - Exploit similarities in supply chains

- Identify a small number of industries or corridors of particular interest and invest in good data collection for these specific areas