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Designing a Bus Bridging Tool for Team iCity

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Key words: Transit management, Dashboard design, Data visualization, Urban systems, Transportation.

Abstract

Bus Bridging occurs when there are unforeseen disruptions to transit services, most commonly along rail lines. Buses are withdrawn from regular routes to service a disrupted segment. A majority of transit agencies use improvised strategies to solve this problem. This project focuses on designing a tool that would aid in estimating the total user delay associated with specific bus bridging scenarios. Researchers at the VAL were given the task of assessing and visualizing the features and benefits of an existing bus bridging tool designed by Amer Shalaby and his team at University of Toronto. This tool is designed to optimize bus bridging techniques and influence the design choice of bus bridging routes.

Focusing on the visual language of the tool, we identified several features to improve, to create a more visually communicative display.

A few of these features are as follows:

1. Passenger count to be graphically scaled
2. Real-time tracking of trains and shuttle buses
3. Delay time for arriving passengers at all affected stations
4. Alternative routes for passengers
5. Time and distance between terminal stations
6. User feedback tool

The team explored two visualization drafts of the delay modelling tool; both drafts focused on ways to better visually convey delay modelling information to its users. Evaluation of these draft prototypes provided valuable feedback to progress work towards a traffic management dashboard.

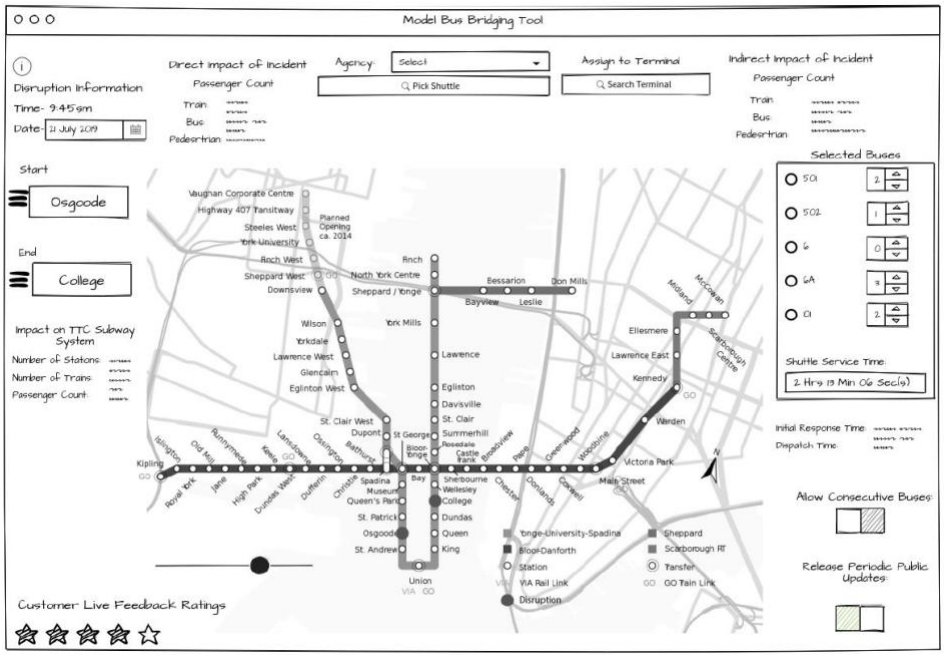

Fig1: Version 1 sketch of dashboard bridging tool

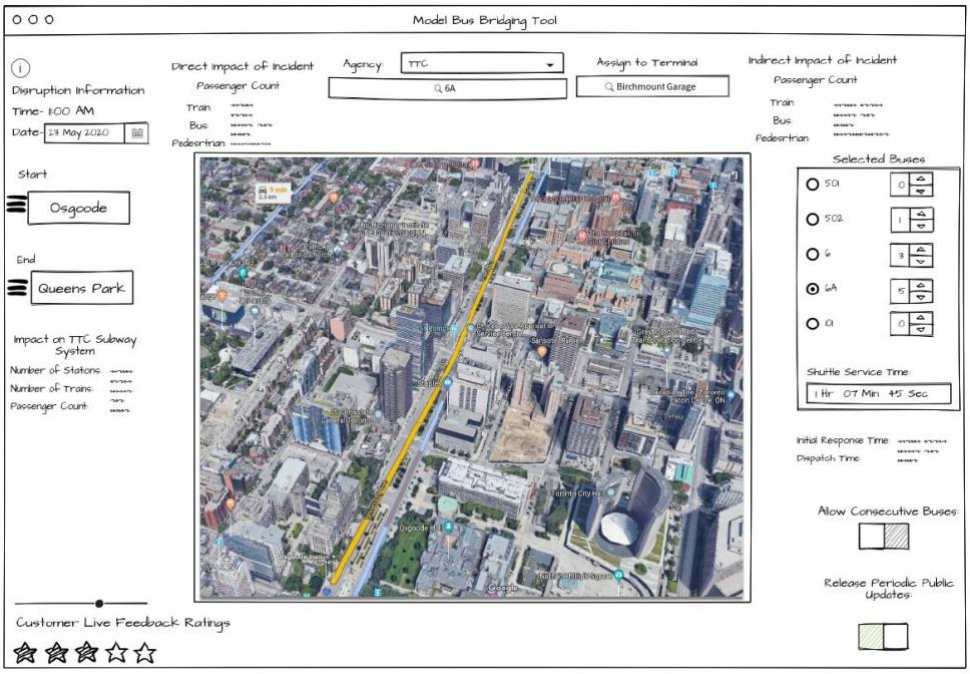

Fig2: Version 2 sketch of dashboard to assist with decision support for bus bridging scenarios

We created this modelling tool with the use of the ArcGIS Operations Dashboard as it handled geospatial data and statistics fluidly. The prototype takes advantage of the ArcGIS workflow in ArcGIS Pro, ArcGIS Online and the functionality of ArcGIS Operations Dashboard software. GTFS data was obtained for identifying schedules and routes for existing bus routes, aiding in creating a sample disruption scenario. Real-time GPS data, however, has not been inputted to the Dashboard yet, as we are working towards this next stage.

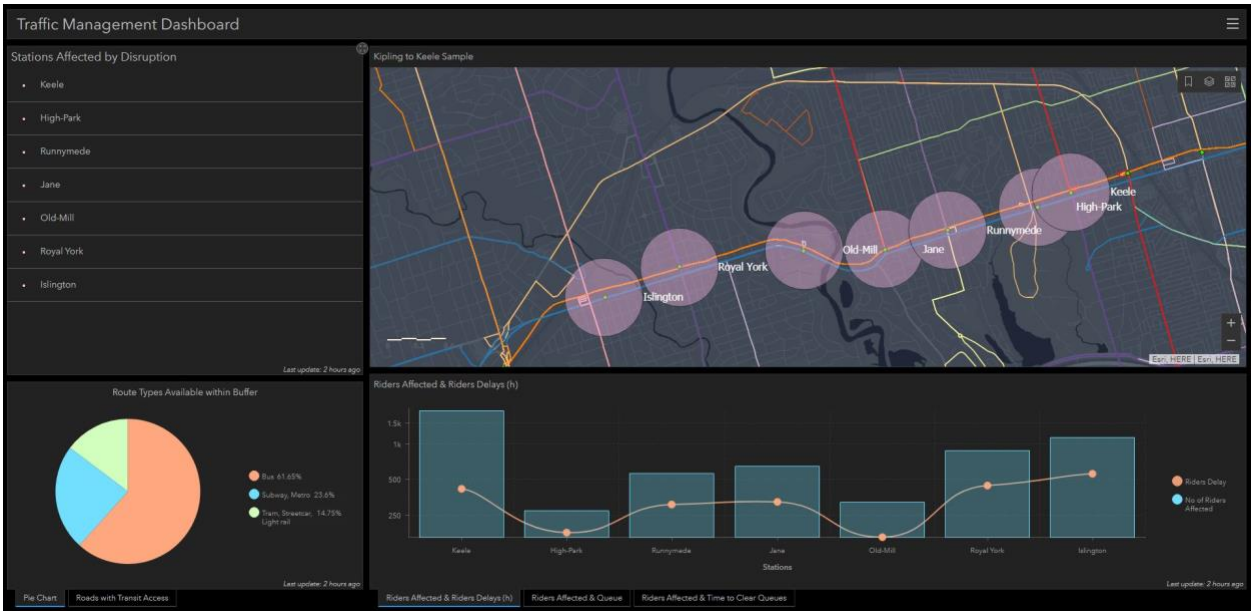

Fig3: Image of Dashboard prototype

This iteration of the tool provides a highly visual representation of bus bridging scenarios and railway disruptions. The dashboard above as an example, shows a scenario of disruptions between the Keele station and Kipling station along the TTC subway system. The map shows which stations are experiencing disruptions and the effect of this on stations along the disruption. Charts and bar graphs also display Route types available within a given buffer radius of the disruption. Riders Affected & time to clear queues, rider delays and the queue at the end of the incident are shown.

The next step would be to integrate live GTFS data into the dashboard in order to see the movement patterns of buses and trains during such disruption's scenarios.

The team also explored a visualization method that showed a number of major bus routes affected by any given disruption. Each of the bus routes would vary in size depending on the amount of delay and congestion traffic for that route. These examples are shown in figures 4 - 5 below.

Fig4: Kipling Bus Route showing impact of delay

Fig5: Keele Bus Route showing impact of delay

In conclusion, this presentation illustrates the use of ESRI tools to support the development of a decision support tool to aid transit management operations in their assessment of the impacts of alternate bus bridging scenarios.

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Biographies:

Amer Shalaby, Professor, Department of Civil and Mineral Engineering, University of Toronto
Associate Director, iCity Centre for Automated and Transformative Transportation Systems (iCity-CATTS)

Amer Shalaby received a B.A.Sc. degree (1988) in Civil Engineering from Ain Shams University in Egypt, and MASc (1991) and PhD (1996) degrees from the University of Toronto, specializing in Transportation Engineering. He was a postdoctoral fellow (1996-1997) at the University of Toronto, NSERC Industrial Research Fellow (1997-1998) at IBI Group and assistant professor (1998-2000) at Ryerson University. Dr. Shalaby is specialized in transit planning and operations, intelligent transportation systems, and transportation planning for large-scale events and mega cities. His research program has been sponsored by many organizations from both the public and private sectors. In addition to research, Dr. Shalaby has delivered consulting services to various transportation organizations in Canada and internationally, and he has offered annual short courses on public transit planning and modelling to the professional community since 2008. Dr. Shalaby has been an active member of several transit technical committees of the TRB, he serves as associate editor of the Canadian Journal of Civil Engineering and he sits on the editorial board of several international journals. Dr. Shalaby has also served on advisory panels of multiple transportation projects in Canada and internationally. Between 2008 and 2010, Professor Shalaby held an honorary appointment of a visiting scholar at Carnegie Mellon University. He has received several recognitions for his research contributions and professional expertise, including the TRB William Millar Award (2015), ThinkTransit Award of Excellence in Innovation (2019) and Sandford Fleming Award (2019).

Professor Amer Shalaby focuses his research on crowds and congestion, both at the local and global levels, with particular emphasis on disruption management. This work intends to help transportation authorities to respond more effectively to unexpected impediments or crises within a network and permit the rerouting of passengers without seriously affecting migration patterns. As this work continues to evolve it will have ramifications for

predicting crowd behaviours on micro levels, such as subways and other public transit applications, where large crowd congestions occur.

Siva Srikukenthiran, Dept. Of Civil Engineering, University of Toronto, Ontario. Dr. Siva Srikukenthiran is a Research Associate in the University of Toronto Transportation Research Institute. He currently sits on the TRB Standing Committee on Internal Transfer Facilities and has a PhD in Civil Engineering from the University of Toronto. Siva's main areas of research are in better understanding how the behaviour and movement of crowds impact transit network performance, developing tools to improve operational response to disruptions in transit networks, and in survey methods to collect data on traveler behaviour.

Alaa Itani, Dept. Of Civil Engineering, Master of Science, University of Toronto, Ontario. Her research at the University of Toronto focuses on planning and management of on-demand transit in the era of new mobility and automation; exploring new and efficient ways to operate such costly services. Her research focuses on managing unplanned rail disruptions through optimizing the shuttle-bus selection and movement.

Dr. Sara Diamond is the President and Vice-Chancellor of OCAD University, the Director of the Visual Analytics Laboratory at OCAD University and Visualization theme Leader of iCity. She holds a PhD in Computing, Information Technology and Engineering. She is an appointee of the Order of Ontario and the Royal Canadian Academy of Artists and a recipient of the Queen's Diamond Jubilee Medal for service to Canada. She is the winner of the 2013 GRAND NCE Digital Media Pioneer Award, recognized as one of Toronto Life's TopFifty. She was honored as one of Canada's 150 leading women and received the Inspiring 50 Canada 2018 Women in Technology and Innovation award. Diamond is a researcher in visual analytics, media arts history and public policy. Diamond was co-principal investigator of the Centre for Information Visualization/Data Driven Design; and is an executive member of the BRAIN Alliance. A well published researcher she holds funding from the Social Science and Humanities Research Council, Canada Foundation for Innovation, MITACS, the National Sciences and Engineering Research Council, Ontario Centres for Excellence, Framework EU, and the Canada Council for the Arts.

Jeremy Bowes is a Professor in Design at OCAD University, and teaches in the Environmental Design program, and the Strategic Foresight and Innovation graduate program. Key areas of research are city housing and transportation systems, within the context of architectural, and urban ecology systems. He works with the Visual Analytics Lab at OCADU with data analysis and visualization for urban, transportation, and ecology research, contributing research on the iCity, Canadian Urban Transit Research & Innovation Consortium, StudentDwell, and StudentMove projects.

Dr. Greice C. Mariano is a Post-Doctoral Research Fellow in Data Visualization at the Visual Analytics Lab (VAL). She earned her PhD and Master of Science degrees in Computer Science in 2018 and 2013, respectively, under the supervision of Professor Ricardo Torres at Institute of Computing (IC) from University of Campinas (UNICAMP) in Campinas, São Paulo State, Brazil. She also concluded a specialization in health informatics at the Federal University of São Paulo (UNIFESP), Brazil in 2010 and graduated in Information Technology also at University of Campinas (UNICAMP) in 2009.

As a Post-Doctoral Research Fellow with the Visual Analytics Lab, she has been working on the iCity project. Her main research interest is to investigate the use of visualization techniques to explore multidimensional and multivariate temporal data. Additionally, she also has an interest in research related to data science, visual analytics tools, scientific visualization, software engineering and database development.

Olufunbi Disu-Sule is a research assistant in the Visual Analytics Lab at OCAD U, and is currently completing his undergraduate work at Fanshawe College through the cooperative education program. He has comprehensive training in ARCGIS Pro, and several other related ESRI software applications, and is working on both the iCity project, and the Canadian Urban Transit Research & Innovation Consortium (CUTRIC) projects.