## Fusion of Travel Demand Modelling, Geospatial Data Science & Big Data For Regional Rail Planning

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# I'm Anthony from Metrolinx. Today I would like to tell you a story...

### **METROLINX MISSION & VISION**

### We connect our communities

## Getting you there better, faster, easier

### WHAT IS METROLINX?

- Metrolinx is responsible for planning and delivery of new rapid transit projects in the Greater Golden Horseshoe (GGH)
- Business Lines include
  - GO Transit,
  - UP Express, and
  - Presto





### **MODELLING & GEOMATICS PROVIDES GIS & FORECASTING LEADERSHIP FOR P&D**

• We conduct demand forecasting and geospatial analysis projects in support of crossfunctional teams across Planning & Development

	RER Head Sponsor	Project Planning	Service Planning	Regional Planning	Fare Integration	TOD			
Regional Partnerships			Engageme	nt Expertise					
Sponsor's Office		Ben	efits Manage	ement Expe	rtise				
Design Excellence		Design Excellence Expertise							
Realty & Property Management			Real Estate	Expertise					
Research & Planning Analytics			Business Ca	se Expertise					
EVIDENCE-BASED FRAMEWORKS	RESEARCH & MODELS		DATA	A	DATA VISUA STORY 1	LIZATION 8 TELLING			

### OUTLINE

- 1. The Value Proposition for **Storytelling with Big Data**
- 2. Context: Land Use Change in a Growing Region
- 3. Rapid Demand Model Visualization: The Fusion of **EMME and GIS**
- 4. Transportation Tomorrow Survey & Next Gen **Travel Data Sources** for Transit Planning
- 5. **PRESTO** Card Data & Emerging **Big Data**: Tapping Into the Future



# The Value Proposition for Story Telling with Big Data

### **MELTING THE ICE: TRANSFORMING DATA INTO KNOWLEDGE**



### **EXAMPLE: COMMUTER FLOWS BETWEEN CITIES**

Can you find the pattern in this data?																
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2016	1001155	1	Division No. 1, Subd.	8.3	0 SNO	1001155	1001542	1 Mount Pea	3.9	0 CY	1001542	30	20	10		

### **TRANSFORMING DATA INTO MAPS**



### **TRANSFORMING DATA INTO ART?**





#### **TRANSFORMING DATA INTO VIDEOS**





# Land Use Scenarios for Demand Modelling & Project Evaluation

### **THE REGION IS GROWING**





### **GREATER ACCESS TO FREQUENT RAPID TRANSIT - INCREASING EQUITY**



\* Walking Distance is 400 m from Priority Bus, BRT and LRT lines, and 800 m from subway and 15-minute GO stations

### THE REGION IS GROWING

We can break
 Growth Plan data
 down into cities to
 illustrate that rate of
 growth is much
 higher outside
 Toronto

#### **2041** Population



41% Growth by 2041 in the Greater Toronto and Hamilton Area

### LAND USE SCENARIOS

Land use scenarios
 are a key input for
 Travel Demand
 Modelling



### **THERE IS RAPID GROWTH IN DOWNTOWN AND THE 905**

- Strong residential growth in 905 centres and outer edge of build up areas
- Employment growth in Toronto has significantly outpaced Growth Plan projections, projected to meet target by 2025
- GO Expansion provides faster travel between suburbs and Downtown



### A DIVERSE COMMUNITY WITH MANY UNIQUE NEEDS

- This map shows Census data on the Top Five Mother Tongue languages in the Region
- Engagement requires understanding different ethnicities and unique needs



### **INCOME INEQUALITY IS INCREASING**

- This map shows Census data on the fraction of people with low income by area
- Transit investments can reduce the cost of living and increase access to employment opportunities



### THE SILVER TSUNAMI IS COMING

- This map shows Census data on the fraction of people over the age of 65
- Transit investments can improve access to destinations people need to connect to without cars





#### GO Transit Mode Share for Trips from Home to Work or School









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### WE HAVE A PLAN: THE 2041 REGIONAL TRANSPORTATION PLAN (RTP)







#### Transit Travel Time to Union Station in the AM Peak (2011 Existing Scenario)



#### Transit Travel Time to Union Station in the AM Peak (2041 Plan Scenario)



### **DATA STRATEGY & 2041 RTP ACTIONS**

- Use big data to optimize infrastructure and improve services
- Action 5.6: Develop a regional transportation big data strategy
  - Create a regional transportation **big data portal**, providing consistent and transparent data collection, management and reporting.
  - Establish **regional standards** for transportation data sourcing, formatting, privacy, security, ownership and reporting.
  - Identify and acquire **new transportation data on all modes** of transportation for planning and operations (e.g., crowd-sourced traffic data).
  - Advance **coordination and standardization** of transportation forecasting, modelling and business case methodologies to support decision-making and evaluation.

## **Rapid Demand Model Visualization**

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### **CONTEXT: DEMAND MODELLING VISUALIZATION IS CURRENTLY LIMITED**

- Current GGHMv4 (EMME platform) model visualization is lacking readability and coherence
- Displays have limited options and do not support design and visualization excellence



Relief Line South Emme Visualization



Relief Line South GEMMELY Model Visualization

### **GEMMELY MODEL OBJECTIVE: RAPID, ROBUST MODEL DATA VISUALIZATION**

### PURPOSE:

To visualize travel demand metrics by using a standard output model that transforms GGHMv4 demand forecasts into GIS format, enabling rapid visualization of geospatial outputs and comparison of scenarios.



- 1. Transit Frequency / Headways
- 2. Customer Volume per Route Segment
- 3. Boardings and Alightings by Station/Stop
- 4. Volume/Capacity Ratio for Transit/Road Networks





#### DRAFT-MAPS SHOW PRELIMINARY MODEL RESULTS-SUBJECT TO CHANGE









### **OTHER EMME DATA / MAPPING OPPORTUNITIES USING GEMMELY MODEL**

GEMMELY model expands the "black box" of GGHMv4, providing opportunities for data extraction and mapping:

- Number of jobs accessible within 45 minutes by transit
- Travel Times
- Trip Density
- Mode Share
- VKT / VHT



# Transportation Tomorrow Survey & New Data Sources

### **TTS 2016 - OVERVIEW**

- World's largest travel survey
- Conducted: Sept 7 Dec 19, 2016
  - Over 1 million people contacted by mail or phone. 16.2% response rate.
  - 171,334 surveys representing 798,093 trips
  - Total cost: \$4.5 million (\$26 per complete survey)
  - First time TTS surveys have been managed by private sector R.A. Malatest & Associates Ltd
- Draft results reviewed by RPA and funding agencies: Sept 2017-Jan 2018



### **ORIGIN-DESTINATION FLOWS FROM TTS**



### **FUTURE OF TRAVEL DATA COLLECTION - NEXT-GENERATION DATA SOURCES**

- New technologies have the potential to provide data in ways that are faster, cheaper, and more complete than the "traditional" travel survey
- There are often issues:
  - Can be one-dimensional many do not connect O/D and demographic data while also being representative
  - Reliability can be unclear some technologies are "black boxes" which can be difficult to quality control
- Alternatives cannot fully replace the TTS, but they could supplement



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### **FUTURE OF TRAVEL DATA COLLECTION - TTS 2.0**

- TTS 2.0 is a separate research project, studying how travel data collection in the GGH should look like in the future
- Includes looking at new technologies may also have the potential to enhance, replace, or supplement traditional methods
- Three-year University of Toronto led project
- Metrolinx involvement
  - Presto BI Provided researchers with data access
  - Mobility Management Potential to "fuse" Smart Commute survey questions and TTS questions. Also potential to use Triplinx within the TTS web survey tool.
  - RPA Overall review and liaison between UofT and Metrolinx



Media coverage of City Logger app

# PRESTO Card Data & Emerging Big Data: Tapping Into the Future



### **BETTER PLANNING WITH ANONYMIZED PRESTO TTC-GO TRANSFER LOCATIONS**



### **IDENTIFYING GO STATION CATCHMENTS USING PASSENGER SURVEY DATA**

- Leveraged a large
   Rail Passenger Survey
   dataset with 11,000
   anonymized
   customer home
   locations
- Linked homes to GO Access Station
- Ellipses show areas where about 70% of customers live per station



### WHERE DO OUR CUSTOMERS COME FROM & HOW ARE THOSE AREAS CHANGING?

 RPA also calculated the population change within each GO station catchment to estimate the impact of land use change on ridership growth

 This table shows stations with greater than 5% population increase between 2011-2016

Station Name	Avg KM to GO	2011 Population	2016 Population	Change	% Change
Milton Station	5.6	80,371	106,115	25,744	32%
Stouffville Station	1.8	24,338	31,195	6,857	28%
Mount Pleasant Station	3.6	131,710	168,065	36,355	28%
Bradford Station	5.7	32,319	39,258	6,939	21%
Mount Joy Station	2.0	50,928	60,072	9,144	18%
<b>Exhibition Station</b>	1.4	143,171	168,796	25,625	18%
<b>Centennial Station</b>	2.3	73,051	84,728	11,677	16%
Maple Station	3.9	124,507	138,990	14,483	12%
Ajax Station	3.4	81,376	90,520	9,144	11%
Lincolnville Station	10.8	31,240	34,573	3,333	11%
Malton Station	10.4	203,736	223,112	19,376	10%
Unionville Station	3.8	129,771	140,975	11,204	9%
King City Station	8.9	221,266	240,266	19,000	9%
Mimico Station	2.6	78,994	85,429	6,435	8%
Guelph Station	3.8	109,791	117,751	7,960	7%
Kipling Station	2.5	78,089	83,163	5,074	6%
Oakville Station	4.1	139,502	148,489	8,987	6%
Barrie South Station	5.6	128,912	137,011	8,099	6%
Bronte GO Station	3.6	63,566	67,473	3,907	6%
Streetsville Station	2.9	99,706	105,490	5,784	6%
Oshawa Station	9.5	250,488	264,797	14,309	6%
Rutherford Station	3.2	82,744	87,337	4,593	6%

### **NEW SOURCES OF BIG DATA - UBER MOVEMENT**

- Our team monitors many new data sources and tools to identify emerging opportunities such as Uber Movement
- On-Demand Micro-Transit Pilots similar to Innisfil are underway



### **TRAVEL TIME ANALYSIS**

 Standard isochrone maps (below) show travel times from Union Station

Driving Time to Union Station Based on Posted Speed Limits TRAVEL TIME IN MINUTES 1 - 4 5 - 9 10 - 14 15 - 19 20 - 24 25 - 29



 Comparing the travel time of Driving to Transit (Above) provides insight into mode competitiveness of options

### **GETTING TO TRANSIT: POPULATION & EMPLOYMENT IN STATION CATCHMENTS**



### **IMPROVING WALKING DISTANCE TO TRANSIT**

- Improving the built environment can improve access to transit
- First and Last Mile connections are critical to improving ridership



### SAMPLE ANALYTICS DASHBOARD FOR STATION ACCESS PLANNING

#### Summary Data



Note: "10km" category includes all trips greater than 10km. Sourced from 2015 GO Rail Passenger Survey, as well as parking counts from MyLinx. Parking utilization is the highest reported during the period from June 2017 to May 2018.

### **MAPPING LOCAL TRANSIT OPERATING AREAS**

These maps were produced by RPA in collaboration with the Fare Integration and Service Planning teams to illustrate where Municipal Service Providers operate





### LEVERAGING KEPLER.GL FROM UBER ENGINEERING LAB

- Our team rapidly deployed Keper.GL, a new, easy to use tool from Uber Engineering
- It allows us to create 3D flow maps, hexagon bins, and animate patterns over time





### PASSIVELY COLLECTED MOBILE PHONE DATA FROM SIDEWALK LABS

- Replica is a new planning tool under development from Sidewalk Labs
- Provides travel patters from mobile phone data
- Could be used to understand where transit customers travel and to enhance existing survey data



### **SEGMENTATION OF CUSTOMERS BASED ON DATA FROM REPLICA**

- Data from Replica can also be used to isolate trips by purpose, age, start time and household income
- These criteria can be used as filters to isolate specific patters such as weekday vs weekend trips and customer demographic segments



Start Time (i) Number of trips starting each hour





Household Income () Number of people in each household income group



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### **PASSIVELY COLLECTED DATA - CELLULAR NETWORK & GPS DATA FROM APPS**

 Sreetlight also provides travel patterns from mobile phone apps

 Also examining other providers of cellular data: Telus, Cellint, Downtown.Al etc.

#### Using Big Data to Improve Pedestrian and Bicycle Access to Transit



A project for a new way to measure bike and pedestrian travel behavior





### **IMPLEMENTING A P&D DATA STRATEGY**

## Challenges

. . .

Inconsistent & incomplete data\_

Redundant data collection

Different time periods & definitions

Confidentiality & security

Difficulty obtaining data

Data standardization Quality assurance Modeling gaps Sharing results Collaboration Innovation & trends

Solutions

Prioritization



Integrating datasets into a comprehensive and consistent structure can reveal new insights that are not apparent in the original, independent sources



In the past, teams were reluctant to share data. This challenge can be minimized through increased collaboration and data sharing

### **COMPONENTS OF A METROLINX BUSINESS CASE**





STRATEGIC CASE

- Determines the strategic value of addressing a problem
- Options are evaluated against strategic objectives
- Establishes 'why' a project should be pursued
- Assesses economic costs and benefits to individuals and society

**ECONOMIC** 

CASE

 Establishes 'what the benefit to society' is in economic

terms

Assesses affordability and financial value for money

**FINANCIAL** 

CASE

- Focuses on capital and resource requirements for the corporation
- Establishes 'how much the project will cost' in financial terms



## DELIVERABILITY & OPERATIONS CASE

- Provides evidence on engineering viability
- May consider procurement strategies, and deliverability and operating risks
- Establishes 'what is required to deliver and operate' the project

### **EVIDENCE IS REFINED THROUGH THE PROJECT LIFECYCLE**





Identifies problem statement and defines benefits that the project needs to Typical point at which deliver.

**Evaluates** options and determines a preferred option. funding for planning and preliminary design is secured.

Refines preferred option, further clarifying scope and cost. Typical point at which funding for procurement and construction is secured.



Develops project framework, designs and requirements used as the basis for procurement.

Procures the project.

Delivers and commissions the project.



After the asset is in service, monitors the benefits and costs to identify opportunities for enhancements and lessons learned.

### SUMMARY

- 1. Storytelling with Big Data is critical to effective engagement and evidence-informed decisions
- 2. We must use data to understand **regional context**
- 3. Rapid Demand Model Visualization provides capability to iterate and review forecasting results
- 4. Survey data still matters, but new data are rapidly **shifting the landscape** of transit planning
- 5. Business Cases depend on timely, high-quality data



## **Thank You!**

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## **METROLINX**