

A User-centred Taxonomy for Urban Transportation Application & Visualization

• The iCity case study

Jeremy Bowes, Sara Diamond, Manpreet Juneja, Marcus Gordon, Carl Skelton, Manik Gunatilleke, Michael Carnevale, Minsheng Davidson Zheng

OCAD University, Toronto, Canada





At the Visual Analytics Lab for the iCity project we are developing decision support tools combining social media and mobile data with GIS, demographic, socio-economic and transit data

What is a taxonomy?

A Taxonomy defines the **'laws of arrangement and division'**, a systematic arrangement of objects or concepts showing the relations between them.

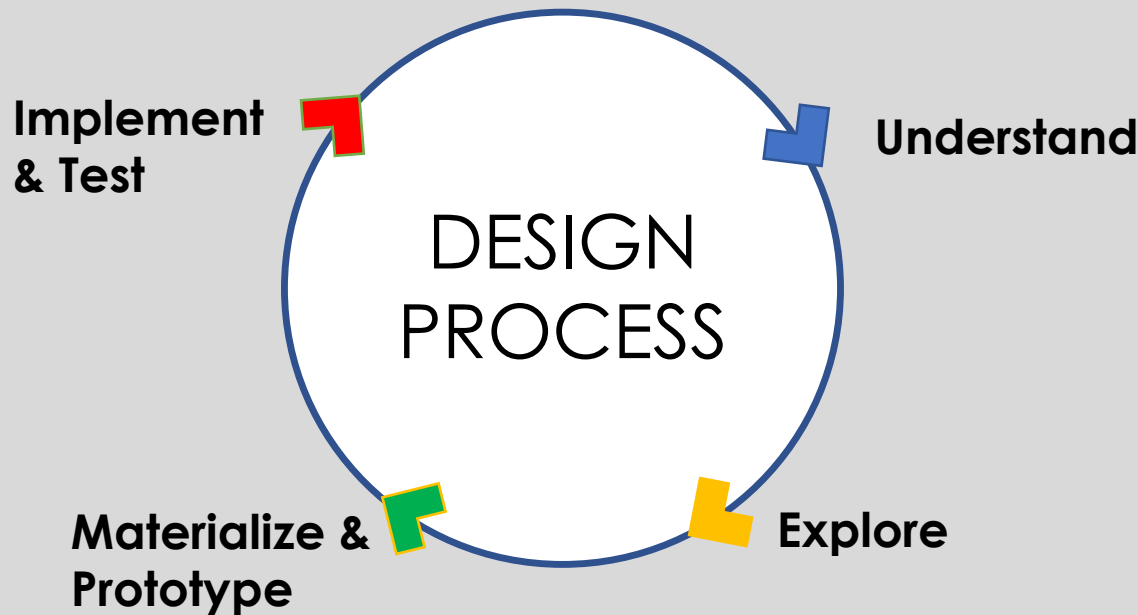


Example: The system of arrangement of books in a library

A taxonomy provides researchers with a common language with which to categorize and review existing systems, classify new ones and address gaps towards further development.

(Price, et al., 1993).

Research approach & process



- Literature Review / taxonomy
- Comparative Methodology in Urban Transportation software applications, tools and methods
- Expert Interviews

Comparative Methodology of Applications & Toolsets

What are the **applications and toolsets** currently being used to serve groups of urban users and designers in the urban design and transportation areas?

How could this information be used to create a **user-centred taxonomy** to support urban transport design and decision making?

Comparative Methodology of Applications & Toolsets

- *survey of the application landscape to understand the types of software, and toolsets that exist and the functions already being served.*

Use Domains: Software Application Categories

User Stories & Narratives

Navigation, Route Mapping, User Generated Data, , Social Media Use

Urban Design & Built Environment

Neighborhood Planning, Complete Streets

Land Use

Agent-based Micro-simulation

Transportation

Traffic Movement, Parking Management

Entertainment & Games

Interactive & Location Based Games, Mixed Reality

Mapping

Cartography, Geo-Visualization

Data Analysis

Intelligent Predictive Analysis, Simulation

Infrastructure Management

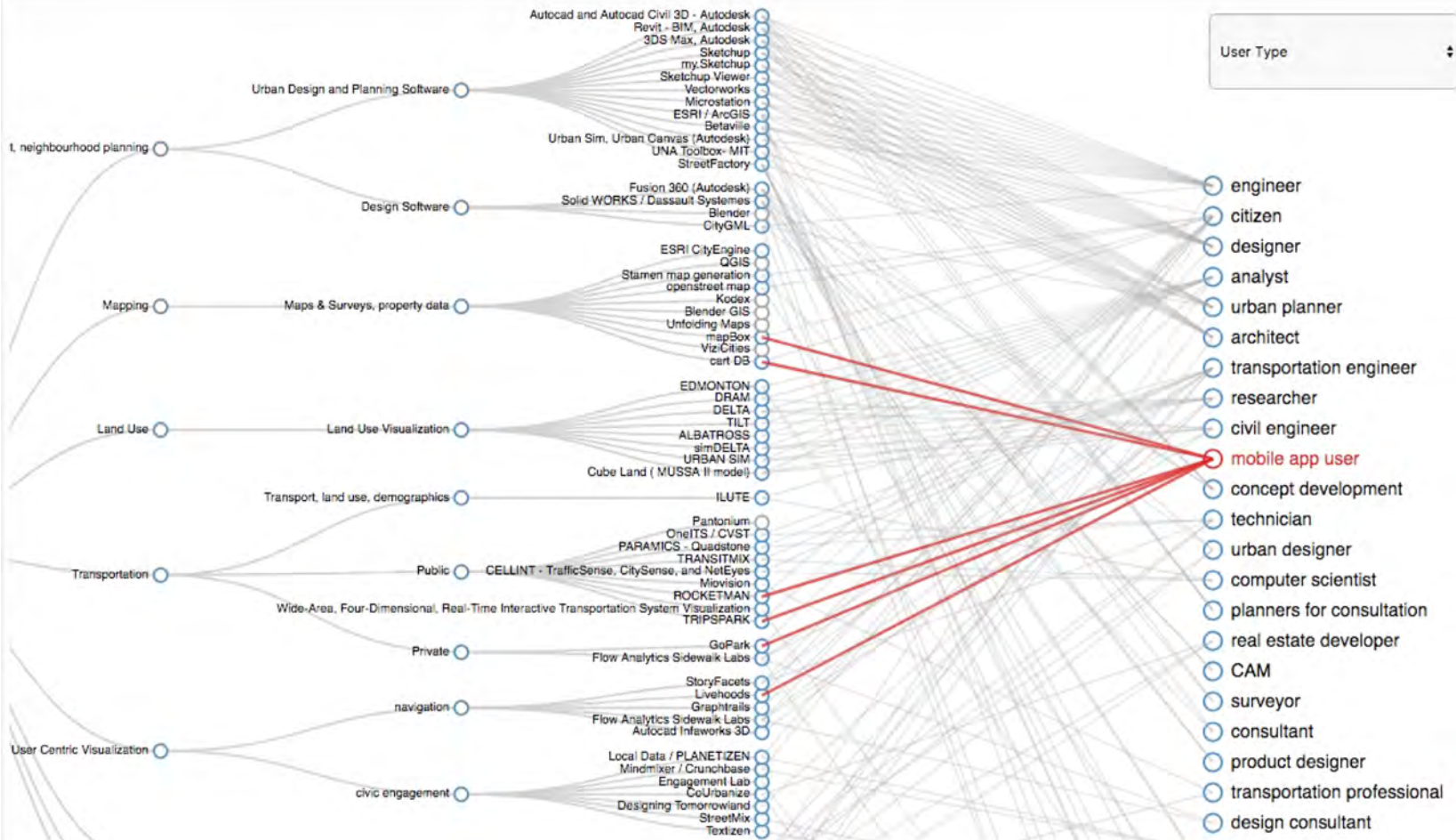
Signal & Transit Operations, Sustainability, Resilient Cities

Comparative Methodology Categories of Table

Comparative Analysis of Software

Type of Urban System Applica-	Software	Technology /	Description / application	User Type	Tasks (High Level)	Engagement Level	Interaction (Low lev-	Data Visualization	Data Attributes
Selected Toolset / Methods									
Built environment, geodata, multi-player urban planning.	Betaville	HTML / WebGL Three.js, Postgres and Post GIS	An open-source multiplayer environment for real cities, in which ideas for new works of public art, architecture, urban design, and development can be shared, discussed, tweaked, and brought	designer, planners, architects, technicians, transportation	modelling, navigation, visualization, search / exploration, analysis (geometrical), simulation, comment / query,	expose (viewing), involve (interacting), analyze (finding trends), synthesis (testing hypothesis)	orbit, walk/ fly-through, pan, scroll, zoom, filter, pivot, linking, select, annotate, transform	3D Bar charts, 3D Pie chart, 3D scatter plot, geo-data	nominal, ordinal, text, geo-spatial, periodic, dynamic, geometry
Qualitative and quantitative Data Exploration and analysis and presentation Tool	StoryFacets	HTML, Javascript, D3 framework, Meteor, MongoDB	Explore data through interaction, visual history, presentation, generate consumable overviews, high level-search /browser, visualization dashboard, visualization slide shows,	technicians, transportation engineers, citizens, Business analysts	dataset/media asset navigation, dataset visualization, dataset history and analysis history visualization, decision	expose (consuming, learning and viewing) involve (interacting), analyze (finding trends)	zooming inset, brushing and linking, scrolling, panning, filter, pivot, compare	bar chart, pie chart, gather plot, markup language	categorical, ordinal, interval, provenance, audio, video, text, image
Transport, land use, demographics	ILUTE (configuration XTME, ILUTE is a plugin (model)	.NET, XTME	Agent (person, business)-based micro-simulation multiyears (over the course of year, scenario)	Planners, Researchers	Land use scenario forecasting (yearly currently) (aim is to continuous simulation for multi years)	Planner: Interact , test hypothesis Re-searcher: model development or submodel development.	drag and drop, node-based processing	(binary matrix) binary format (mtx files, Excel (tabular data), csv data	relationships, all facets, census+transportationnetwork+(information about business characteristics, formological: based on model for e.g. marriage rate, birth rate, etc)

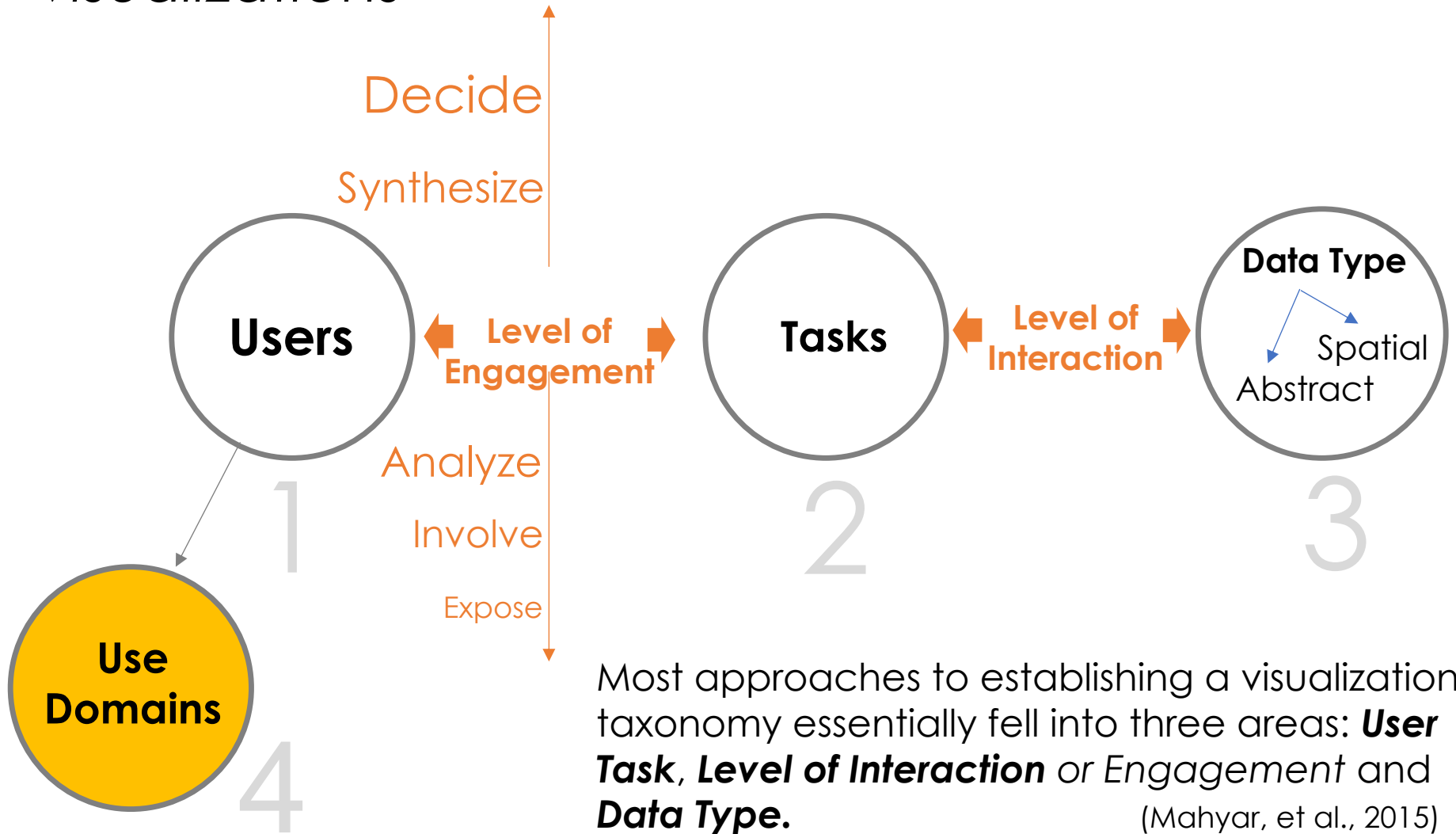
This survey aided in aggregating **User Types**, **Use Domains**, **User Tasks**, and the **type of Data** being used for Urban Transportation applications, and we recorded the information into a large spreadsheet database.



“Compara”

The VAL research assistants Marcus Gordon, Davidson Zheng and Michael Carnevale, created a first iteration of a web based prototype. This allowed for the dataset modelled from the master spreadsheet, to be explored interactively.

Taxonomy Sketch showing essential aspects of visualizations



Research approach & process



Explore

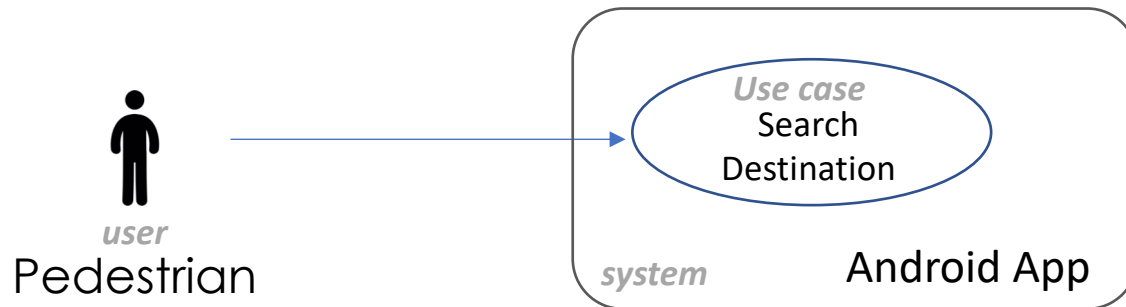
- Use Case Survey
- Use Case Mapping
- Design Charrette, Priority identification / mapping

*Thus, the challenge is to ensure diverse groups of users have **appropriate levels of accessibility** to data in usable forms, which in turn requires understanding the **visualization needs** of multiple user groups.*

A well-developed taxonomy of visualization types can help designers understand which visualization techniques (or combinations of them) best serve the goals and needs of user and stakeholder groups (Chengzhi, 2013).

Use case surveying

A use case is a **series of related interactions between a user** (or more generally, an “actor”) **and a system** that enables the user to achieve a goal.



Example: A Pedestrian searching a destination

Whether experts or casual users, different user groups can have varied information-seeking motivations and objectives, and desire **diverse representations** of urban data.

Use Case survey

User Type

Gender, Age, Nationality,
Occupation

Application Scenario

Description of Tasks

Preconditions

Technology

Software, Environments and
Frameworks

Assets

Formats, Functions

Task interaction

How are you using this software/
tool?

Data Visualization

What is the visualization functionality
of this software/ tool?

Improvements

How could the software/ tool be
changed to support the required
tasks?

URBAN INFORMATICS USE CASE PROFILE		Case Number: C3
		Date: January 30th, 2017
User Type	Gender: Male Age: 56 Nationality: Canadian Occupation: Architectural technician	
Laz is a senior architectural technician working for city planning His area of expertise is reviewing rezoning applications and new development projects		
Application Scenario	Laz is processing an application for a building rezoning in the new West Don neighbourhood The applicants have not provided any parking statistical information, and Laz needs to ascertain whether the existing street, and lot spaces will be overburdened by new users if the project proceeds He must perform Quantitative Data Exploration and Analysis of existing parking resources, land use, and demographics, to evaluate current and proposed parking space inventory against policy/regulations, as documented in the city's geodata/survey and 3D model resources He needs to provide two documents of his findings <ul style="list-style-type: none">• an explanatory presentation (slide show) for an upcoming community meeting,• a formal record of the application's parking implications, context, applicable regulations• recommended ruling based on the above items	
Description of Tasks	Exploration of geodata & 3D model of existing conditions, record of parking inventory in defined area, calculation of requirements with/without proposed changes, export of tabular data and graphics, preparation of formal document and slide presentation for ruling recommendation decision support/justification/communication with decision-makers and stakeholders	
Preconditions	Knowledge of local study area, accessibility to platform, understanding of interface & functionality, availability of peak parking data, both on-street and private etc	
Technology	Software ArcGIS, CityEngine, Insights	
	Environments & Frameworks html5, WebGL, Javascript	
Assets	Formats online SHP, CSV, XLS, JSON, dwg, dmg files	
	Functions 3d Bar charts, Geo-Data, Bar chart, interactive digital maps with on/off information layer switching, call-out boxes	
Task Interaction	How are you using this software / tool?	
	Orbit, Walk/ fly-through, pan, scroll, zoom, select, annotate, measure, (annotate measurement?), zooming inset, scrolling, panning, compare, microsimulation etc	
Data Visualization	What is the visualization functionality of this software / tool?	
	Uses technological interface to visualize street segment, with displayed data of parking information per location as statistical comparison Capture of generated scenario data in a form for presentation Access of demographic community data to project potential local patrons to future establishments Interface to select, analysis, and prepare a visual summary of queried data on parking locations	
Improvements	How could the software / tool be changed to support the required tasks?	
	Real-time 3D infographics superimposed, 2D map, highlighted statistical charts, prep of visual narrative	



Image: Use Case Surveys, iCity process phases, Manpreet Juneja, Carl Skelton, Jeremy Bowes

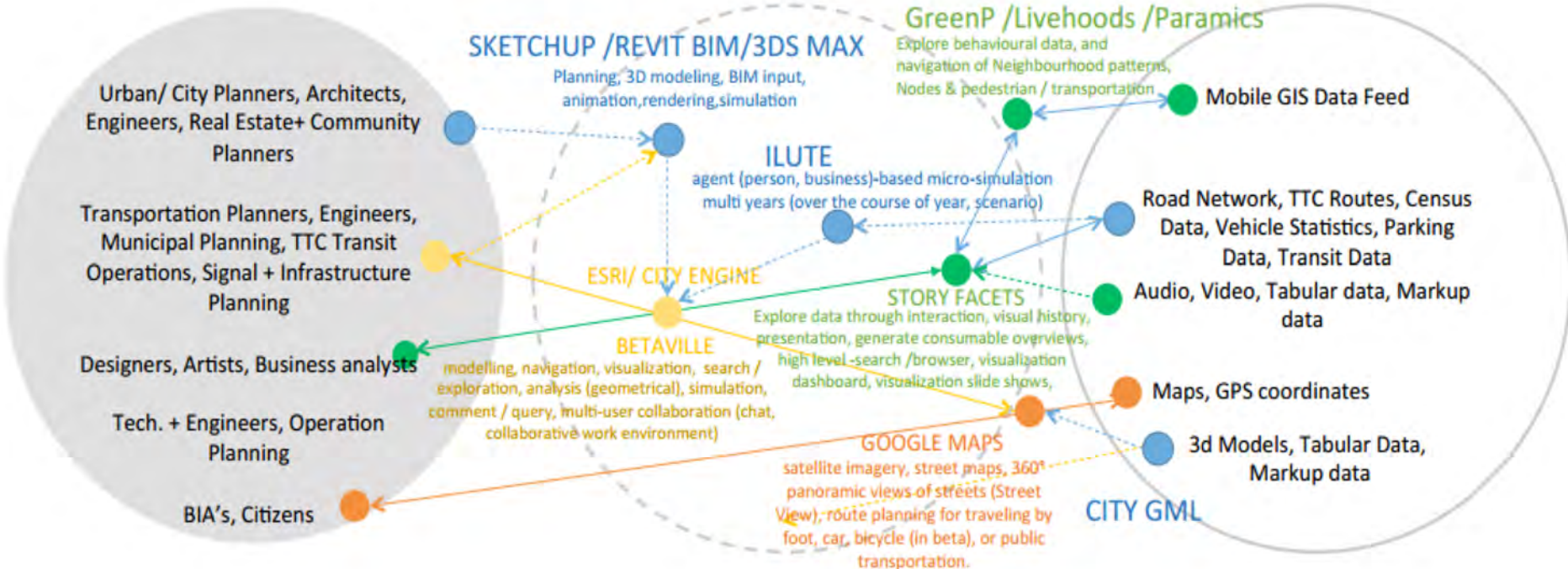
Use Case Mapping

Selected Integrated Use Domain Example

USERS

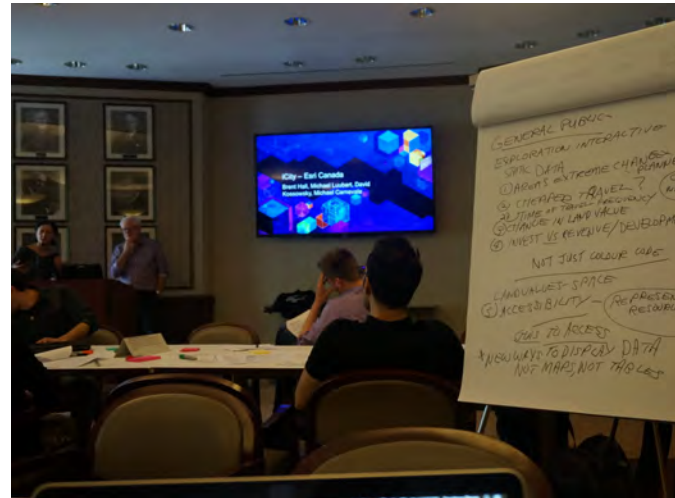
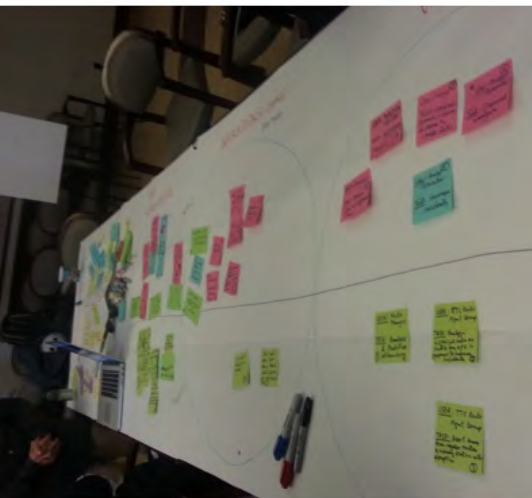
TASKS

DATA



Design Charrette

Test and Refine Taxonomy Sketch Concepts and to Establish priorities to build interface prototypes



Research approach & process



- User-Centred Taxonomy for Urban Transportation Applications
- Template prototype

**Materialize
and
prototype**

- *Design a taxonomy prototype that qualifies **types of users, use domains** and detailed context of use, integrates **user engagement goals** with the essential components of visualization, and highlights the **end user** and their **intended interactions with the visualization.***

User-centred Taxonomy for Urban Transportation application visualization

User engagement goals

Use Domains	Context for User Engagement	
	Engagements	Tasks
Traffic Transit Roadways Design Cartography Operations Urban Design Urban Planning Policy and Regulation Land Use Services Maintenance Capital Planning	(High Level Engagement)	
Users	Decide (Deriving decisions)	share, distribute, publish
	Synthesize (Testing hypothesis)	derive, simulate,
	Analyze (Finding Trends)	explore, compare, encode, infer, survey, etc.
	Author (Adding content)	comment, query, upload
	Involve (Interacting)	navigation, way finding, search, locate, games, etc
	Expose (viewing)	information display
	(Low Level Engagement)	

Visualization components

Data Type		
Abstract (a) / Spatial (s) (Input<--> Output)		
a<-->s a<-->a s<-->a s<-->s		
Data (Da/Ds)	Visual (Va/Vs)	Navigation (Na/Ns)
Da<-->Ds Da<-->Da	Va<-->Ds Va<-->Da	Na<-->Ds Na<-->Da
Ds<-->Da Ds<-->Ds	Vs<-->Da Vs<-->Ds	Ns<-->Da Ns<-->Ds
Da<-->Vs Da<-->Va	Va<-->Vs Va<-->Va	Na<-->Vs Na<-->Va
Ds<-->Va Ds<-->Vs	Vs<-->Va Vs<-->Vs	Ns<-->Va Ns<-->Vs
Da<-->Ns Da<-->Na	Va<-->Ns Va<-->Na	Na<-->Ns Na<-->Na
Ds<-->Na Ds<-->Ns	Vs<-->Na Vs<-->Ns	Ns<-->Na Ns<-->Ns
Context for Interactive Controls in Visualizations		
(High Level)		
Representation Intent	Interaction Intent	
Depict, Differentiate, Identify, Show outliers, Compare	Select, Explore, Reconfigure, Encode, Elaborate, Filter, Connect, Simulation, Authoring, Modelling	
Representation Technique	Interaction Technique	
Charts, Graphs, Networks, Treemaps, Parallel Coordinates	Selection, Brushing, Dynamic query, Pan/ Zoom,.....	
(Low Level)		



Testing the Taxonomy template

Use Case – the **architectural technician**

This use case from our user group research depicts the technician working on the review of a rezoning proposition for a new building. Two main tasks occupy this technician's work on such a project:

- (1) the exploration of datasets, and
 - (2) analysis of land use, parking resources, and demographics.
- Using our template taxonomy chart, we can first classify our user engagement goals with the **technician as user** and **urban planning as use domain**.

Use Domains	Traffic Transit Roadways Design Cartography Operations Urban Design	Urban Planning	Policy and Regulation Land Use Services Maintenance Capital Planning
--------------------	---	-----------------------	---

Use Domain of the Architectural Technician tasks

Use Case – the **architectural technician**

- technician is required to perform **quantitative data exploration and analysis** in order to determine if the building application in question would create any issues with parking lot spaces being overwhelmed by new users.
- the taxonomy's **user engagement** context would classify this **technicians' activity as analysis** and the **finding of trends**, (to unravel the patterns that will help the technician to generate decision support data for synthesis.)

Context for User Engagement	
Engagements	Tasks
(High Level Engagement)	
Decide (Deriving decisions)	share, distribute, publish
Synthesize (Testing hypothesis)	derive, simulate,
Analyze (Finding Trends)	explore, compare, encode, infer, survey, etc.
Author (Adding content)	comment, query, upload
Involve (Interacting)	navigation, way finding, search, locate, games, etc
Expose (viewing)	information display
(Low Level Engagement)	

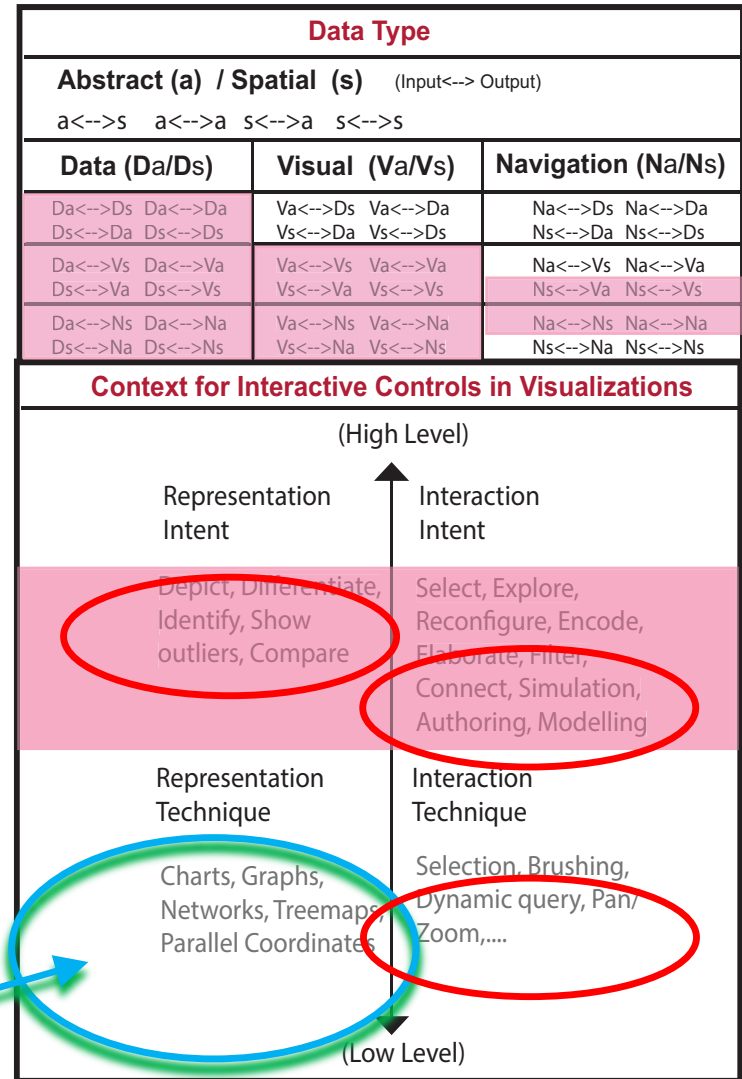
Architectural technician's User Engagement

Use Case – the **architectural technician**

- The technician's work in this use case involves **geospatial data**, (GIS) web, and graphic frameworks, making use of (a) abstract and (b) spatial data types.
- in this example, these include sheets, tables, maps and charts - both as input source & output target domains.
- quantitative data sets of a neighborhood population, can be displayed as a table of data or a 3D geospatial plot to compare or simulate*

Suggested Visual representation options are added here

Visualization Components



Use Case Example's Interaction Model

USER CENTRED TAXONOMY

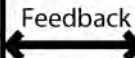
Use Case – the architectural technician

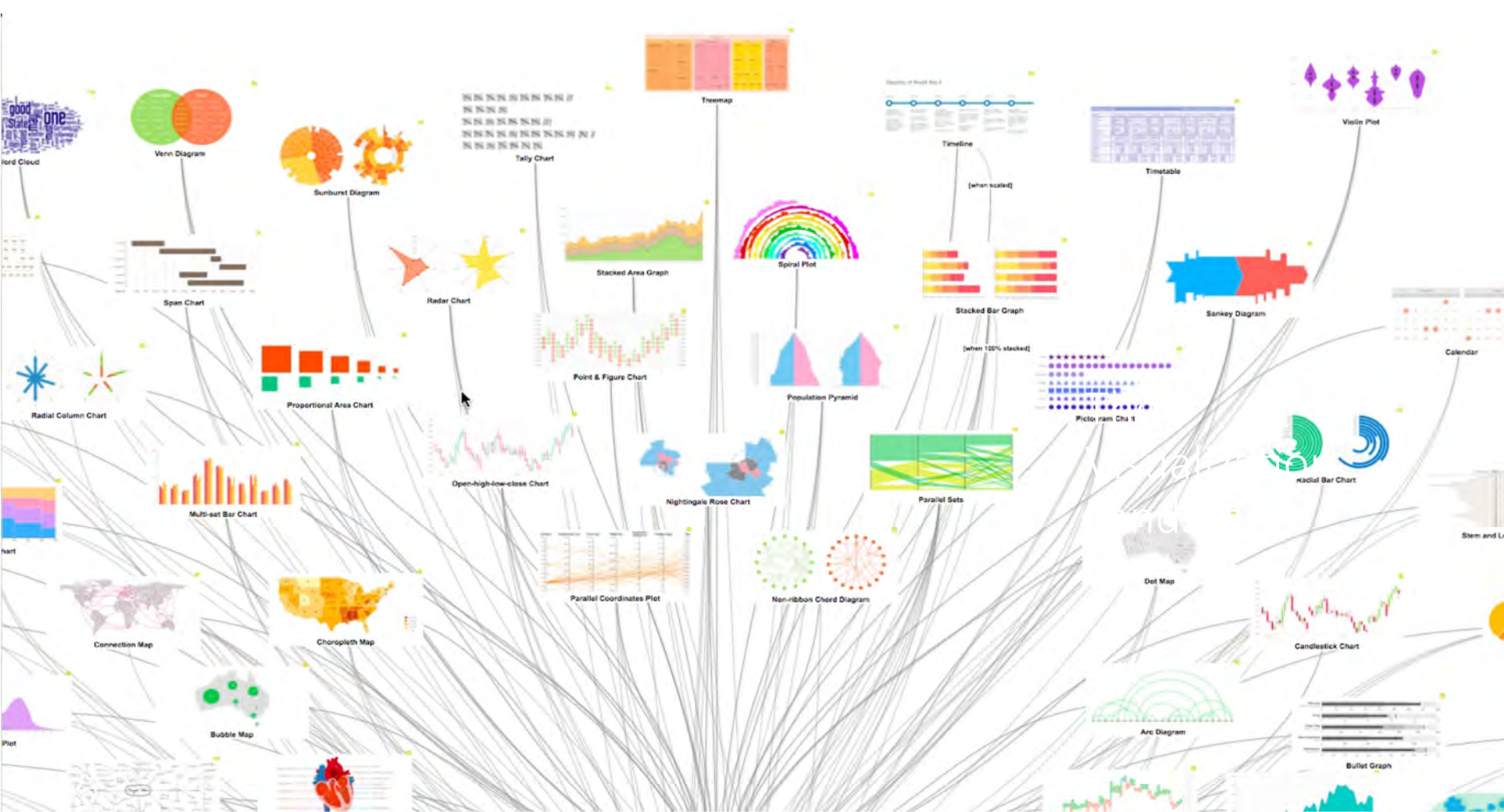
User Engagement Goals

Use Domains	Traffic Transit Roadways Design Cartography Operations Urban Design Urban Planning Policy and Regulation Land Use Services Maintenance Capital Planning	
	Context for User Engagement	
Users	Engagements	Tasks
	(High Level Engagement)	
Researcher Hardware/ Software vendor Designer, Planner, Operator Decision-maker/ proponent Politician Real-estate -developer Advocate City staff Surveyor Statistician Engineer Business user Citizen/resident Home-owner Tenant Guest/tourist Driver Pedestrian Cyclist	Decide (Deriving decisions)	share, distribute, publish
	Synthesize (Testing hypothesis)	derive, simulate ,
	Analyze (Finding Trends)	explore, compare, encode, infer, survey, etc.
	Author (Adding content)	comment, query, upload
	Involve (Interacting)	navigation, way finding, search, locate, games etc.
	Expose (viewing)	information display
(Low Level Engagement)		

Visualization Components

Data Type		
Abstract (a) / Spatial (s) (Input<-> Output)		
a<->s a<->a s<->a s<->s		
Data (Da/Ds)	Visual (Va/Vs)	Navigation (Na/Ns)
Da<->Ds Da<->Da Ds<->Da Ds<->Ds	Va<->Ds Va<->Da Vs<->Da Vs<->Ds	Na<->Ds Na<->Da Ns<->Da Ns<->Ds
Da<->Vs Da<->Va Ds<->Va Ds<->Vs	Va<->Vs Va<->Va Vs<->Va Vs<->Vs	Na<->Vs Na<->Va Ns<->Va Ns<->Vs
Da<->Ns Da<->Na Ds<->Na Ds<->Ns	Va<->Ns Va<->Na Vs<->Na Vs<->Ns	Na<->Ns Na<->Na Ns<->Na Ns<->Ns
Context for Interactive Controls in Visualizations		
(High Level)		
Representation Intent	Interaction Intent	
Depict, Differentiate, Identify, Show outliers, Compare	Select, Explore, Reconfigure, Encode, Elaborate, Filter, Connect, Simulation, Authoring, Modelling	
Representation Technique	Interaction Technique	
Charts, Graphs, Maps, Networks, Tables, Treemaps, Parallel Coordinates	Selection, Brushing, Dynamic query, Pan/ Zoom,....	
(Low Level)		





The visualization landscape project (VIZLAND)

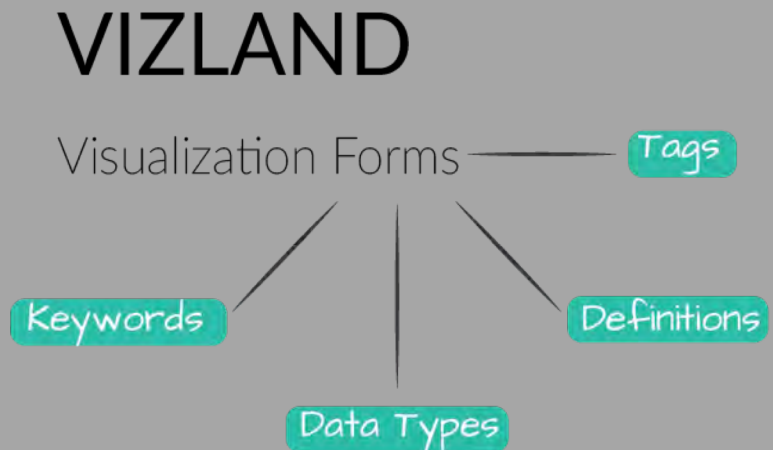
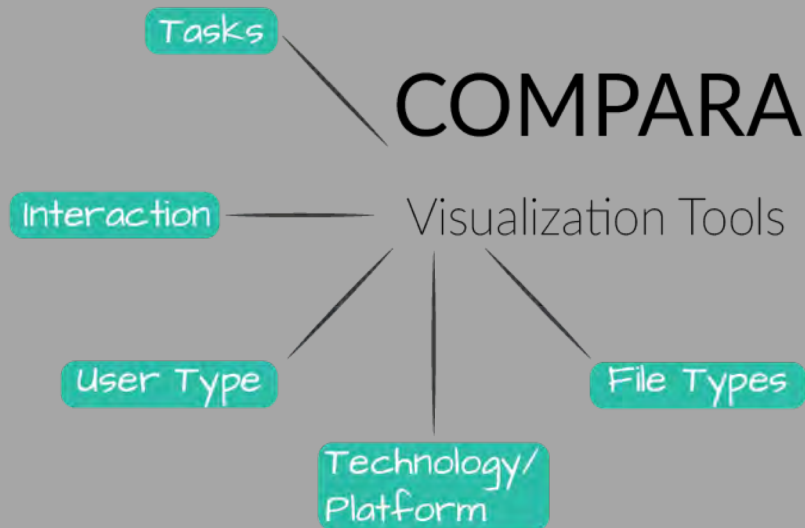
The ability to query keywords associated to these visualizations is to give the user quick access to matching keywords that relate to the visuals. This is done by the user typically matching functions that are prominent in selected visualizations.

Next steps: Research process



Implement to dashboard

- Creating the dashboard prototype
- COMPARA derives intelligence on toolsets and software that are mapped to their respective User Group and Domain specifications.
- VIZLAND (the Visualization LANDscape) provides the optimum representation techniques most suited for a particular use case.



USER CENTRED TAXONOMY FOR URBAN TRANSPORTATION APPLICATIONS

User engagement goals

Use Domains	Traffic Transit Roadways Design Cartography Operations Urban Design Urban Planning Policy and Regulation Land Use Services Maintenance Capital Planning	
Users	Context for User Engagement	
	Engagements	Tasks
Researcher Hardware/ Software vendor Designer, Planner, Operator Decision-maker/ proponent Politician Real-estate -developer Advocate City staff Surveyor Statistician Engineer Business user Citizen/resident Home-owner Tenant Guest/tourist Driver Pedestrian Cyclist	(High Level Engagement)	
	Decide (Deriving decisions)	share, distribute, publish
	Synthesize (Testing hypothesis)	derive, simulate,
	Analyze (Finding Trends)	explore, compare, encode, infer, survey, etc.
	Author (Adding content)	comment, query, upload
	Involve (Interacting)	navigation, way finding, search, locate, games, etc
Expose (viewing)	information display	
(Low Level Engagement)		

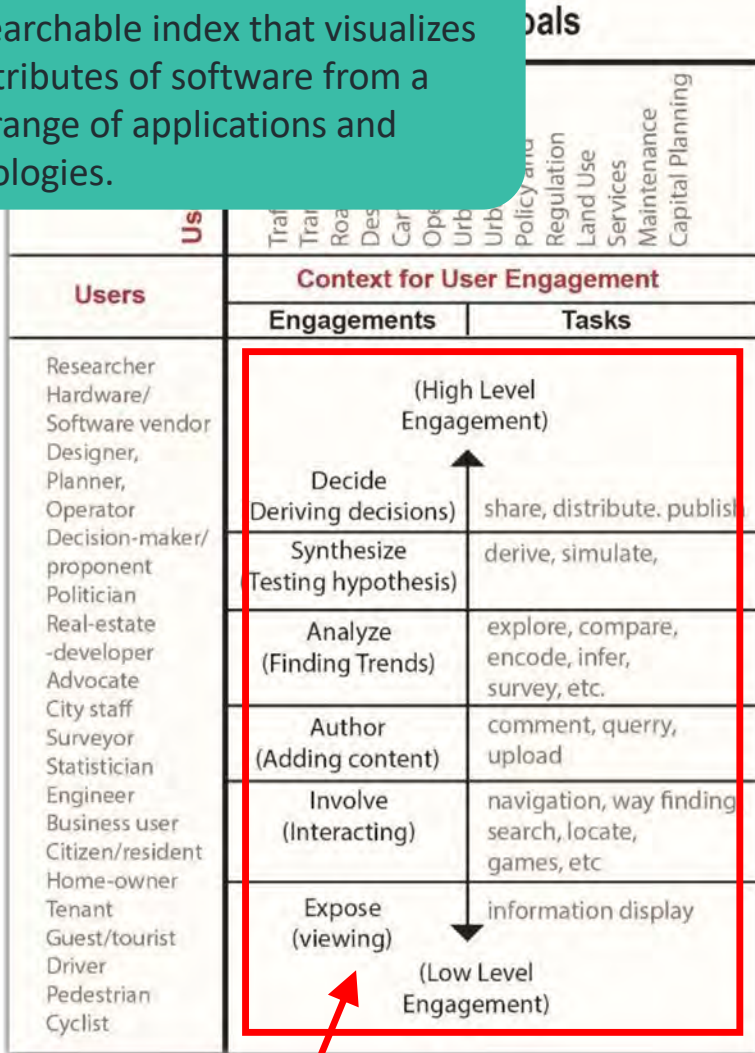
Visualization components

Data Type				
Abstract (a) / Spatial (s) (Input<-> Output) a<->s a<->a s<->a s<->s				
Data (Da/Ds)		Visual (Va/Vs)		Navigation (Na/Ns)
Da<->Ds	Da<->Da	Va<->Ds	Va<->Da	Na<->Ds
Ds<->Da	Ds<->Ds	Vs<->Da	Vs<->Ds	Ns<->Da
Da<->Vs	Da<->Va	Va<->Vs	Va<->Va	Na<->Vs
Ds<->Va	Ds<->Vs	Vs<->Va	Vs<->Vs	Ns<->Va
Da<->Ns	Da<->Na	Va<->Ns	Va<->Na	Na<->Ns
Ds<->Na	Ds<->Ns	Vs<->Na	Vs<->Ns	Ns<->Na
Context for Interactive Controls in Visualizations				
(High Level)				
Representation Intent		Interaction Intent		
Depict, Differentiate, Identify, Show outliers, Compare		Select, Explore, Reconfigure, Encode, Elaborate, Filter, Connect, Simulation, Authoring, Modelling		
Representation Technique		Interaction Technique		
Charts, Graphs, Networks, Treemaps, Parallel Coordinates		Selection, Brushing, Dynamic query, Pan/ Zoom,....		
(Low Level)				



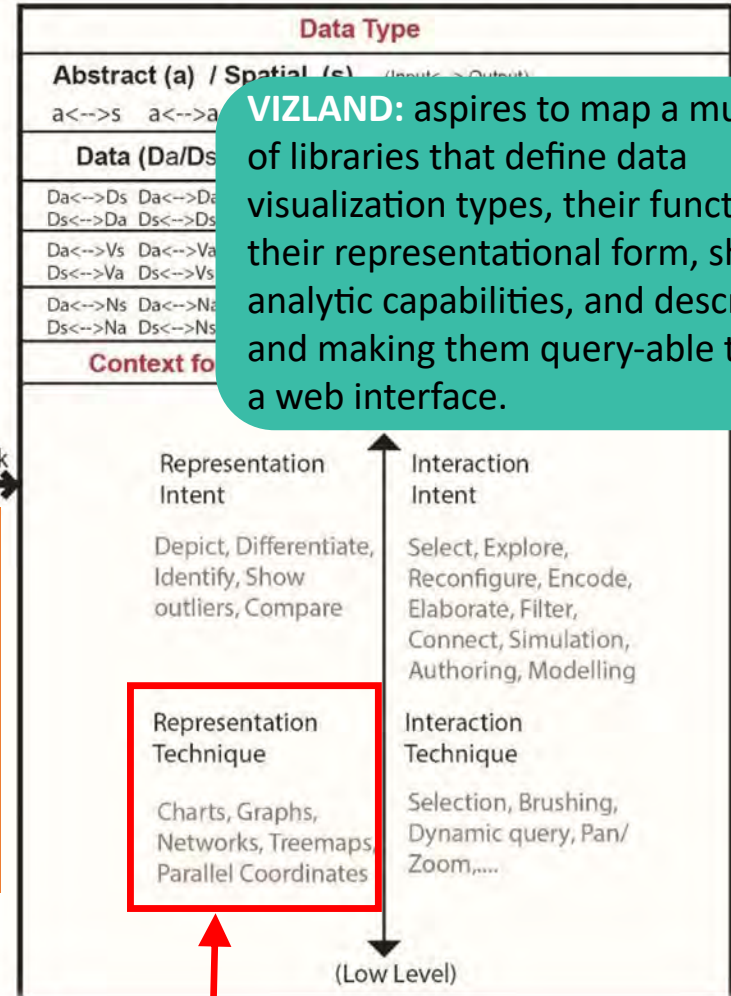
USER CENTRED TAXONOMY FOR URBAN TRANSPORTATION APPLICATIONS

COMPARA: an intuitive interactive and searchable index that visualizes the attributes of software from a wide-range of applications and technologies.



COMPARA

Visualization components



VIZLAND: aspires to map a multitude of libraries that define data visualization types, their functions, their representational form, shapes, analytic capabilities, and descriptions, and making them query-able through a web interface.

VIZLAND



RESEARCH PATHWAY



Drawing from both Ontology & Taxonomy studies in iCity, the Dashboard will incorporate elements that produces the most viable visualization recommendation for applications hosted within the platform.

WHY DASHBOARDS? - Contributions



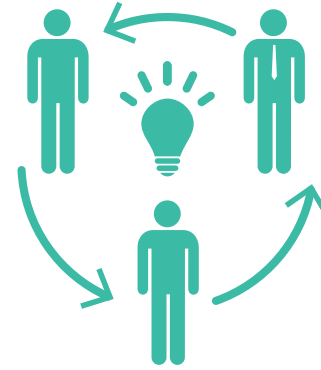
Engagement

Allows for Civic Engagement in the context of the City and its many affordances.



Statistics

The City stats creates rationale as well as proves plans for functional urban planning & management

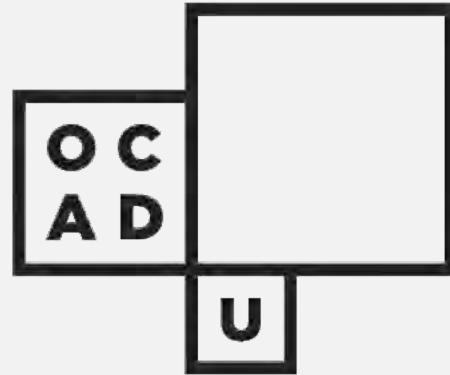


Planning & decision support

Urban Planning based on insights that are crowd-sourced from residents of the City.

Summarizing

- These findings focused our approach to establishing a visualization taxonomy focused on three areas: **User Task**, **Level of Interaction** or *Engagement* and **Data Type**, and the detailed classification of interactive elements based on user tested needs for **spatial and non-spatial data types** within our research groups.
- The **taxonomy** prototype outlines a key framework to create a series of **interactive dashboards** that provide the integration of these functional user elements to provide visualization support for a variety of users.



Thank you
Questions ?

Professor Jeremy Bowes
Visual Analytics Lab, OCAD University
Jbowes@faculty.ocadu.ca

Implementing the Taxonomy framework into the Dashboard Use Case – the **the traffic operator**

User Engagement goals

Use Domains	Traffic	Transit	Roadways	Design	Cartography	Operations	Urban Design	Urban Planning	Policy and Regulation	Land Use	Services	Maintenance	Capital Planning
	Context for User Engagement												
Users	Engagements						Tasks						
	(High Level Engagements)						(Low Level Engagements)						
Researcher	Decide (Deriving decisions)						share, distribute, publish						
Hardware/ Software vendor													
Designer	Synthesize (Testing hypothesis)						derive, simulate						
Planner													
Operator	Analyze (Finding Trends)						explore, compare, encode, infer, survey, etc.						
Decision-maker/ proponent													
Politician	Author (Adding content)						comment, query, upload						
Real-estate developer													
Advocate	Involve (Interacting)						navigation, way finding, search, locate, games, etc.						
City staff													
Surveyor	Expose (viewing)						information display						
Statistician													
Engineer													
Business user													
Citizen/resident													
Home-owner													
Tenant													
Guest/tourist													
Driver													
Pedestrian													
Cyclist													

Feedback

iCity Ontology

Visualization Components

Data Type		
Abstract (a) / Spatial (s) (Input <--> Output)		
a<-->s a<-->a s<-->a s<-->s		
Data (Da/Ds)	Visual (Va/Vs)	Navigation (Na/Ns)
Da<-->Ds Da<-->Da Ds<-->Da Ds<-->Ds	Va<-->Ds Va<-->Da Vs<-->Da Vs<-->Ds	Na<-->Ds Na<-->Da Ns<-->Da Ns<-->Ds
Da<-->Vs Da<-->Va Ds<-->Va Ds<-->Vs	Va<-->Vs Va<-->Va Vs<-->Va Vs<-->Vs	Na<-->Vs Na<-->Va Ns<-->Va Ns<-->Vs
Da<-->Ns Da<-->Na Ds<-->Na Ds<-->Ns	Va<-->Ns Va<-->Na Vs<-->Na Vs<-->Ns	Na<-->Ns Na<-->Na Ns<-->Na Ns<-->Ns
Context for Interactive Controls in Visualizations		
(High Level)		
Representation Intent	Interaction Intent	
Depict, Differentiate, Identify, Show outliers, Compare	Select, Explore, Reconfigure, Encode, Elaborate, Filter,	
	Connect, Simulation, Authoring, Modelling	
Representation Technique	Interaction Technique	
Charts, Graphs, Networks, Treemaps, Parallel Coordinates	Selection, Brushing, Dynamic query, Pan/ Zoom,....	
(Low Level)		

INPUT

OUTPUT



Presets Date Range


HISTORICAL


LIVE



PREDICTIVE


Events


- May 20 2018 3:48 PM Traffic Data Analysis Custom >
- May 13 2018 10:48 AM Live Data Snapshot Live >
- May 13 2018 3:48 PM Transit Analysis Preset >

Social Media


#TrueNorth18 @tchelps @TTCNotices @TorontoComms @blogTO #torontolife #toro... >


 @CP24 11:58 am
Music video that takes aim at TTC being investigated by police <https://www.cp24.com/news/music-video-that-takes-aim-at-ttc-being-investigated-by-police-1.3950474> ...

 @TTCnotices 11:56 am
We're here to help from 7am-10pm! Tweet questions, comments, complaints and compliments.

12:47 pm 23°C 

Toronto
Tuesday May 22, 2018

09:17 pm 35°C 



Presets User Type Use Domains Date Range From To Apply

User Types

- Advocate
- Business user
- Citizen/resident
- City staff
- Cyclist
- Decision-maker / proponent
- Designer
- Driver
- Engineer
- Guest/tourist

Use Domains

- Traffic
- Transit
- Roadways
- Design
- Cartography
- Operations
- Urban Design
- Urban Planning
- Policy and Regulation
- Land Use
- Services
- Maintenance
- Capital Planning

Users

- Researcher
- Hardware/ Software vendor
- Designer
- Planner
- Operator
- Decision-maker/ proponent
- Politician
- Real-estate developer
- Advocate
- City staff
- Surveyor
- Statistician
- Engineer
- Business user
- Citizen/resident
- Home-owner
- Tenant
- Guest/tourist
- Driver
- Pedestrian
- Cyclist

Context for User Engagement	
Engagements	Tasks
Decide (Deriving decisions)	(High Level Engagements)
	share, distribute, publish
Synthesize (Testing hypothesis)	derive, simulate
Analyze (Finding Trends)	explore, compare, encode, infer, survey, etc.
Author (Adding content)	comment, query, upload
Involve (Interacting)	navigation, way finding, search, locate, games, etc
Expose (viewing)	information display
	(Low Level Engagements)

Image: iCity Dashboard Development; Lee Balki, Jeremy Bowes



Presets Date Range From To

HISTORICAL

Social Media

#TrueNorth18 @ttchelp

CP24 @CP24 Music video the... www.cp24.com gated-by-police

TTCnotices @TTCnotices We're here to f... and complimen

Settings

User Types

Domain

Goals





Decide Synthesize

Analyze Author

Involve Expose

Use Domains	Context for User Engagement	
Users	Engagements	Tasks
Traffic	(High Level Engagements) ↑ Decide (Deriving decisions)	share, distribute, publish
Transit		Synthesize (Testing hypothesis)
Roadways	Analyze (Finding Trends)	explore, compare, encode, infer, survey, etc.
Design	Author (Adding content)	comment, query, upload
Cartography	Involve (Interacting)	navigation, way finding, search, locate, games, etc
Operations	Expose (viewing)	information display
Urban Design	↓ (Low Level Engagements)	
Urban Planning		
Policy and Regulation		
Land Use		
Services		
Maintenance		
Capital Planning		

Image: iCity Dashboard Development; Lee Balki, Jeremy Bowes

Presets Operator  Traffic  Date Range 5-14-18  5-20-18  **Apply**



HISTORICAL





LIVE



PREDICTIVE

Social Media

#TrueNorth18 @ttchelps @TTCNotices @TorontoComms @blogTO #torontolife #toro... >

-  @CP24 11:58 am
Music video that takes aim at TTC being investigated by police <https://www.cp24.com/news/music-video-that-takes-aim-at-ttc-being-investigated-by-police-1.3950474> ...
-  @TTCnotices 11:56 am
We're here to help from 7am-10pm! Tweet questions, comments, complaints and compliments.

< May 2018 >

Su	Mo	Tu	We	Th	Fr	Sa	
29	30	1	2	3	4	5	Today
6	7	8	9	10	11	12	Yesterday
13	14	15	16	17	18	19	Tomorrow
20	21	22	23	24	25	26	Week Month
27	28	29	30	31	1	2	Year Custom

- May 13 2018 10:48 AM Live Data Snapshot *Live* >
- May 13 2018 3:48 PM Transit Analysis *Preset* >

Date Range further specifies data to be filtered.

toronto
Tuesday May 22, 2018

35°C



Presets Driver Traffic Date Range 5-14-18 5-20-18 Apply

Historical Data Applications

Bottleneck Analysis Traffic Congestion Hotspots (Downtown) Hotspots (GTA)

Live Data Applications

Route Calculator Incident Monitor Road Closures Weather Report

Predictive Data Applications



Travel Time Indicator

Preview

! Select application from the left to see Preview


Applications: Preset views of datasets derived from present Use case scenario.

Use Case Scenario: A combination of User Type, Use Domain & Date Range (selected above) along with a range of Engagement Goals & Tasks, based on priority.


Presets Operator ▼ Traffic ▼ Date Range 5-14-18  5-20-18  Apply

 Historical Data Applications

Bottleneck Analysis Traffic Congestion **Hotspots (Density)** Hotspots (Cost)

 Live Data

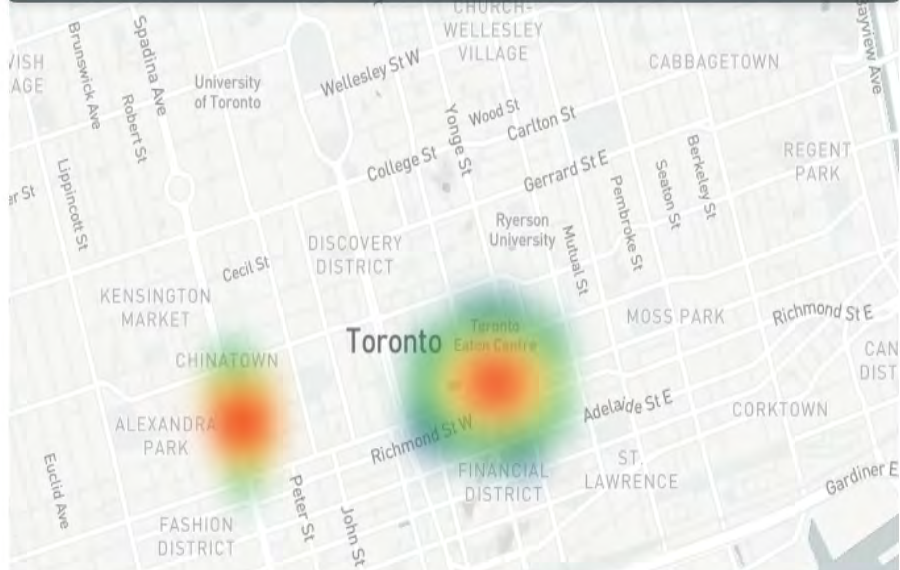
Route Calculator Incident Monitoring

 Predictions

Travel Time Indicator

Data Type		
Abstract (a) / Spatial (s) (Input <--> Output)		
a<-->s a<-->a s<-->a s<-->s		
Data (Da/Ds)	Visual (Va/Vs)	Navigation (Na/Ns)
Da<-->Ds Da<-->Da Ds<-->Da Ds<-->Ds	Va<-->Ds Va<-->Da Vs<-->Da Vs<-->Ds	Na<-->Ds Na<-->Da Ns<-->Da Ns<-->Ds
Da<-->Vs Da<-->Va Ds<-->Va Ds<-->Vs	Va<-->Vs Va<-->Va Vs<-->Va Vs<-->Vs	Na<-->Vs Na<-->Va Ns<-->Va Ns<-->Vs
Da<-->Ns Da<-->Na Ds<-->Na Ds<-->Ns	Va<-->Ns Va<-->Na Vs<-->Na Vs<-->Ns	Na<-->Ns Na<-->Ns Ns<-->Ns Na<-->Ns
Context for Interactive Controls in Visualizations		
	(High Level)	
Representation Intent	↑	Interaction Intent
Depict, Differentiate, Identify, Show outliers, Compare		Select, Explore, Reconfigure, Encode, Elaborate, Filter, Connect, Simulation, Authoring, Modelling
Representation Technique	↓	Interaction Technique
Charts, Graphs, Networks, Treemaps, Parallel Coordinates		Selection, Brushing, Dynamic query, Pan/Zoom,.....
	(Low Level)	

Preview



Preset views make use of the taxonomy framework (VIZLAND component) to choose the representation technique for a given dataset

Presets Operator Traffic Traffic Date Range 5-14-18 5-20-18 Apply

Historical Data Applications

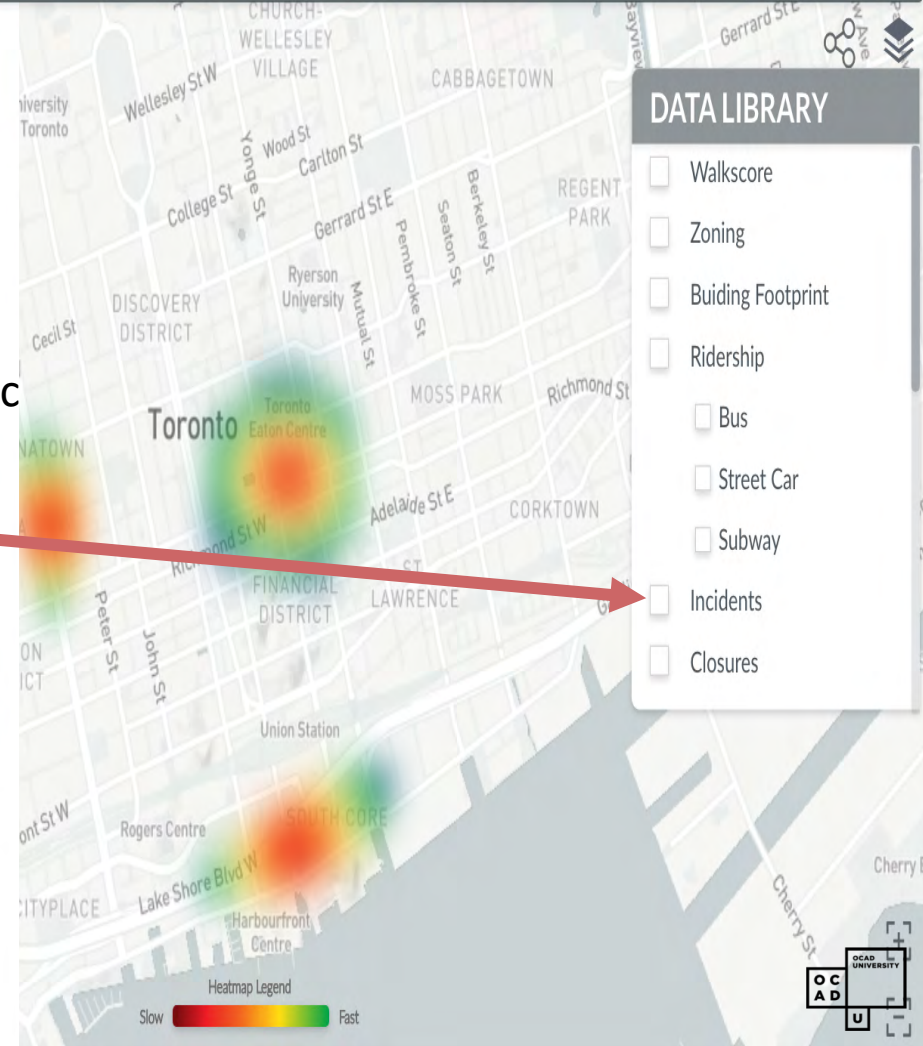
Bottleneck Analysis Traffic Congestion Hotspots Hotspots

Live Data

Route Calculator Incident Monitoring

Predictions

Travel Time Indicator



Data Type		
Abstract (a) / Spatial (s) (Input <--> Output)		
a<-->s a<-->a s<-->a s<-->s		
Data (Da/Ds)	Visual (Va/Vs)	Navigation (Na/Ns)
Da<-->Ds Da<-->Da Ds<-->Da Ds<-->Ds	Va<-->Ds Va<-->Da Vs<-->Da Vs<-->Ds	Na<-->Ds Na<-->Da Ns<-->Da Ns<-->Ds
Da<-->Vs Da<-->Va Ds<-->Va Ds<-->Vs	Va<-->Vs Va<-->Va Vs<-->Va Vs<-->Vs	Na<-->Vs Na<-->Va Ns<-->Va Ns<-->Vs
Da<-->Ns Da<-->Na Ds<-->Na Ds<-->Ns	Va<-->Ns Va<-->Na Vs<-->Na Vs<-->Ns	Na<-->Ns Na<-->Na Ns<-->Ns Ns<-->Na

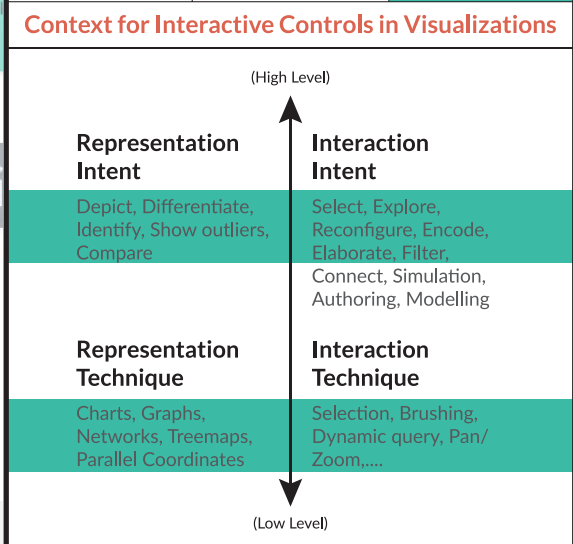
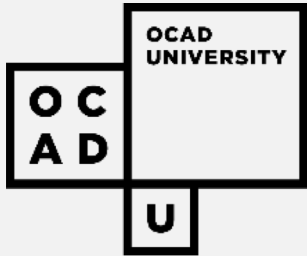


Image: iCity Dashboard Development; Lee Balki, Jeremy Bowes



THANK **Y**OU!

Find out more about research at OCAD U at:

<http://www.ocadu.ca/research>



Acknowledgements

The authors gratefully acknowledge the support of **OCAD University and the Visual Analytics Lab**, Canada Foundation for Innovation, the **Ontario Ministry of Research & Innovation** through the **ORF-RE program** for the iCity Urban Informatics for Sustainable Metropolitan Growth research consortium; **IBM Canada** and **MITACS Elevate** for support of post-doctoral research; **NSERC Canada CreateDAV**, and **Esri Canada** and MITACS for support of graduate graduate internships; Artjem Disterhof at the Media2Culture (M2C) Institut für Angewandte Medienforschung at the University of Applied Sciences of Bremen for development work on the Betaville html5 prototype; the Rockefeller Foundation through its Cultural Innovation Fund; Microsoft Research; the Bundesministerium für Bildung und Forschung; and the department of Informatics of the City University of Applied Sciences, Bremen.

Bibliography

Amar R., Eagan J., Stasko J.: **Low-level components of analytic activity in information visualization**. *IEEE Symp. On Info. Vis.* (2005), 111-117, 2, 3

Bertini E., Kennedy J. and Puppo E., 2015, **Task Taxonomy for Cartograms**, retrieved from https://www2.cs.arizona.edu/~kobourov/cartogram_taxonomy.pdf

Boy J., Detienne F., and Fekete J.D., (2015), **Storytelling in information visualizations: Does it engage users to explore data?** In proceedings of the 33rd ACM conference on Human Factors in Computing systems (CHI 2015), Pages 1449-1458. ACM, 2015.

Brehmer M., Munzner T.: **A multi-level typology of abstract visualization tasks**. *IEEE Transaction on Visualization and Computer Graphics* 19, 12 (2013), 2376-2385. 2, 3

Chengzhi, Q., Chenghu, Z. & Tao, P. (2003), **Taxonomy of Visualization Techniques and Systems—Concerns between Users and Developers are Different**, *Asia GIS Conference 2003*.

Chignell, M. H. (1990). **A taxonomy of user interface terminology**. *ACM SIGCHI Bulletin*, 21(4), 27.

Fishkin, K. P. (2004). **A taxonomy for and analysis of tangible interfaces**. *Personal and Ubiquitous Computing*, 8(5), 347-358.

Mahyar N., S.-H. Kim and B. C. Kwon. (2015), **Towards a Taxonomy for Evaluating User Engagement in Information Visualization**, retrieved from <http://www.vis4me.com/personalvis15/papers/mahyar.pdf>

Pike W.A. et.al. (2009), **The Science of Interaction Information Visualization** - William A. Pike, John Stasko, Remco Chang, Theresa A. O'Connell, 2009. (2017). *Information Visualization*. Retrieved from <http://journals.sagepub.com/doi/abs/10.1057/ivs.2009.22?journalCode=ivia>

Bibliography

Simon, H.A. (1969). *The sciences of Artificial*, MIT Press.

Shneiderman, B. (1996) "The eyes have it: A task by data type taxonomy for information visualization" Proceedings of Australian symposium on information visualization" IEEE Symposium on Visual Language, 336-343.

Shrivathsan, M. (2017). *Use Cases - Definition* (Requirements Management Basics). Pmblog.accompa.com. Retrieved 11 August 2017, from <http://pmblog.accompa.com/2009/09/19/use-cases-definition-requirements-management-basics/>

Sorger J., et.al. (2015), *A Taxonomy of Integration Techniques for Spatial and Non-Spatial Visualizations*: Institut für Computergraphik und Algorithmen - Arbeitsgruppe für Computergraphik. (2017). Cg.tuwien.ac.at. Retrieved 21 August 2017, from <https://www.cg.tuwien.ac.at/research/publications/2015/sorger-2015-taxintec>

Tory M. and Moller T. (2002) *A Model Based Visualization Taxonomy*, <http://citeseer.nj.nec.com/564142.html>
Valiati, E. R., Pimenta, M. S., & Freitas, C. M. (2006, May). A taxonomy of tasks for guiding the evaluation of multidimensional visualizations. In Proceedings of the 2006 AVI workshop on Beyond time and errors: novel evaluation methods for information visualization (pp. 1-6). ACM.

Wang, X., & Dunston, P. S. (2011). *A user-centered taxonomy for specifying mixed reality systems for aec industry*. Journal of Information Technology in Construction (ITcon), 16(29), 493-508.

Wehrend S: Appendix B: *Taxonomy of visualization goals*. In *Visual cues: Practical data visualization* (1993), Keller P.R., Keller M. M., (Eds.) IEEE Computer Society Press 1,3

Zhou M. X., Feiner S.K.: *Visual task characterization for automated visual discourse synthesis*. SIGCHI conference on Human Factors in computing systems 23, 18 (1998), 392-399. 1