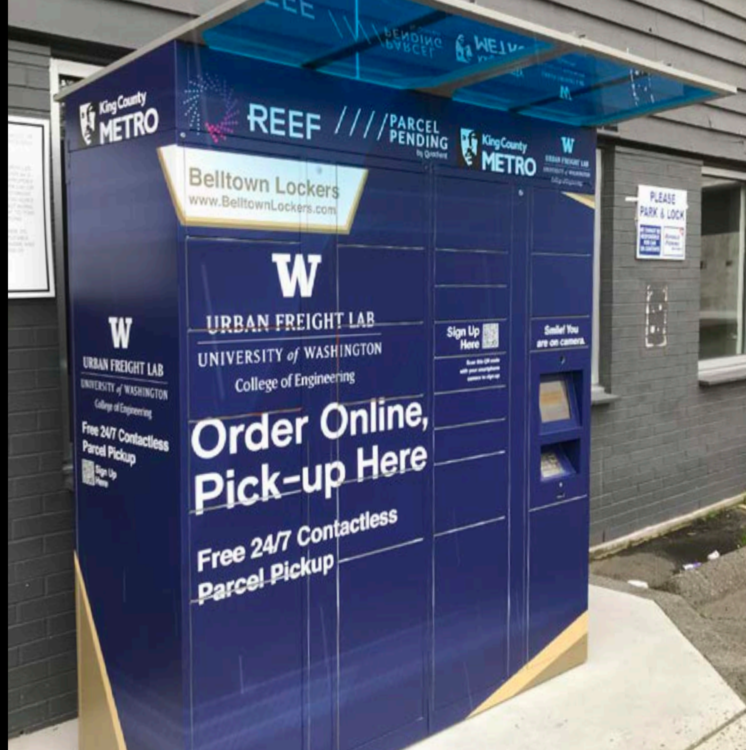

Technology Integration to Gain Commercial Efficiency for the Urban Goods Delivery System, Meet Future Demand for City Passenger and Delivery Load/Unload Spaces, and Reduce Energy Consumption

YEAR TWO PROGRESS REPORT

JANUARY 1, 2020 - DECEMBER 31, 2020

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Project Introduction

We are living at the convergence of the rise of e-commerce, ride-hailing services, connected and autonomous vehicle technologies, and fast-growing cities. Many online shoppers want the goods delivery system to bring them whatever they want, where they want it, in one to two hours. At the same time, many cities are replacing goods delivery load/unload spaces with transit and bike lanes. Cities need new load/unload space concepts that are supported by technology to make the leap to autonomous cars and trucks in the street, and autonomous freight vehicles in the final 50 feet of the goods delivery system. The final 50-foot segment starts when a truck parks in a load/unload space and includes delivery persons' activities as they maneuver goods along sidewalks and into urban towers to make their deliveries.

In this project, the Urban Freight Lab, part of the Supply Chain Transportation and Logistics Center at the University of Washington; the Pacific Northwest National Laboratory, and project partners will develop, pilot test, and (using a learn/do approach) improve upon technologies supporting new operational strategies to optimize use of urban load/unload space, as well as business efficiencies, in the final 50 feet of the goods delivery system.

Objectives

The objectives of this project are to develop and implement a technology solution to support research, development, and demonstration of data processing techniques, models, simulations, a smart phone application, and a visual-confirmation system to:

1. Reduce delivery vehicle parking seeking behavior by approximately 20% in the pilot test area, by returning current and predicted load/unload space occupancy information to users on a web-based and/or mobile platform, to inform real-time parking decisions
2. Reduce parcel truck dwell time in pilot test areas in Seattle and Bellevue, Washington, by approximately 30%, thereby increasing productivity of load/unload spaces near common carrier locker systems, and
3. Improve the transportation network (which includes roads, intersections, warehouses, fulfillment centers, etc.) and commercial firms' efficiency by increasing curb occupancy rates to roughly 80%, and alley space occupancy rates from 46% to 60% during peak hours, and increasing private loading bay occupancy rates in the afternoon peak times, in the pilot test area.

Approach

The project team has designed a 3-year plan, as follows, to achieve the objectives of this project.

In Year 1, the team developed integrated technologies and finalized the pilot test parameters. This involved finalizing the plan for placing sensory devices and common parcel locker systems on public and private property; issuing the request for proposals; selecting vendors; and gaining approvals necessary to execute the plan. The team also developed techniques to preprocess the data streams from the sensor devices, and began to design the prototype smart phone parking app to display real-time load/unload space availability, as well as the truck load/unload space behavior model.

In Year 2, the team executed the implementation plan;

- oversaw installation of the in-road sensors, and collecting and processing data,
- managed installation, marketing and operations of three common locker systems in the pilot test area,
- tested the prototype smart phone parking app with initial data stream, and
- developed a truck parking behavior simulation model.

In Year 3, the project team will evaluate the impact of these tools and technologies on urban freight operations in the test area. We will continue to measure results against project goals and make improvements; develop a visual-confirmation system to alert drivers if they overstay their authorized time in the space (inducing improved compliance); and run the behavior model to evaluate demand and other scenarios.

Results

Key accomplishments of the project over the past fiscal year (January 1, 2020 through September 30, 2020) are summarized below, in terms of each project objective.

1 **Objective 1) Reduce parking seeking behavior by approximately 20% in the pilot test areas**

ACHIEVEMENT #1 – ALL SENSORS IN PLACE

The Seattle Department of Transportation and the Bellevue Transportation Department released Requests for Proposals for the procurement and deployment of parking occupancy sensors in the two case study areas. Fybr and Cleverciti Systems were selected as designated vendors in Seattle and Bellevue, respectively. Parking occupancy sensors and respective gateways for data communications have been deployed and installed in the 10-block study area in Belltown, Seattle (see pictures in Figure I.1.1), and one-block area in downtown Bellevue.

Figure I.1.1 The left picture shows one of the gateways installed in Belltown, Seattle, which collects sensors' data and sends it to the cloud; the center picture shows a passenger load zone with sensors installed; right picture shows a close-up photo of one sensor.

ACHIEVEMENT #2 – PARKING APPLICATION DISPLAYING REAL-TIME DATA

The Pacific Northwest National Laboratory developed and published an online application to display real time and predicted parking occupancy information for the test areas in Seattle and Bellevue. The first version of the application is currently available online at https://uwtechint.pnnl.gov/ and a beta version is currently being tested. Sensors in Bellevue and Seattle are streaming occupancy data.

ACHIEVEMENT #3 – PARKING SIMULATION MODEL CODED

A parking simulation model was developed to generate synthetic parking occupancy data. The data has been used to test an initial version of the online parking application and to derive a first parking occupancy prediction model.

KEY FINDING #1 – COMMERCIAL VEHICLES SPEND 28% OF THEIR TIME SEEKING PARKING

The research team developed a methodology to estimate and analyze parking seeking behavior for commercial vehicles using GPS data from commercial vehicle fleets. The team further collected GPS data from 3 commercial companies and implemented the developed method to estimate the time commercial vehicles spent looking for available parking in the study area. The results represent the first empirical estimate of parking seeking behavior in the scientific literature. The main results from this analysis were published in Dalla Chiara, Giacomo and Goodchild, Anne. "Do commercial vehicles cruise for parking? Empirical evidence from Seattle," *Transport Policy* 97, (2020): 26-36.

KEY FINDING #2 – DRIVERS PREFER EARLY-BLOCK COMMERCIAL VEHICLE LOAD ZONES (CVLZS)

During Year 1, the research team performed ridealongs with commercial vehicle drivers to learn about the delivery process and their parking behaviors. During each ridealong, observers collected quantitative data and performed interviews with drivers. In Year 2, the team analyzed the obtained data. These observations resulted in recommendations for how to modify commercial vehicle load zones to improve their utilization.

KEY FINDING #3 – COMMERCIAL DRIVERS REORDER DELIVERIES AND CONSOLIDATE DELIVERIES, WHEN PARKING SCARCE

During Year 1 ridealongs, the team also identified four different behaviors drivers adopt in response to the lack of available parking: cruising for parking, re-routing, unauthorized parking and walking.

2 Objective 2) Reduce parcel truck dwell time in pilot test area locations by approximately 30%, via increasing productivity of load/unload spaces near common locker systems

ACHIEVEMENT #4 – ALL LOCKERS INSTALLED AND FUNCTIONING

Three common-carrier parcel lockers have been successfully installed in the study area in Belltown, Seattle, in the following locations (see pictures in Figure I.1.2):

1. Royal Crest building: 2100 3rd Ave, Seattle, WA, 98121
2. Market Place Tower building: 2033 1st Ave, Seattle, WA, 98121
3. REEF public parking lot: 314 Bell St., Seattle, WA, 98121

Locker 1 is located indoors and accessible only by tenants of the residential building. Locker 2 is located in a publicly available parking area under a building with a mix of commercial and residential floors. Locker 3 is located in an off-street surface parking lot and can be accessed by anyone upon registration. All three lockers are currently operating. Two of the lockers are actively receiving deliveries from six major carriers (UPS, FedEx, USPS, Amazon, OnTrac and DHL).

Figure I.1.2 The top-left picture shows the locker installed inside Market Place building; the bottom-left picture shows the locker installed inside Royal Crest building; the right picture shows the locker installed at REEF public parking lot.

ACHIEVEMENT #5 – 43 CUSTOMERS ENROLLED AFTER MARKETING CAMPAIGN

An integrated marketing campaign was launched in August 2020 to align with the installation of Locker 3 located in the REEF parking lot. The campaign included: a joint press release with the University of Washington and Parcel Pending, a targeted social media campaign, multiple rounds of direct mailers sent to more than 5,000 Belltown residents and businesses, posting of flyers in public areas in nearby buildings, sidewalk sandwich board signage at the parking lot, and coverage in local media.

ACHIEVEMENT #6 – LOCKER USE DATA STREAMING

The research team is monitoring, through field data collection and data received by the locker company, locker usage, both from the perspective of consumers and the delivery drivers' behaviors. A statistical framework has been designed to evaluate the impact of the introduction of common-carrier parcel lockers on several performance metrics, including commercial vehicles' dwell time, total time spent delivering in a building and parking occupancy, among others. During Year 2, baseline data is being collected for both buildings where the team installed a parcel locker as well as buildings without parcel lockers as control buildings. Preliminary findings showed that the average dwell times before the introduction of common parcel lockers were 25.7 min (Locker 1), 35.4 minutes (Locker 2), and 27.9 minutes (Locker 3).

3 **Objective 3) Increase network and commercial firms' efficiency by increasing curb occupancy rates to roughly 80%, and alley space occupancy rates from 46% to 60% during peak hours, as well as underutilized private loading bay occupancy in the afternoon peak times, in the pilot test area.**

ACHIEVEMENT #7 - BASELINE ESTABLISHED

The "Before" data on commercial vehicle activities was collected in the surrounding curb spaces near the parcel locker locations. The data was used to create a baseline for commercial vehicle parking behavior before installation of common-carrier parcel lockers and deployment of a parking information system for the study area.

KEY FINDING #1 – CVLZ OCCUPANCY RATES HAVE BEEN REDUCED BY COVID-19

The average commercial vehicle occupancy was the highest for commercial vehicle load zones in the residential building (Royal Crest) at just over 40%.

KEY FINDING #2 – DRIVERS USE CVLZ AND PEDESTRIAN LOAD ZONES FLUIDLY FOR GOODS DELIVERIES

At the commercial building (Market Place Tower), average occupancy rates for commercial vehicle load zones and pedestrian load zones were nearly equal (about 30% and 25% respectively).

KEY FINDING #3 – DRIVERS CHOOSE LOAD ZONES OVER PAID PARKING AREAS

Average occupancy for paid parking and no parking was below 5% for all locations.

Conclusions

This project will significantly improve three important aspects of urban freight systems:

1. It will provide new and deep knowledge of urban goods delivery system operations.

There are significant gaps in the current understanding of urban goods systems at an operational level. This project integrates and analyzes real-time data (when vehicles are occupying load/unload spaces, as well as how long each of the spaces are occupied) collected via multiple sensory technologies, with a new network-use-concept for city load/unload spaces. Data from the sensors will develop knowledge of curb, loading zone, and alley usage, and parking cruising behavior, including which vehicles use which infrastructure features; how dwell times vary across these parking locations; and how usage of these features is differentiated over the course of a typical day. Answering these questions is essential to developing improved city infrastructure planning and policy development.

In addition to benefiting city officials and professional staff responsible for planning and managing public assets, this information can benefit delivery firms' dispatchers and drivers. Drivers can better plan their routes to schedule visits when parking is more likely to be available, and carriers can compare their average dwell times to the status quo, and identify drivers who spend longer/less time than average at locations. Municipalities can use this information to inform pricing and enforcement strategies that will best achieve desired outcomes.

2. It will enable active management of the comprehensive urban load/unload space network.

Real-time information about dwell times and infrastructure usage allows cities to implement active management strategies. The proposed integrated data systems will enable evaluations of alternative management approaches. In many cities, curb space is allocated to specific vehicle types: transit, passenger, or freight vehicles. With comprehensive sensor systems, alternative approaches to curb management could be tested by comparing results to the status quo. These could include sections of the curb dedicated to vehicles with certain stop durations (e.g. 15 minutes or less), or to vehicles of certain size (e.g. motorcycles, cars, etc.) and dynamically allocating usage by time of day. In the future, sensor data could be incorporated into a separately considered permitting upgrade where the sensors play a role in vehicle recognition, payment and enforcement. This could scale beyond loading, to cover digital permitting for many very short-term curb uses such as ride-hailing. Moreover, the sensor data could support strategies such as time-of-day pricing, where the prices can be set based on evidence and knowledge of existing usage patterns.

3. It will produce commercial benefits.

Real-time information about infrastructure usage and parking availability may make dramatic improvements for drivers and carriers possible. This information could be provided on mobile devices available in vehicles, and/or at fixed locations around the city, and could reduce the amount of vehicle circulation and the amount of time required per stop. When integrated into mobile device applications, driver routing tools can direct vehicles to the route that minimizes parking or cruising time. In the future, these apps could also automatically reserve spaces so that parking will be guaranteed to be available upon arrival. Of course, parking reservations could also be made independent of the routing algorithm.

A final application of the proposed sensing, information, and communications systems is specific to driver stop times. The common carrier lockers systems can cut truck dwell times, leading to higher turnover and increased productivity of load/unload spaces.

The project achievements to date are:

1. Parking occupancy sensor networks deployed in the two study areas in Seattle and Bellevue, are currently streaming data, and will be tested and validated before the end of Year 2.
2. A parking occupancy information app has been developed, tested, released, and is receiving data from sensors.
3. A parking occupancy prediction model was developed on synthetic data that simulated parking behaviors and is currently being calibrated as more data is collected by the sensor networks.
4. Three common parcel lockers were deployed in the study area in Seattle and are currently functional. One locker is operating at capacity with 157 users, while marketing campaigns are underway to increase the use of the other two.
5. Data collection conducted at 3 locations with and 3 locations without parcel lockers to evaluate the impacts of lockers on delivery efficiency.

Key Publications

Dalla Chiara, G. and Goodchild, A. "Do commercial vehicles cruise for parking? Empirical evidence from Seattle," *Transport Policy* 97, (2020): 26-36.

Dalla Chiara, G., Krutein, F.K., Ranjbari, A., Goodchild, A. (under review) "Commercial Vehicle Driver Behaviors and Decision Making: Lessons Learned from Urban Ridealongs", *Transportation Research Record*

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- Seattle Department of Transportation
- Sound Transit
- UPS
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