Using Big Data to Develop Improved Intermodal Freight Mobility

Ohio Transportation Engineering Conference

Session 47: Advancing Freight Mobility and Freight Facilities

Beth Kulick
Sr. Professional TranSystems

October 3, 2018
Introduction

- This project part of TranSystems Operations Planning and Analysis practice for transportation industry
  - Utilizing analytical methods and models to evaluate transportation projects, facility improvement and goods movement strategies
  - Integrating technologies into the process including dynamic simulation, “big data”, GIS, and others
- Approach allows for analysis of transportation at a systems level and ability to explore tradeoffs between infrastructure, operating rules, and policy
Deployment of GPS Data to Improve Intermodal Planning and Regional Performance
Challenges of a Port Environment

- A planning, leasing, and management authority with environmental and economic responsibility to a regional area
- Support and encourage coordination between many stakeholders and operators with independent objectives:
  - Steamship lines
  - Rail carriers – long and short haul
  - Drayage/trucking companies
  - Marine Terminal operators
Scope of Intermodal Activity

Geographical Scope of Travel from Marine Terminal

Business Scope of Container Drayage
PMV is comprised of different port areas spread throughout the region:
- North Shore
- South Shore
- Fraser River
- Delta Port

Each area has its own mix of intermodal and bulk terminals
Project = Smart Fleet program, a Port initiative

Started in 2013, with three goals:

1. Improve efficiency & reliability of intermodal terminal operations
2. Reduce greenhouse emissions from trucks
3. Strengthen Port’s competitive advantage
Big Data to Support Intermodal Planning

- Traditional data collection methods include surveys of drayage trucker:
  - Expensive
  - Time consuming
  - Difficult to get participation
  - One time survey
    - Reflects the historical days of the survey
    - Does not reflect current trends
Use of Current Data to Improve Intermodal Planning

- **Master Planning:**
  - Capabilities of port facilities to reach capacity projections
  - Framework to evaluate capacity or environmental improvement scenarios
  - Identification of specific improvements or projects needed

- **Operations:**
  - Report terminal performance and environment for trucking community
    - Gate queues
    - Truck turnaround time

- **Environmental:**
  - Provide metrics to quantify Air Quality impacts
  - Demonstrate impacts of reduced congestion
GPS Data Collected

- GPS installation - points are recorded in response to certain events
  - Ignition On
  - Ignition Off
  - Start Moving
  - Stop Moving
  - Turn
  - Enter/Leave Geofence
  - Time (5-minute intervals)

Over a million records can be recorded each day
Planning goal is to use 30 days
Significant GPS attributes collected:

- Longitude
- Latitude
- Truck ID
- Speed
- Direction
- Street Name
- Address Number
- Received On (Date/Time)
- Trigger Event
- Geofences are areas of significant container activity
  - Marine terminals
  - Regional Intermodal Rail Facilities
  - Major warehouse business areas
How?

- Process raw GPS Data to correlate points into a truck trip “diary”
- Used GIS mapped with specific locations (geofences) to filter data:
  - Origins and destinations
  - Inbound terminal waiting areas
  - Port roadways
  - Terminals
  - Key business locations
- Use of different Vancouver GIS layers
  - TAZ
  - Port reporting zones
  - CTI reporting zones
Goal: Provide a Planning and Analysis tool to PMV to evaluate Operating, Environmental, and Financial Impacts

- Use GPS data to support planning and analysis model
  - Process GPS data points for model use
  - GIS filtering and display of data
- Develop Operating, Financial, Environmental models
- Provide user interface to connect GPS data processing, GIS mapping, scenario creation, and launching of models
Solution that Integrates GPS and Other Data

1. GPS Data and GPS Data Processor
2. Operational Model Inputs
3. Environmental Model Inputs
4. Financial Model Inputs
Key Components of the Drayage Model

- Capability to rapidly process GPS data, a renewable data source, to build a user-friendly analysis tool
  - Data to leverage modeling: Origin/Destination Matrix, Routes, Trip Times, etc.
  - Provides performance metrics
  - Allows visualization through ESRI ArcMAP

- Built a regional drayage model:
  - Combined GPS data and data processing
  - Unique because the data is renewable on a monthly or more frequent basis allowing for continual and up-to-date scenario planning and monitoring
Drayage Model User Interface

Strategic Planning with GPS and GIS
Decision Making Power

- Reports truck movement and evaluates potential changes in regional transportation policies/regulations
- Forecasts and analyzes potential impacts to stakeholders
- Evaluates emissions, estimated costs, turn times, volumes, hours of operations, and effects on competitiveness

Benefits include more informed decision-making and ability to predict financial and environmental outcomes.
GPS Data Processing

- Processing of 200,000 monthly trips
  - 20 million segments
  - 15GB file geodatabase
Analysis of Trip Details

Key Trip States:

- Traveling
- In Queue at Terminal
- Processing Time at Terminal
- At Off-Dock Facility
GPS and GIS Together Provide Valuable Information

- Trip diary and GIS together provide a powerful tool to be able to get information on a geospatial basis:
- Where trucks travel
- Time at different states:
  - Traveling at different speed levels
  - Waiting at Terminal
  - Processing at Terminal
  - Off duty
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### Emissions Outputs

#### Duty Cycle

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#### Emissions Outputs

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GPS Data to Monitor Terminal Performance

Today's Average Turn Time 32m, total 152 trucks.
Time of Day Truck Arrivals

Time of Day Patterns of Trucks

- **Time**
  - 12:00 AM, 1:00 AM, 2:00 AM, 3:00 AM, 4:00 AM, 5:00 AM, 6:00 AM, 7:00 AM, 8:00 AM, 9:00 AM, 10:00 AM, 11:00 AM, 12:00 PM, 1:00 PM, 2:00 PM, 3:00 PM, 4:00 PM, 5:00 PM, 6:00 PM, 7:00 PM, 8:00 PM, 9:00 PM, 10:00 PM, 11:00 PM, 12:00 AM

- **Numbers of Trucks Entering Terminal**
  - 0, 50, 100, 150, 200, 250

- **Truck Patterns**
  - Centerm
  - Vanterm
  - Deltaport
  - Fraser Surrey
GPS Data to Support Regional Truck Activity

Strategic Planning with GPS and GIS
Weekly On-Line Dashboard to Inform Community

**Deltaport weekly truck turn time report**

**Reporting period:** June 11-17, 2017

**Weekly statistics**

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**Turn time by Hour**

Average turn time, by hour, recorded by GPS locators in staging and on terminal footprint.

**Graphs:**
- Trips by time interval
- Weekly statistics
- Turn time by hour at staging and terminal
Model Used to Identify Areas of Environmental Impact

- Annual report of emissions produced throughout region
  - Ability to show routes and regional areas most impacted
  - Visualization of areas
- Trip information used to identify how many drayage trucks are needed to move projected intermodal containers
  - Too many trucks increases congestion, impacts air quality, less favorable economic environment
  - Model used to determine how many trucks should be in drayage fleet and quantify limits
Summary

- Successfully processed all truck GPS data and implemented a solution that updates every 30 days
- Model has been used by various Port planning groups
- Recent feedback from the Port (2018):
  - Actively using for regional planning issues
  - Continually finding new uses including an air quality map-based report
Conclusions

- It has been traditionally difficult to obtain data to measure terminal performance at a system level.
- GPS data provides a data source that can be used to identify and measure intermodal system performance.
- Integrating GPS data with other data and models provides a powerful framework.
- Continually monitor regional environmental impacts with ability to prioritize and plan for area improvements.
- Measure impact of new policies.