Evaluating Walkable Streets with a 3D Stated Preference Survey

A collaboration between UTTRI, Esri Canada, OCAD U & Waterfront Toronto

iCity-ORF 3rd Annual Research Day

June 22nd, 2018

Gaps

- Most street designs prioritize car travel.
- Urban design guidelines for streetscapes are **rarely based on empirical evidence** of their relationship to behaviour or psychology or **user experience**.
- Empirical research on the built-environment correlates of walking and cycling are **dominantly at the neighbourhood scale**.
- Little is known about the **trade-offs** made between various design attributes.

Relevance


WELCOME
THE CITY WE WANT:
FEBRUARY 22, 2018
SPECIAL GUEST
--- CONVERSATION WITH ---
MODERATED BY
Jeff Risom
Partner & Managing Director
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Barbara Gray
General Manager
Transportation Services
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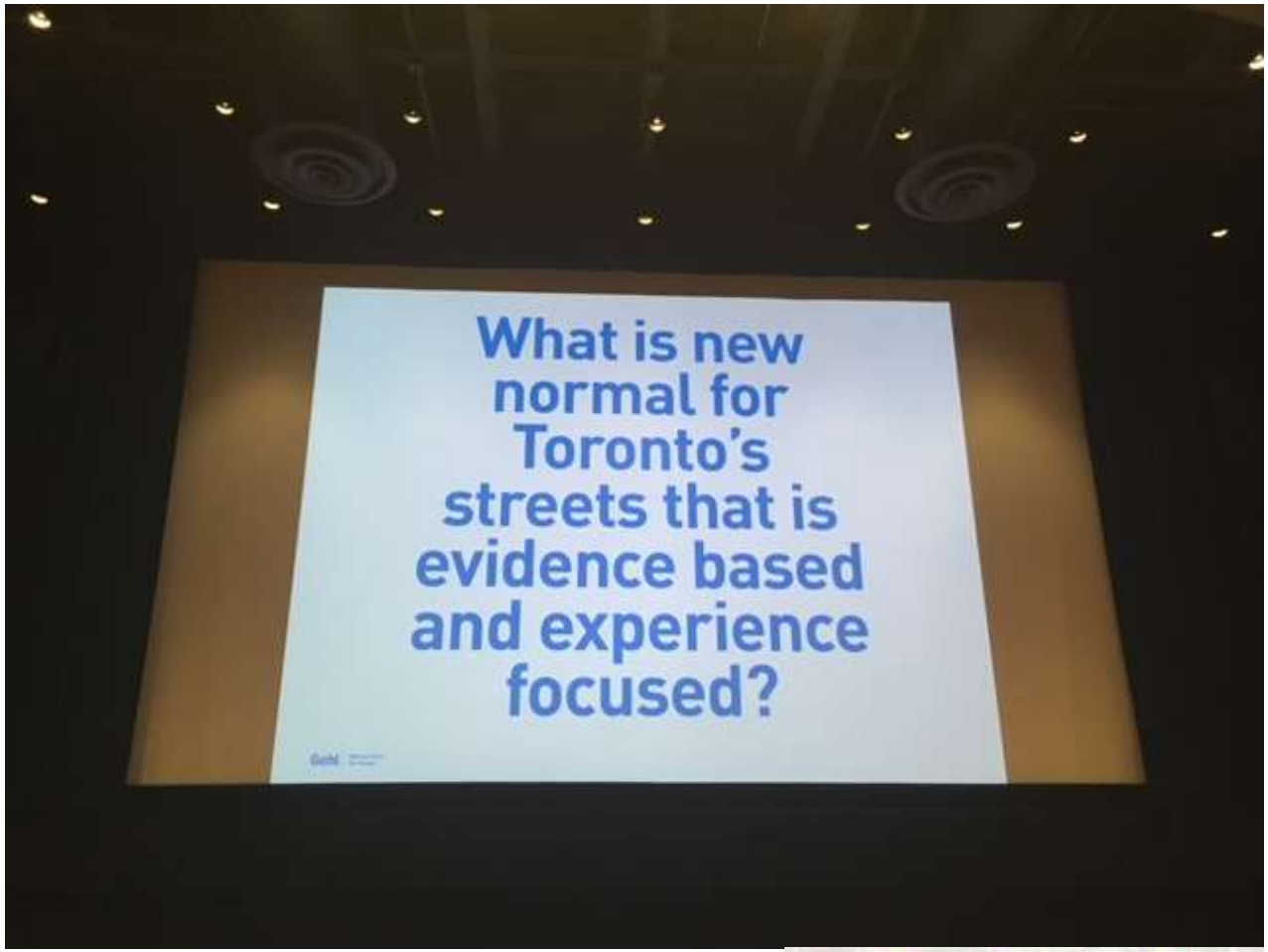
INNIS COLLEGE
TORONTO

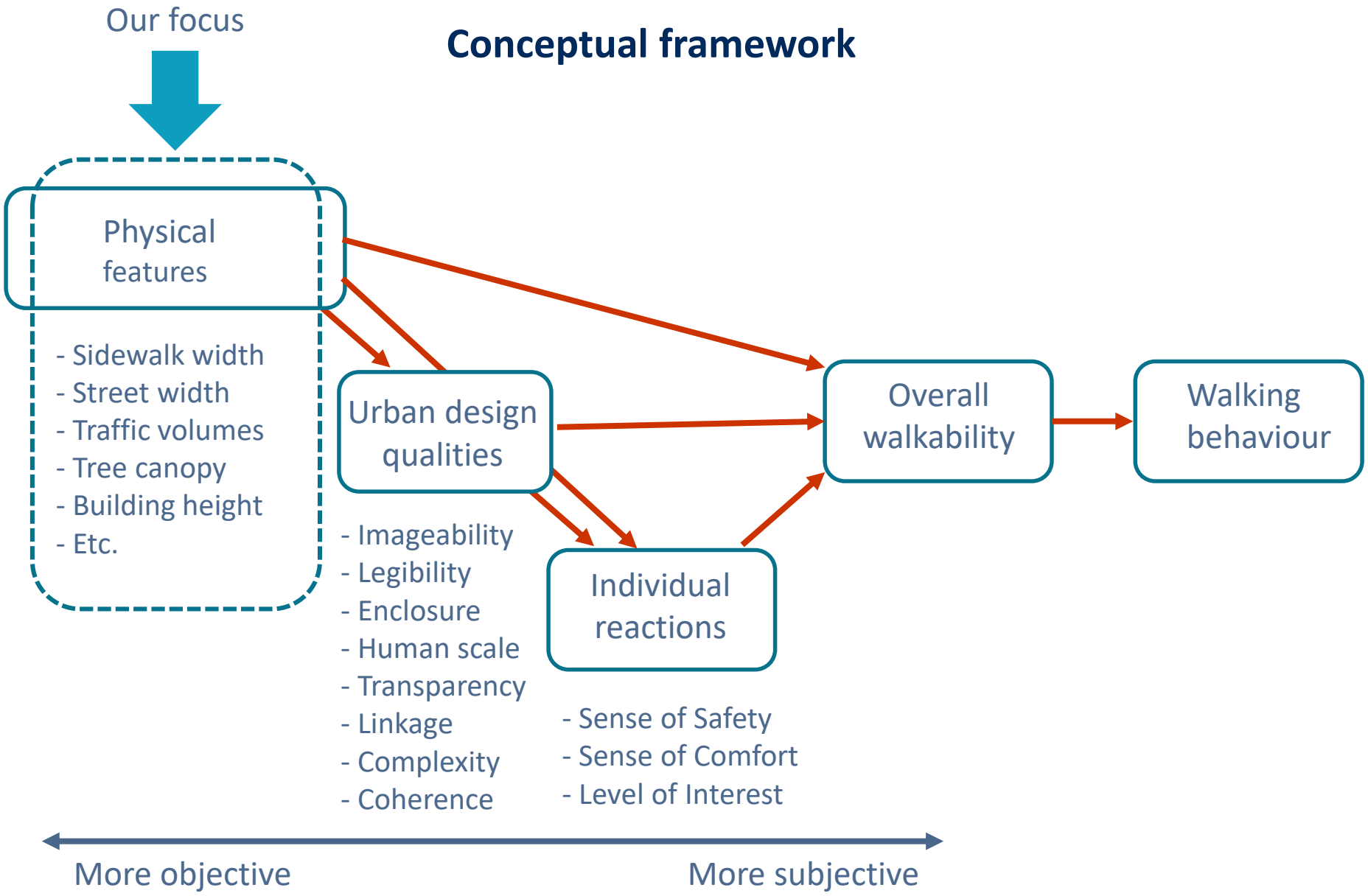

SIDE
WALK
LABS


PEOPLE ARE

Relevance


What is new normal for Toronto's streets that is evidence based and experience focused?
FEBRUARY 22, 2018

Conceptual framework



Based on Ewing & Handy (2009)

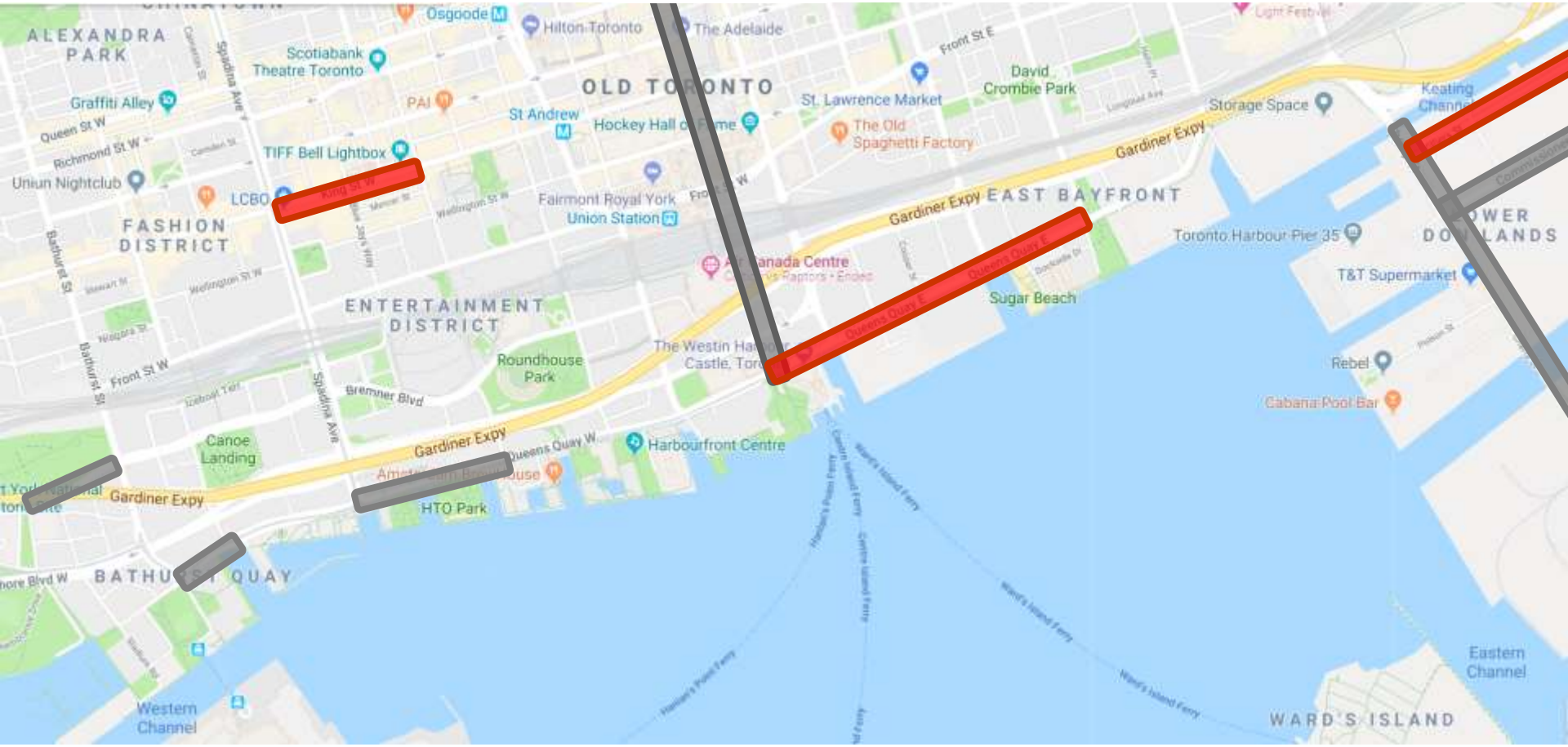
Method:

- Scope

Attributes at the **street segment level**, for the purpose of **recreational** walking

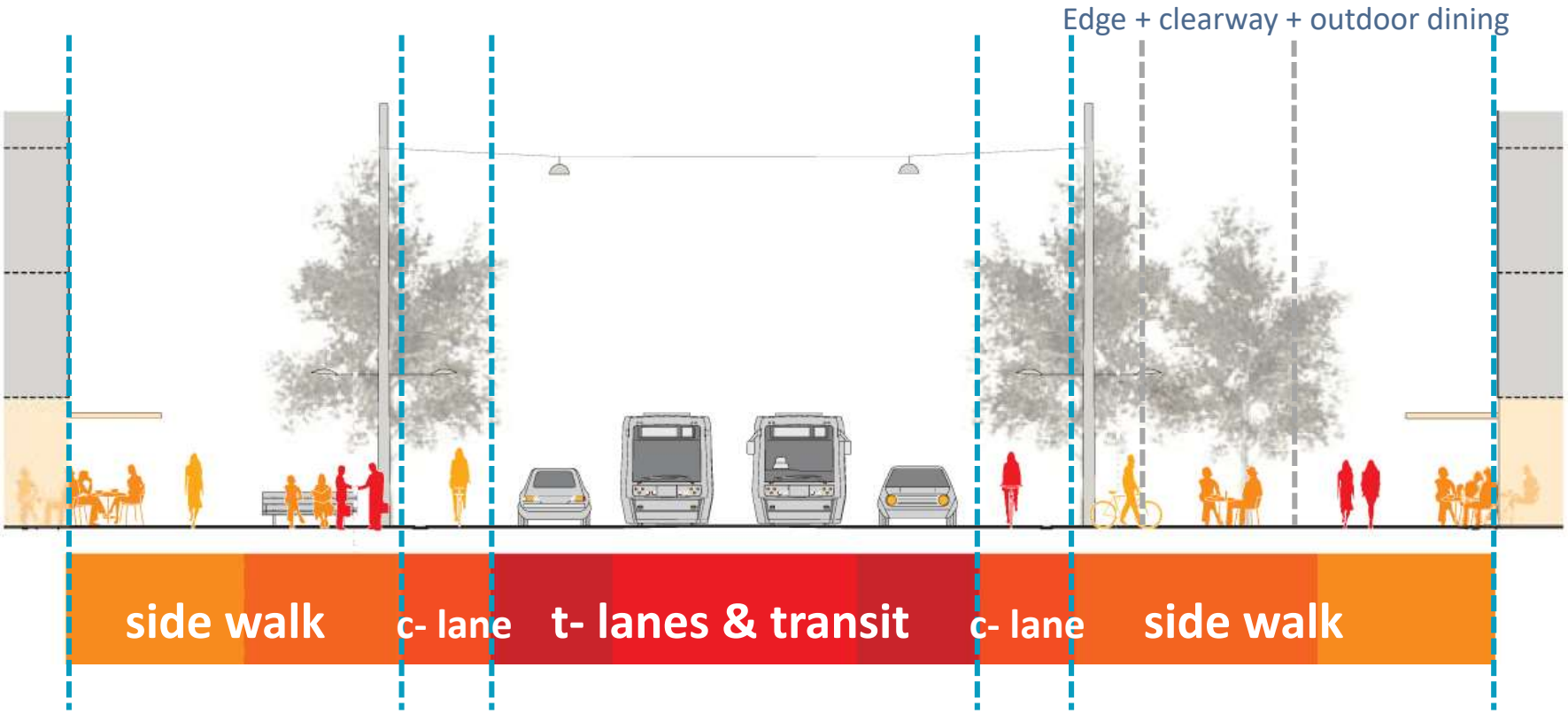
- Web-based survey:
  - Ask respondents to rate an existing street (revealed preference)
  - Provide them with systematically manipulated options to re-rate (stated preference).
- Visualisation environment: CityEngine + Unity
- Locations: A number of streets at Toronto waterfront & down town

Locations


ALEXANDRA PARK
Osgoode
Hilton Toronto
The Adelaide
Scotiabank Theatre Toronto
OLD TORONTO
Graffiti Alley
PAI
St Andrew
St. Lawrence Market
David Crombie Park
Storage Space
Queen St W
Richmond St W
TIFF Bell Lightbox
Hockey Hall of Fame
The Old Spaghetti Factory
Gardiner Expy
Union Nightclub
LCBO
Fairmont Royal York
Union Station
Gardiner Expy EAST BAYFRONT
FASHION DISTRICT
Toronto Harbour Pier 35
T&T Supermarket
Sugar Beach
ENTERTAINMENT DISTRICT
Roundhouse Park
Front St W
Bremner Blvd
Rebel
Cabana Pool Bar
Canoe Landing
Harbourfront Centre
Queens Quay W
Gardiner Expy
HTO Park
BATHURST QUAY
Western Channel
Eastern Channel
WARD'S ISLAND

Attributes

side walk + curb lane + through lanes & transit + curb lane + side walk ☑



Adjacent buildings and land uses ☒

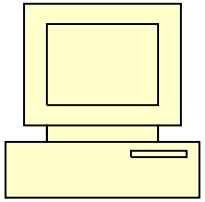
1	30	3	15	4
2	30	1	35	4
3	30	1	20	4
4	20	1	25	4
5	25	5	30	2
6	20	3	35	2
7	20	1	20	4
8	25	3	40	2
9	25	5	25	2
10	20	5	15	2
11	30	5	30	2
12	25	3	40	4

experimental design

online survey respondents

0 0 1 0
0 1 0 0
0 1 0 0
0 0 0 1
1 0 0 0
0 1 0 0
1 0 0 0

data



estimation

$\hat{\beta}$

$se(\hat{\beta})$

results

evidence base

informed planning

Complete Streets

Partially adopted from Rose & Bliemer (2009)

Experimental design

Attributes

Through lane	Curb lane	Side walk
• car+car	• none	• narrow edge + wide clearway
• transit+transit	• one-way cycle path	• medium edge + normal clearway
• car+car+car+car	• two-way cycle path	• medium edge + wide clearway
• car+transit+transit+car	• on-street parking + cycle path	• outdoor dining + normal clearway
• transit+car+car+transit	• cycle path + on-street parking	• narrow edge + normal clearway + outdoor dining

Attribute levels

Experimental design

Through lane	Curb lane	Side walk
• car+car	• none	• narrow edge + wide clearway
• transit+transit (3.5 m + 3.5 m)	• one-way cycle path 2*(0.8 m + 1.5 m)	• medium edge + normal clearway 2*(1.6 m + 1.6 m)
• car+car+car+car	• two-way cycle path	• medium edge + wide clearway
• car+transit+transit+car	• on-street parking + cycle path	• outdoor dining + normal clearway
• transit+car+car+transit	• cycle path + on-street parking	• narrow edge + normal clearway + outdoor dining

Street width: 18 m

Experimental design: orthogonal design

Scenario	through lane	curb lane	sidewalk	tlane_width	clane_width	sidewalk_width	street_width
King street							
1	transit+car+car+transit	none	medium edge+wide clearway	13	0	9,6	22,6
2	car+car	cycle path+on street parking	medium edge+normal clearway	6	9,4	6,4	21,8
3	car+car	cycle path_one way	narrow edge+normal clearway+outdoor dining	6	4,6	11,2	21,8
4	transit+transit	cycle path_one way	medium edge+wide clearway	7	4,6	9,6	21,2
5	car+car	cycle path_two way	outdoor dining+normal clearway	6	3,8	9,6	19,4
6	car+car+car+car	none	medium edge+normal clearway	12	0	6,4	18,4
7	transit+transit	cycle path_two way	medium edge+normal clearway	7	3,8	6,4	17,2
8	transit+transit	none	outdoor dining+normal clearway	7	0	9,6	16,6
9	car+car	none	narrow edge+wide clearway	6	0	8	14
Queens Quay between Lower Jarvis & Lower Sherbourne							
1	car+transit+transit+car	on street parking+cycle path	medium edge+normal clearway	13	9,4	6,4	28,8
2	car+transit+transit+car	cycle path_one way	outdoor dining+normal clearway	13	4,6	9,6	27,2
3	car+car+car+car	cycle path_two way	narrow edge+normal clearway+outdoor dining	12	3,8	11,2	27
4	car+transit+transit+car	cycle path_two way	medium edge+wide clearway	13	3,8	9,6	26,4
5	car+car	on street parking+cycle path	medium edge+wide clearway	6	9,4	9,6	25
6	transit+car+car+transit	cycle path_two way	narrow edge+wide clearway	13	3,8	8	24,8
Queens Quay between Yonge & Freeland							
1	car+transit+transit+car	cycle path_two way	medium edge+wide clearway	13	3,8	9,6	26,4
2	car+car	on street parking+cycle path	medium edge+wide clearway	6	9,4	9,6	25
3	transit+car+car+transit	cycle path_two way	narrow edge+wide clearway	13	3,8	8	24,8
4	car+car+car+car	cycle path_one way	narrow edge+wide clearway	12	4,6	8	24,6
5	car+transit+transit+car	none	narrow edge+normal clearway+outdoor dining	13	0	11,2	24,2
6	transit+car+car+transit	cycle path_one way	medium edge+normal clearway	13	4,6	6,4	24
Villiers Street Don to Cherry							
1	transit+car+car+transit	on street parking+cycle path	narrow edge+normal clearway+outdoor dining	13	9,4	11,2	33,6
2	transit+car+car+transit	cycle path+on street parking	outdoor dining+normal clearway	13	9,4	9,6	32
3	car+car+car+car	on street parking+cycle path	outdoor dining+normal clearway	12	9,4	9,6	31
4	car+car+car+car	cycle path+on street parking	medium edge+wide clearway	12	9,4	9,6	31
5	car+transit+transit+car	cycle path+on street parking	narrow edge+wide clearway	13	9,4	8	30,4
6	car+transit+transit+car	on street parking+cycle path	medium edge+normal clearway	13	9,4	6,4	28,8

As a pedestrian, how attractive do you find the street designs below?

Please click on each animation, then rank the scenarios as the 1st, 2nd or 3rd best designs.

- Four Car lanes
- Cycle path (one way)
- Sidewalk 4 m

1st 2nd 3rd

- Two Car lanes & transit in the middle
- Cycle path (two way)
- Sidewalk 4 m

1st 2nd 3rd

- Four Car lanes
- Cycle path (one way)
- Sidewalk 4.8 m

1st 2nd 3rd

Impacts

- **Evidence-based design guidelines** for walking friendly streets
- **Specific guidelines** for improvements of pedestrian facilities in Toronto downtown and Waterfront
- 'Dashboard' platform to **visualise and assess** various street designs
  → Policy-support - commercializable product

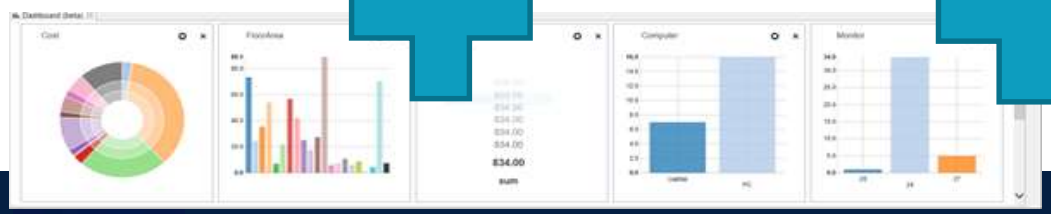
Impacts

Complete Streets Game launched at TCAT's Complete Streets Forum, May 27, 2013
Photo Credit: Chris Hardwicke

Impacts

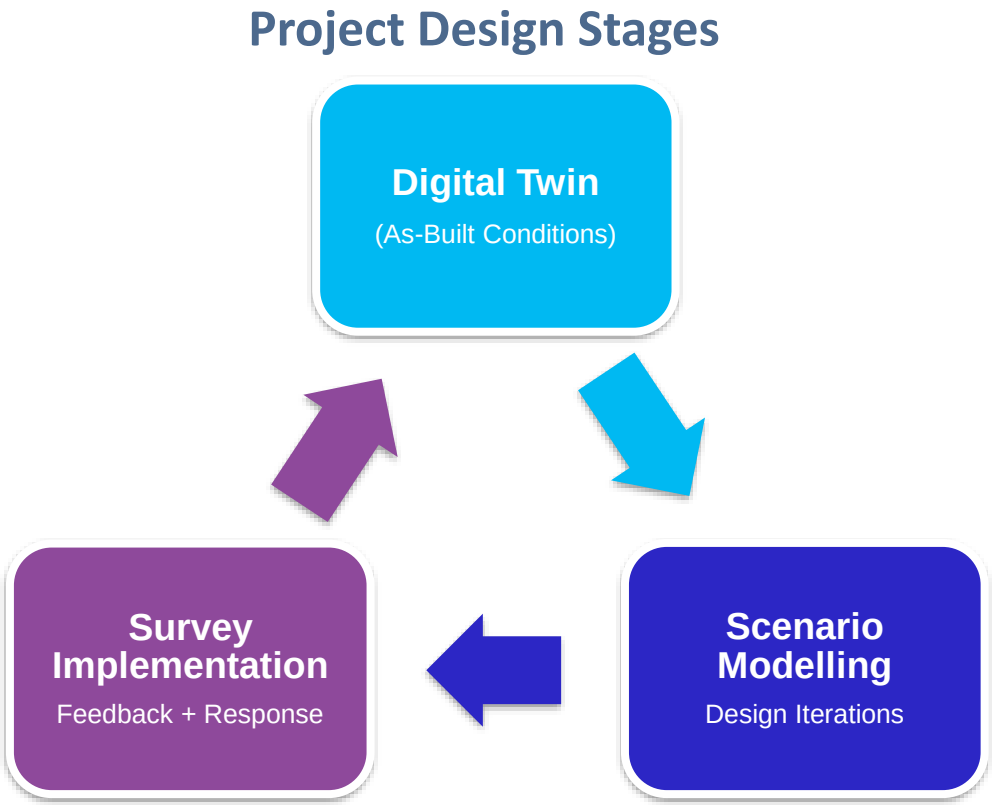
A dashboard environment to:

- Visualize
- Quantify
- Assess
- Provide guidelines



iCity Project Collaboration

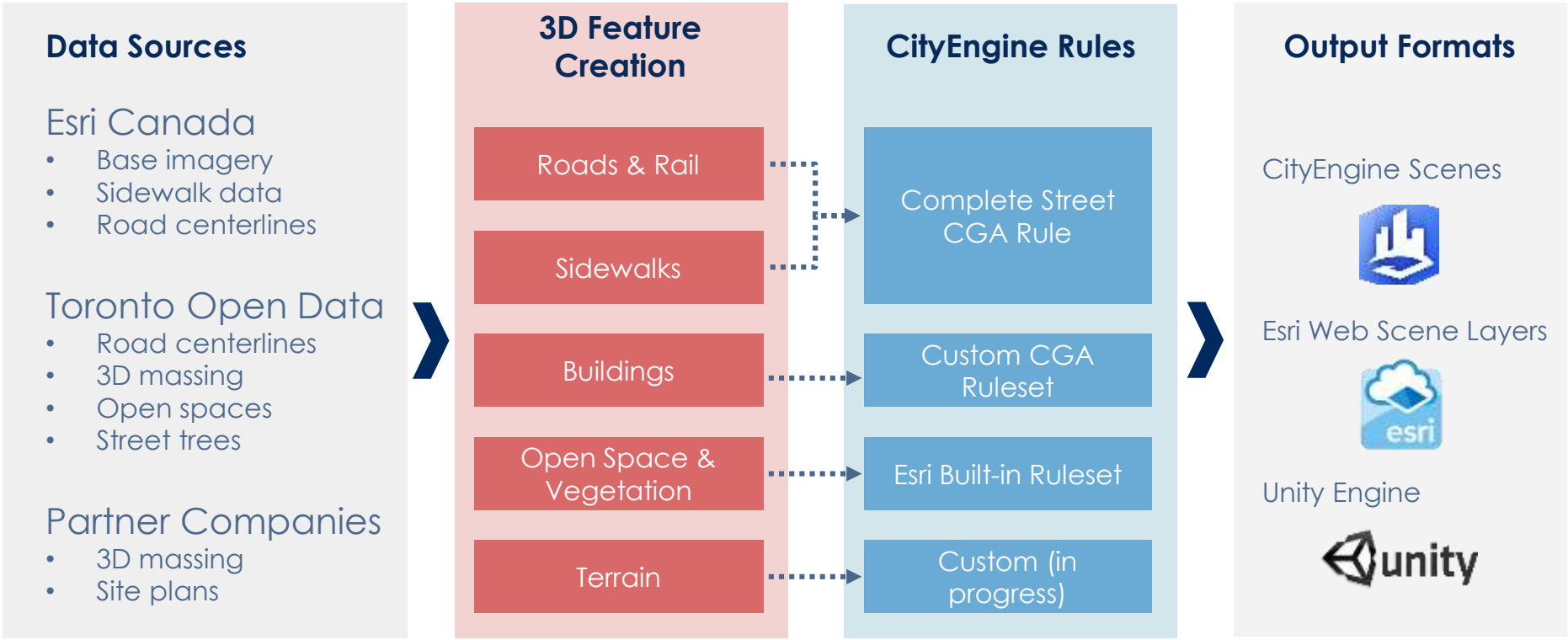
- esri Canada is acting as an industry partner and providing research contribution and consultation



Creating a “Digital Twin” of Toronto

- A “digital twin” is a digital replica of physical assets, processes and systems. A digital twin acts as a test-bed for new ideas, where we can run simulations and consider improved, and even radial scenarios without actually impacting the physical world

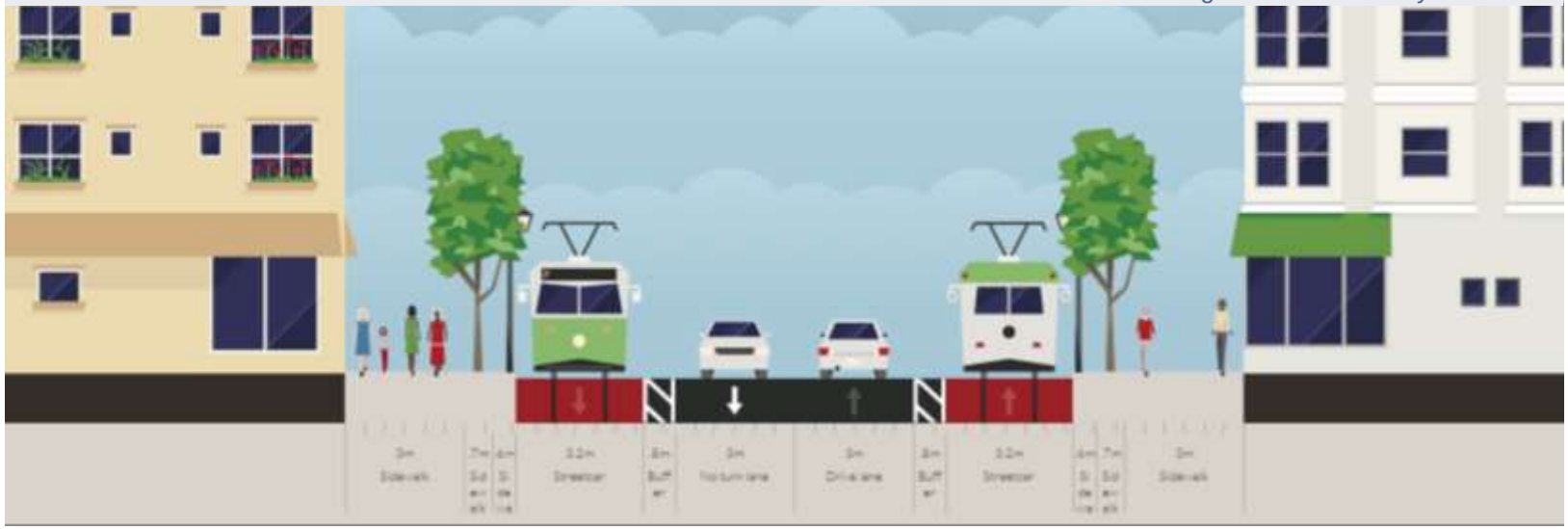
3D Visualization Workflow



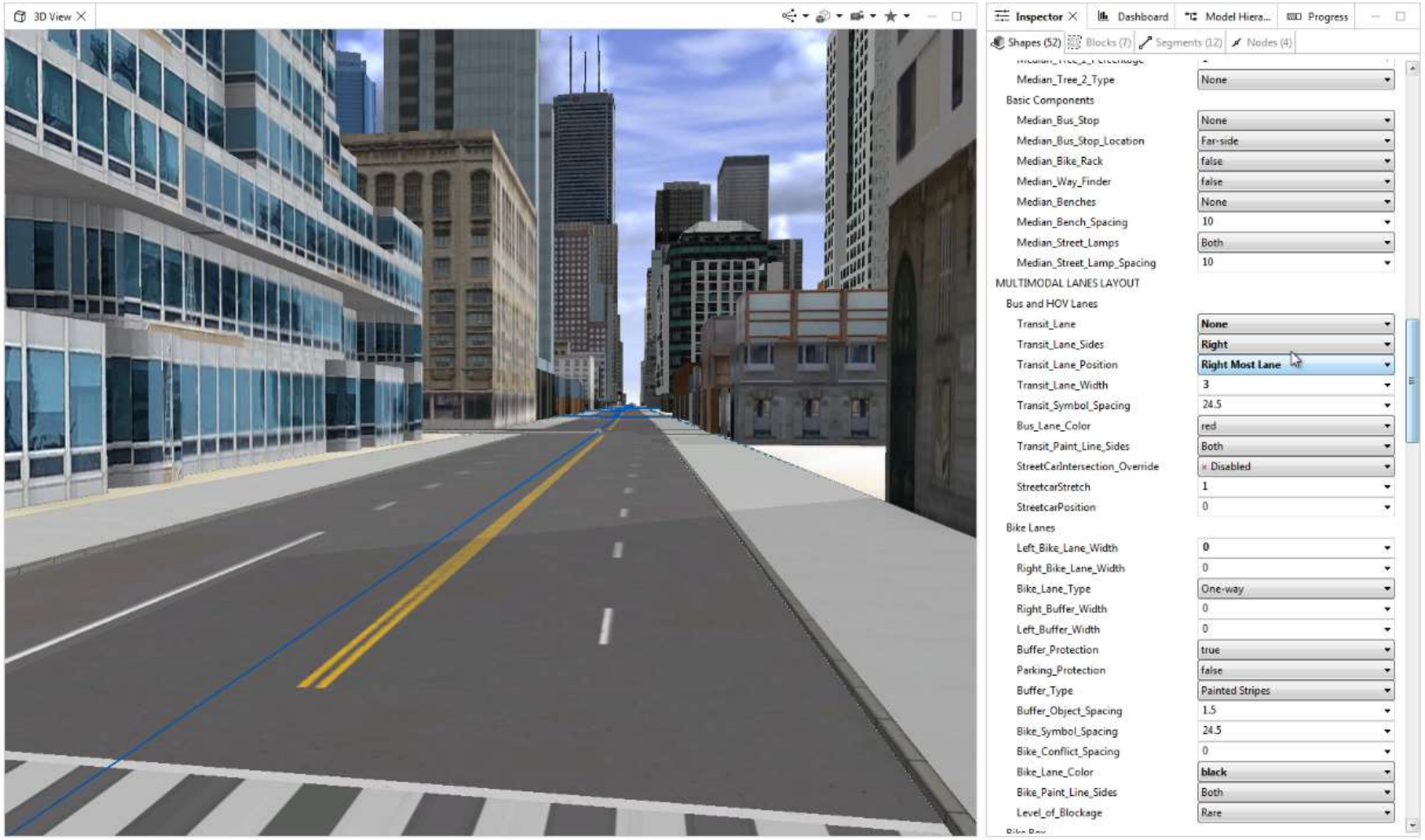
Toronto’s Digital Twin

Complete Street Parameters

Scenario #	Through Lane	Curb Lane	Sidewalk
King Street			
1	transit+car+car+transit	none	medium edge+wide clearway
2	car+car	cycle path+on street parking	medium edge+normal clearway
3	car+car	cycle path_one way	narrow edge+normal clearway+outdoor dining
4	transit+transit	cycle path_one way	medium edge+wide clearway
5	car+car	cycle path_two way	outdoor dining+normal clearway
6	car+car+car+car	none	medium edge+normal clearway



Complete Street Modelling in CityEngine



Scenario Models in CityEngine

Street Animations – Unity

Complete Street Survey Implementation

Scenario 1

Scenario 2

Scenario 3

Thank you!
Questions?