BEHAVIORAL URBAN INFORMATICS, LOGISTICS, & TRANSPORT (BUILT) LAB
Center for Urban Intelligent Transportation Systems

--- 2015 Research Brief ---

Greetings, and Happy New Year! It is that time of the year to reflect on what we've done and look forward to what we plan to accomplish. 2015 has been a turbulent but exciting year for our research group. With my relocation from Ryerson University to my new position at New York University, this has been quite a transitional year.

The Urban Transportation Lab at Ryerson remains in good hands with my postdoctoral fellow, Dr. Xintao Liu, managing it under the care of the Ryerson Institute for Infrastructure Innovation. We completed and continue to wrap up the last of several research projects at Ryerson with the remaining graduate students there: the Canada Research Chair program; a research grant from the Ryerson Centre for Urban Research and Land Development; an NSERC Discover Grant; a joint NSERC Engage and OCE project funded under the Connected Vehicles-Autonomous Vehicles Research Program with industry partner Transnomis; and another NSERC Engage grant with Metrolinx. Two graduate students from our group have successfully defended their theses in 2015: Dr. Hamid Sayarshad and Ahmed Amer.

On the NYC front, I am working with other faculty members to re-instate the Center for Urban Intelligent Transportation Systems under the NYU Tandon School of Engineering. We are expecting to have a new website, research facilities, and equipment in spring 2016—stay tuned. Within my own group, re-branded as the ***Behavioral Urban Informatics, Logistics, and Transport (BUILT) Lab***, we have already recruited several PhD students this fall and begun some collaborative research with international friends in Toronto, Luxembourg, and Korea.

Research Highlights

Our research agenda this year continued our mission of finding innovative solutions to make use of data and information in managing urban transport systems.

Anticipatory network optimization

Our group developed several products to improve the way we use historical and real time information to improve the efficiency of real time network operations. We developed the first anticipatory dynamic pricing optimization model for demand responsive transit, taxi fleets, microtransit, and other flexible transit services. The model is based on queue pricing theory. The methodology is published in Sayarshad & Chow (2015) and in Sayarshad's PhD thesis.

We also addressed a problem in my earlier research on dynamically designing and timing a network. Prior, we could improve upon the myopic decision-making, but it required enumerating all possible sequences of projects/links and solving the timing problem for each sequence. We found that we can sample sequences and use extreme value theory to construct a distribution of the policy value which would also provide a bound to our sampled policy. This distribution can further be used as a benchmark that captures both network and stochastic characteristics, which is often missing in common benchmarks like myopic or perfect hindsight assumptions. This work was published in Chow & Sayarshad (2015).

Transit service evaluation

We made several advances in the evaluation of the demand for transport service operations so that we can quantify the welfare impacts of different information-driven operating designs. For example, with Toronto Transit Commission (TTC) finally adopting the PRESTO smart card fare payment system, there's a question of how to design a more differentiated pricing scheme that can account for congestion in the system. We developed a model of TTC's subway network to illustrate how a simple distance-based fare would be ineffective in addressing the differing demand patterns between downtown commuters and non-downtown commuters (Chin et al., 2016). The model can be used to evaluate other types of zonal pricing schemes as well.

We also tackled this question for flexible transit services and other types of mobility options like ridesharing, carsharing, demand-responsive transit, taxis, many of which exist because of the advances in information and communications technologies (ICTs). Existing tools for evaluating demand only exist for either traffic networks or fixed schedule transit networks. We developed a new agent-based model framework that captures *the two-sided market* nature of this type of system. It was presented at IATBR conference in Windsor, UK.

Urban freight

Interest in urban freight has been steadily gaining with increased urbanization and the lack of prior research in this underdeveloped area. It is also an area ripe for data-driven innovations. We made several new contributions in this area in 2015. While some innovations involve setting optimal pricing schemes based on real time demand data, we took a step back to try to answer the policy questions related to welfare impacts of truck delivery operations. Because trucks behave differently from passenger cars—a key example being that they don't cruise for parking but they would simply double-park near their destination—we sought to extend an earlier economic model by Richard Arnott to capture truck behavior as well. We published a report commissioned by the Centre for Urban Research and Land Development on these findings.

We also made some headway on freight demand modeling through my earlier work with colleagues from University of California, Irvine (the lead author is now at Google); typically these models follow the passenger modeling paradigm of obtaining annual flows from which peak hour flows are factored out. However, freight patterns throughout the day and year exhibit much more seasonal patterns that depend on inventory information. We developed a model that integrates the inventory decision-making and validated its performance using data from California. This work will allow for much more dynamic and realistic urban freight modeling as a last mile portion of regional freight models.

Cyber-physical transportation systems for connected/autonomous vehicles

2015 has been an amazing year for connected vehicles (CV) and autonomous vehicles (AV). Much progress has been made in the technologies as well as the regulatory environment. Our group made our mark on this progress in a number of different ways. We started by expanding the existing high level intelligent transportation systems (ITS) architecture to explicitly incorporate the use of surrogate technologies to evaluate technologies on the field using cheaper surrogates, such as tablet devices (Harvey et al., 2016).

Using that architecture, we have been working with industry partner Transnomis to expand their business offerings into the mobile device market. The project is funded by the CV/AV joint funding program sponsored by the Ontario Ministry of Transportation. We are currently wrapping up development of software that will make it easier for companies like Transnomis to test and develop new CV or AV technologies, such as V2I communications or cooperative route guidance.

Energy

We have been collaborating with researchers from University of Toronto to investigate the impact that vehicle-to-grid (V2G) technologies have on travelers. Because electric vehicle charging is a scheduling problem, it is important that evaluation of impacts be made using an activity-based model of their behavior. We adopted the activity based equilibrium model from William Lam (HK PolyU) within an integrated bilevel model to represent the V2G system. This research will allow policymakers to better link electric pricing decisions with propensity for travel through the use of plugin electric vehicles as the catalyst.

Dissemination

2015 has been a very busy year involving much sharing of findings and results with the academic community and industry friends. We were invited to present at a number of events: the PUTRUM conference at University of Calgary, the Western Canada Connected Vehicle Workshop at University of Alberta, the Luxembourg Institute of Socio-Economic Research (LISER), the Bruce Podwal Serminar Series at City College of New York, the Seoul Metropolitan Forum on Future Cities at University of Seoul, and at KAIST. We also presented findings at ISTTT21, at IATBR, at TRB, and at INFORMS. Through these discussions, we have begun initiating some collaborative work with other researchers and hope that we can report on progress at the end of the year.

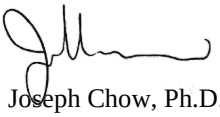
Looking Ahead

As we glimpse ahead to what lies in store for us this year, the focus will be on consolidating our efforts along three research areas: dynamic decision-making, multimodal systems, and inverse network problems. These topics cover some key challenges facing current research trends in autonomous vehicle fleets, vehicular security, private mobility services, and network resiliency against disasters.

With our operations shifting from Toronto to NYC, we expect the remaining graduate students to complete their thesis work this year. Shadi Djavadian will be presenting her thesis work at the TRB Workshop on Doctoral Research in Transportation Modeling.

In NYC, we are looking forward to reach out and collaborate with local agencies like NYC DOT, NYMTC, and Port Authority of NY and NJ to develop solutions to problems they face. There are also opportunities to connect with the private sector working on similar problems, such as technology companies like Google and IBM or service providers like Lyft or Via. We are also working closely with startup companies from NYU's incubators to develop solutions. Entrepreneurship will play a big role moving forward, as we seek to not only train skilled professionals in this field, but to also help shape the field as it evolves worldwide.

Sincerely,



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Research Team in 2015

Ryerson:

Postdoc: Dr. Xintao Liu
PhD students: Dr. Hamid R. Sayarshad, Shadi Djavadian
MASc students: Ahmed Amer, Anchor Chin, Matthew Harvey
Undergraduate research assistants: Alex Chan, Mark Eskander, Andy Lai

NYU:

PhD students: Mahmoud Moussa, Susan Jia Xu, Jinkai Zhou

Research Products in 2015

Journal publications:

Chow, J.Y.J., **Sayarshad, H.R.**, 2015. Reference policies for non-myopic sequential network design and timing problems. Networks and Spatial Economics, in press, doi: 10.1007/s11067-015-9315-5.

Nourinejad, M., **Chow, J.Y.J.**, Roorda, M.J., 2016. Equilibrium scheduling of vehicle-to-grid technology using activity-based modelling, Transportation Research Part C, special issue on Advances in Alternative Fuel Vehicle Transportation Systems, conditionally accepted for publication.

Sayarshad, H.R., **Chow, J.Y.J.**, 2015. A scalable non-myopic dynamic dial-a-ride and pricing problem, Transportation Research Part B, Special Issue on Urban Service Networks, 81(2), 539-554.

Zhao, M., **Chow, J.Y.J.**, Ritchie, S.G., 2015. An inventory-based simulation model for annual-to-daily temporal freight assignment, Transportation Research Part E 79, 83-101.

Conference proceedings:

Chin, A., **Lai, A.**, **Chow, J.Y.J.**, 2016. Non-additive public transit fare pricing under congestion with policy lessons from Toronto case study. In: Proc. 95th Annual Meeting of the Transportation Research Board, Washington DC.

Chow, J.Y.J., **Sayarshad, H.R.**, 2015. A network-sensitive reference policy for non-myopic sequential network design and timing problems. In: Proc. 94th Annual Meeting of the Transportation Research Board, Washington, DC.

Harvey, M.J., **Liu, X.**, **Chow, J.Y.J.**, 2016. A tablet-based surrogate system for "in-situ" evaluation of cyber-physical transport technologies. In: Proc. 95th Annual Meeting of the Transportation Research Board, Washington DC.

Nourinejad, M., **Chow, J.Y.J.**, Roorda, M.J., 2016. Equilibrium scheduling of vehicle-to-grid technology using activity-based modelling. In: Proc. 95th Annual Meeting of the Transportation Research Board, Washington DC.

Chow, J.Y.J., **Djavadian, S.**, 2015. Activity-based market equilibrium for capacitated multimodal transport systems, Transportation Research Procedia, ISTTT 21, 7, 2-23.

Theses:

Amer, A., 2016. A downtown on-street parking model with urban truck delivery effects. MASc Thesis, Ryerson University.

Sayarshad, H.R., 2015. Smart Transit Dynamic Optimization and Informatics. PhD Thesis, Ryerson University, https://www.researchgate.net/publication/283213089_Smart_Transit_Dynamic_Optimization_and_Informatics

Research Reports:

Amer, A., Chow, J.Y.J., 2015. A downtown on-street parking model with urban truck delivery effects: a case study of Toronto's financial district. Research Report #4, Centre for Urban Research and Land Development, http://www.ryerson.ca/content/dam/cur/pdfs/Projects/CUR%20Report%20No.%204_Chow_September%202015.pdf